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The Motor Oil Bible Contents

INTRODUCTION TO THE MOTOR OIL BIBLE

What Will You Find in The Motor Oil Bible?

Thank you for purchasing your copy of "The Motor Oil Bible". Before you get into reading the book, I'd like to take a moment to clarify something. This printed version is basically an exact duplicate of the electronic version minus background colors, navigational links, etc. I figured that would be a waste of space and ink. However, I want to make it clear that there may be a few sections where I make reference to links or other portions of the book that have no real relevance in this printed version. These are few, but don't let them confuse you. Just remember, you're printing the same content that's in the electronic version, and sometimes certain references to the ebook structure or its use don't make sense in the context of a printed book.

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"INTRODUCTION TO THE MOTOR OIL BIBLE"

You'll notice there are four sections to this eBook, each containing a number of chapters. The first section, "Introduction to the Motor Oil Bible", is what you are reading now. It is simply an introduction to the eBook, telling you what's free and what's not, but since you have already purchased the full version, that little portion won't mean much to you. The "Introduction" section has information on becoming an affiliate and info regarding the use of this ebook to promote your website and/or business.

"THE MOTOR OIL BIBLE"

The second section titled "The Motor Oil Bible" is the meat of the book. A few of these chapters are unlocked in the free version to give you a taste of the quality information that is contained in this book. In all, over 25 pages of FREE information about oil. However, much of the book is locked. After all, I put a great deal of time into researching, writing and compiling the information in this book. Besides, I've got a wife and four kids to feed.

So, in order to read the majority of the chapters in this section of the book, you'll need to purchase the unlocking password. There are over 120 more pages of excellent information within this section of the eBook for anyone who really wants to know about oil.

Some of the information can be found on the net and/or in lubrication books and technical journals at the library for free. You're welcome to spend some time searching for it and sifting through it all. I don't want to make it sound like I've cornered the market on oil and filter information. I haven't. There is plenty of information out there if you're willing to spend the time and effort searching for it.

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So, we've recently compiled our printer ready version which cuts through the "red tape". All unnecessary background colors and ink wasting graphics (not content graphics) have been removed and the rest has been put into one easy to print file. Just a few mouse clicks and you've got the entire "Motor Oil Bible" on paper to take with you anywhere you go. Just a little bonus for paying customers.

"SPECIAL BONUS CONTENT"

The fourth section entitled "Special Bonus Content" is just what it says. If you purchase "The Motor Oil Bible" these are the little extras that we throw in as a special thanks.

WHAT SHOULD YOU DO NOW?

I'm certain that you'll find even the free content within this ebook to be very worth your time. I highly recommend that you read every chapter of the FREE eBook and pay close attention to the information contained within. You might learn a thing or two.

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In fact, I "double" guarantee it. If you aren't completely satisfied with your purchase of "The Motor Oil Bible", I'll refund your purchase price **TIMES TWO!!**

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"The Motor Oil Bible" is a 158 page eBook which provides **useful**, yet easy to read information about automotive lubrication and filtration. It is designed to help auto owners choose the best engine oil and filtration systems for their vehicle and particular driving and auto purchasing habits.

Within "The Motor Oil Bible" are a number of FREE chapters containing a great deal of information which discusses:

- What the functions of a motor oil really are
- Environmental issues associated with changing oil
- Whether or not to use oil additives, and why
- How to choose the right viscosity for your vehicle
- Whether or not to use the new 5w20 weight oils
- When is the right time to switch to synthetics and when isn't
- GM's oil life monitoring system
- Synthetic oils and leaky seals
- Effect of extended drains on new car warranties
- What do API ratings mean & how to choose the right one
- When is an oil "too dirty" to be of use anymore
- Effects of over filling your oil crankcase
- Engine flush products - their worth and their use
- How to make sure ALL of your tranny fluid gets changed
- Rotary engines and synthetic oil dilemma

If a person decides they want to know more, they can purchase the full version of "The Motor Oil Bible". Affiliates for "The Motor Oil Bible" can make a commission on these upgrade sales if they were the one who referred the new customer to me.

MAKE MONEY GIVING AWAY A FREEBIE

Why not increase your revenue or gain a small side income by giving away the useful information contained in "The Motor Oil Bible"? Even the free chapters, although not nearly as complete as the complete "Motor Oil Bible", contains some very useful and interesting information.

Put a link to it in your forum signature. Give it away as a special bonus to customers who sign up for your newsletter or place an order or maybe take a survey. It costs you nothing but gives your customer something of great value which they will appreciate. In addition, if they end up purchasing the password to unlock the entire eBook, you make a commission on the sale.

EXCELLENT INFORMATION AT A GREAT PRICE

"The Motor Oil Bible" is the most comprehensive eBook of its kind. In fact, if you haven't purchased the full version yet, you can get an idea of all of the subject matter covered by taking a look at the chapter headings in the right-hand column. Of course, these are only very broad subject headings. Each

chapter will contain much more detailed information than the chapter heading can possibly convey.

Other, similar books regarding lubrication cost from $50 to $200 and are written for a highly trained lubrication engineer in most cases. Very few, if any, of them are written for John Smith regular car owner or backyard mechanic. That's how "The Motor Oil Bible" is different.

This eBook currently (as of December 5th, 2001) retails for under $10 (electronic version), yet, it contains well over 150 printed pages of automotive lubrication information that is written so that anyone can understand it. No super technical jargon to sort through. Just down to earth information about motor oil to help a regular Joe make an educated decision about automotive lubrication.

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A LITTLE FINE PRINT

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Promote Your Website and/or Company

As a webmaster/business owner I am constantly looking for new ways to increase my website traffic AND convert more of those website visitors into customers. I am certain that you also have these goals in mind for your own business. However, it's difficult to do both of these effectively.

Gaining website visitors is a full time job in and of itself. But, if you devote all of your time to website promotion, you lose sight of the other important aspects of your business such as converting more of those visitors into loyal customers. Visitors are great, but if they never buy anything, they're useless.

So, there are three important concepts that all business owners must understand if they are going to market their product or service on the web.

NUMBER ONE: It is far easier and far cheaper to get website visitors to return to your website than to gain new website visitors.

This is absolutely true. If you're using the right methods, getting return visits to your site should be quite easy and very inexpensive. For instance, if you get your website visitors to subscribe to a monthly newsletter, you have the opportunity of following up with them every month at little or no cost to you - and they requested it! Don't underestimate the power of this follow-up tool.

In addition, if you write just one useful and informative article in each of your newsletters, your subscribers will see you as an expert in your field which will lend credibility to your website information and your product or service offering.

NUMBER TWO: The more times you can get a visitor to return to your website, the more likely you are to make a sale.

This is a time proven concept that every ad agency knows very well. Most visitors to your website will not pay much attention to your company or offer until they've been exposed to it at least 5 to 7 times. Of course, the importance of this should be obvious. If you get someone to visit your website but don't have the opportunity to follow up with them, you'll most likely never get them to purchase anything. However, if you can follow up with them every month through your newsletter, you have a much better chance of eventually making a sale.

NUMBER THREE: The more value you add to your offer, the more likely a website visitor is to take advantage of it.

Think about this for a minute. Whenever you purchase anything, you purchase it because of the benefits you get from it, right? So, if you can provide more benefit to your customer, he/she will be far more likely to take you up on your offer. As a result, it is VERY important that you always focus on the benefits of using your product. What will your customer get out of it?

In addition, the chances of achieving the desired result from your offer will increase exponentially with each free bonus you can add to the offer. But, you have to be careful not to give away bonuses that will cost you an arm and a leg. That will simply eat into your profits. It is far better to offer free bonuses that a potential customer will perceive as having value when the cost to you is actually very little.

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Of course, if you have any questions about getting this all set up, feel free to send me an e-mail or give me a call. My most recent contact information can always be found in the electronic version of The Motor Oil Bible.

THE MOTOR OIL BIBLE

Everything you ever wanted to know about motor oil but didn't know to ask

Let's Really Talk About Oil

Well, if you are reading this introduction to "The Motor Oil Bible", it is obvious that you are someone who wants to know everything you can about properly maintaining your vehicle. Rest assured you're reading the right book. There is NOTHING more important to the life of your vehicle than proper lubrication and filtration of its engine and other moving parts.

Obviously, the more you know about these two issues, the better equipped you'll be to "do it right". When you finish reading "The Motor Oil Bible", you'll know everything necessary to choose the proper oil and filtration system for your vehicle in order to virtually eliminate engine component wear.

Throughout the course of the following chapters I will try to explain, in non-technical language, exactly how motor oil is made, what it does, how it does it, how it is tested, how it shouldn't be tested and how to compare one oil to another. I'll discuss many of the misconceptions regarding motor oil and specifically synthetic oil.

In addition, I'll provide information that should help you in finding the right oil and air filtration systems for your vehicle based upon their relative cost effectiveness related to your particular application. By the time you're done reading this eBook, you'll know everything I know about automotive lubrication and filtration. And, as GI Joe used to say, "Knowing is half the battle".

But, I should point out that only portions of this book are available for free. If you've already purchased the full version, it should say "Full Version" in large red letters to the left of the "scrolling banner" at the top of every page of this book. If the book says "Free Version" instead, then you either haven't purchased the full version, or you have not yet entered your password.

If your version is the free version, you have the opportunity to preview a few chapters from the book, to see if you think you'd be interested in reading more. Those chapters that are available in the free version are denoted by a red "*" after the chapter title. Feel free to browse through these chapters and pick up a little information about oil.

Should you decide after reading the free chapters that you'd like to unlock all of the chapters, all you need to do is click on any chapter that isn't already unlocked. Full purchasing instructions will be provided.

What Does Motor Oil Do?

As automobiles are redesigned to create more powerful yet efficient engines, lubricants have to be redesigned to meet the increased demands placed on them. Higher engine temperatures and decreased oil sump capacities mean that motor oils have to work much harder in today's engines than they used to.

But what is it really that an oil does? Of course, we know that oil is necessary, and we all probably have the general idea that oil makes things slippery so that metal parts can more easily pass by one another. But, is there more to it than that?

YES. Much more.

FUNCTIONS OF A MOTOR OIL

In order for your engine to function properly and with adequate power, a lubricating motor oil must perform four main functions:

IT MUST LUBRICATE

Motor oil must lubricate engine components so that they will easily pass by one another without a significant loss of power due to friction. Of course, at start-up, this is especially true. As an engine sits, oil tends to run down into the oil pan. Therefore, when the engine is started, the oil must be quickly pumped throughout the engine to provide sufficient cranking speed for the engine to turn over.

Once the engine is running, motor oil must create a film between moving parts to make them "slippery" which increases power, performance and efficiency. Each different type of engine requires a certain viscosity range in order that the oil will provide an adequate film between moving parts while still flowing quickly and easily enough throughout the engine.

Some people believe that if a 30 weight oil provides good protection, a 50 weight must provide great protection. That's not necessarily true. If your vehicle was not designed to take a 50 weight oil, using one may not cause more engine wear, but it will likely cause an increase in engine temperatures. This can be just as bad for the longevity of your engine as increased engine wear.

IT MUST PROTECT

The film that a motor oil provides between metal surfaces does more than just lubricate. By keeping engine components from coming in contact with each other, a motor oil also provides protection against wear. That probably seems pretty obvious. However, there is another way in which an oil protects.

Motor oil must protect against corrosion of engine components. Oxidation of the oil and contamination via condensation and combustion by-products all cause acids within an engine oil. If these acids are allowed to come into contact with engine components, corrosion occurs and premature component failure is the result. Engine oils are designed to combat these acids.

IT MUST CLEAN

If an engine does not remain clean, it does not remain efficient. Deposits within an engine gum up the works and reduce fuel efficiency while robbing your engine of performance. In addition, contaminants within an oil that are left "unguarded" can cause incalculable wear within an engine.

Any particle larger than 5 to 20 microns in size (depending upon the vehicle) will seriously damage an engine if not removed or contained. To give you an idea of how small this is, a human hair is 100 microns thick. Although filtration plays a big role in this area, the oil also has to play it's part by keeping deposits from forming within the engine and by holding contaminants in suspension until they can be removed by the oil filter.

IT MUST COOL

Motor oil is responsible for a large percentage of the cooling that takes place within your engine. Your radiator (anti-freeze system) is only responsible for cooling the upper portion of your engine. The rest (crankshaft, camshaft, timing gears, pistons, main and connecting rod bearings and many other critical engine components are cooled mainly by the motor oil within your engine.

Heat is generated within an engine from both the combustion process and the friction caused by the motion of engine components. As oil passes through the system it is directed onto these hot surfaces in order to carry the heat away to the oil pan. From here the heat is dissipated to the air surrounding the pan.

It is with this overall motor oil "job description" in mind that we move on to the next chapter of "The Motor Oil Bible": What goes into an oil?

What Goes Into an Oil?

If you're going to study oil, it makes sense to start at the beginning. How is an oil made? What components are used to create it? What is the difference between the manufacturing of a standard petroleum oil and a premium synthetic oil? It is these questions which you will find answers to within this chapter of "The Motor Oil Bible".

THE MAIN COMPONENTS

There are two main components that any motor oil is made of. There is a base fluid (sometimes called a basestock) and the additive package. The base fluid typically makes up the bulk of the oil. Additive chemicals are then added to enhance the positive qualities of the basestock and to overcome whatever negative qualities there may be.

BASE FLUIDS (BASESTOCKS)

There are two main types of basestocks, petroleum and synthetic. Petroleum basestocks are a purified form of crude oil and have been used as the base for automotive lubricants since motor oils were first being developed.

Synthetic basestocks, on the other hand, are chemically engineered in a lab specifically for the purpose of lubrication. They are engineered from pure compounds that contain no contaminants which must be removed via purification. Synthetic basestocks have been around since the early 1900's but were not widely used in automotive type applications until the 70's.

PETROLEUM BASESTOCKS

As indicated above, petroleum basestocks are refined from crude oil that has been recovered from natural underground "storage areas". Once the oil is recovered, it must be run through a series of purification steps to improve the following desirable lubrication qualities:

1. **Viscosity Index**

   A measure of an oil's ability to maintain it's viscosity over a wide temperature range. The higher the number, the less change in viscosity with a change in temperature. Better oils will generally have higher viscosity indexes.

2. **Low Temperature Performance**

   The better an oil will flow at low temperatures, the better its low temperature performance. Better low temperature performance provides more immediate engine protection at start-up in cold weather climates.

3. **High Temperature Performance**

   How well does an oil hold up under extremely hot conditions. Will it burn off easily? Will it allow metal to metal contact under hot conditions as a result of viscosity loss? Obviously, better oils will hold up more effectively under extreme heat.

4. **Oxidation Resistance**

Oxidation occurs when oxygen reacts with the components of an oil to form sludge and other engine deposits. Oxidation leads to increased oil viscosity making the engine work harder to pump the oil through its system. An oil should be able to resist oxidation.

The Refining Process

In order to enhance the above qualities for the final lubricant base oil, crude oil is passed through a series of purification steps. The series of steps will be something closely resembling the following:

1. **Desalting**

   Removal of salt contaminants from the crude oil to make the rest of the refining process easier.

2. **Partial Vaporization**

   The crude oil is heated within a vaporization chamber which collects portions of the crude that have differing boiling points. Lubricating basestocks are the components with the highest boiling point with the exception of asphaltic materials.

3. **Vacuum Distillation**

   Process by which lubricating basestocks are separated into fractions of differing molecular weights, and, therefore, differing viscosity ranges.

4. **Solvent Extraction**

   Solvents are added to each fraction obtained from the distillation process and the mixture is allowed to settle into a phase containing aromatic compounds and a phase containing non-aromatic compounds. The aromatic compounds are extracted from the basestock before the next step in the refining process.

   Up to 80% off the aromatic contaminants are removed through this method. This greatly improves thermal and oxidative stability and raises the viscosity index of the stock considerably.

5. **Dewaxing**

   Wax is removed to improve low temperature fluidity. In cold temperatures wax contaminants will crystalize making the lubricant thick and difficult to pump.

   Methyl ethyl ketone (MEK) is added to the lubricant basestock and the oil is cooled to just below the intended pour point of the basestock. All wax crystals that form are removed via filtration. NOTE: The pour point of an oil is often referred to in its technical specifications and basically refers to the lowest temperature at which an oil will still pour (it's actually slightly more complicated than that, but pour points will be discussed in another chapter).

6. **Hydrofinishing or Clay Treatment**

   This is an optional component of the refining process reserved for more premium petroleum basestocks. Hydrofinishing uses a catalyst bed through which hydrogen and heated oil are passed. As these components pass through the bed, unstable components such as sulfur and nitrogen are removed. Clay treatment uses a different method to achieve a similar outcome.

Both of these refining processes improve oxidation stability, thermal stability and color of the lubricant basestock.

7. Hydrotreating

In some cases a more severe method is used in addition to regular hydrofinishing. Hydrotreating involves putting the lubricant basestock through extremely high temperature and pressure extremes in the presence of a catalyst.

This will convert any remaining aromatic hydrocarbon contaminants into usable nonaromatic hydrocarbon molecules. The resulting hydrocarbon molecules are much more stable, and the resulting basestock is very pure with very few contaminants.

This process can be used in place of solvent extraction of aromatics and/or in addition to solvent extraction. It is much more effective, achieving about 99% removal of aromatic contaminants as opposed to only about 80% for solvent extraction. Only super-premium petroleum basestocks will be manufactured using this method.

A Note of Importance - Crude oil comes from many sources and has a wide range of quality levels and contamination levels. The refining process above can only do so much. As a result, petroleum basestocks will have a wide range of quality levels.

To minimize these quality differences lubricant companies must exercise tremendous care in selecting crude oil stocks. In addition, the refining process must be done under the strictest of quality control measures.

As a result, those companies that exercise this care will charge more for their oil - they simply have to. So, if you are going to use a petroleum lubricant, keep in mind that you generally get what you pay for. Although you're paying somewhat for the brand name, in most cases there is a reason that brand name oils are priced higher - they're of higher quality.

Just because you see the API starburst on the bottle doesn't mean it's a "quality" oil - it only means that the oil in that container meets the absolute minimum specifications in order to adequately protect your engine. Just be careful what you use to protect your "baby".

PSEUDO-SYNTHETIC BASESTOCKS

There are some petroleum lubricants available on the market that are so pure and refined, they can now be passed off as synthetics. They are not made from true synthetic basestocks (at least not in the way that synthetics have traditionally been defined), but they have so little in common with traditional petroleum basestocks, it is really somewhat silly to classify them as merely petroleum lubricants.

Petroleum lubricant basestocks can be put through a super-extreme refining process called hydrocracking. In some cases, as in the case of one particular name-brand "synthetic" oil, these highly refined petroleum basestocks can actually be termed and sold as "synthetic". It is completely legal for lubricants manufacturers to label these oils as "synthetic".

These are extremely high performance petroleum basestocks, but they are not truly synthetic the way that most people understand the term and will not necessarily perform to the same level as a premium synthetic oil.

Hydrocracking involves changing the actual structure of many of the lubricant basestock molecules by breaking and fragmenting different molecular structures into far more stable ones. This results in a

basestock which has far better thermal and oxidative stability as well as a better ability to maintain proper viscosity through a wide temperature range - when compared to a typical petroleum basestock.

Although contaminants are still present, and these are still petroleum basestocks, contamination is minimal and performance characteristics are high. This process also can turn a wider range of crude oil stock into well-performing petroleum lubricant basestocks.

SYNTHETIC BASESTOCKS

Synthetic lubricant basestocks have very little in common with their petroleum "cousins". They are used for a similar purpose. But, while one is designed specifically for the purpose of lubrication, the other has been simply transformed into something that will adequately do the job.

In fact, the relationship between these two basestock types would be similar to the relationship between a big rock and a hammer. Both can be used to drive nails, but one will be far more effective than the other. A hammer which is designed for driving nails will do so much more efficiently than will a rock.

In addition, the hammer will be able to drive nail after nail without any significant loss in its integrity. The quality of the hammer will degrade very little over time. However, the rock will easily be chipped and cracked when used to pound nails. In fact, you would probably find that after only a few dozen nails, you would need to go find a new rock to pound nails with.

You see, the rock was not designed to pound nails. Of course, you could fashion it into something that looked like a hammer if you like, but it's still a rock. It will work in a pinch, but it is not the right tool for the job.

But, along comes "Nail Drivers Inc." with a novel idea. They decide to first determine what the qualities of a good "nail driver" would be. Then they fashion a tool that is specifically designed to have these qualities.

Doesn't it make sense that the new tool will accomplish the job far better than the old rock? The same is true of a synthetic oil when compared to a petroleum oil.

Designed to be Better

In the case of synthetic basestocks the first step is the most important. The lubricant manufacturer first decides what the final lubricant is going to be used for. Once that is determined, research is done to determine what lubricant characteristics will be best suited to that particular application. Only then is manufacture of the actual lubricant basestock begun.

On the surface, the manufacture of synthetic basestocks may seem far more simplistic than the manufacture of a petroleum oil. In the case of synthetics, materials of low molecular weight are chemically reacted with each other to produce materials of higher molecular weight with very specific lubricating properties.

There is no need to separate the basestock into fractions of differing molecular weight because the intended molecular weight is formed at the start. There is no need to extract contaminants or transform them into something useful because there are no contaminants to begin with. As a result, there is little for me to explain when it comes to synthetic basestock manufacturing.

Nevertheless, it is important to understand that the particular materials used for chemical reaction and the methods used for those reactions will result in synthetic basestocks of varying quality. Experience is essential to proper manufacture of a quality synthetic basestock.

Synthetic basestocks manufactured in this way will have the following basic benefits over their petroleum basestock counterparts: improved low and high temperature performance, improved oxidative and thermal stability, enhanced frictional characteristics and longer lubricant life.

Types of Synthetic Basestocks

Synthetic basestocks are not all the same. There are few different chemical types that may be used as synthetic basestock fluids. There are only three that are seen commonly in automotive applications:

1. **Polyalphaolefins (PAO's)**

   These are the most common synthetic basestocks used in the US and in Europe. In fact, many synthetics on the market use PAO basestocks exclusively. PAO's are also called synthesized hydrocarbons and contain absolutely no wax, metals, sulfur or phosphorous. Viscosity indexes for nearly all PAO's are around 150, and they have extremely low pour points (normally below -40 degrees F).

   Although PAO's are also very thermally stable, there are a couple of drawbacks to using PAO basestocks. One drawback to using PAO's is that they are not as oxidatively stable as other synthetics. But, when properly additized, oxidative stability can be achieved.

   PAO's also tend to shrink seals which was discovered in the early 70's when a major oil manufacturer had seal troubles with their first synthetic formulation.

2. **Diesters**

   Less commonly used, these synthetic basestocks offer many of the same benefits of PAO's but are more varied in structure. Therefore, their performance characteristics vary more than PAO's do. Nevertheless, if chosen carefully, diesters generally provide better pour points than PAO's (about -60 to -80 degrees F) and are a little more oxidatively stable when properly additized.

   Diesters also have very good inherent solvency characteristics which means that not only do they burn cleanly, they also clean out deposits left behind by other lubricants - even without the aid of detergency additives.

   As with PAO's, diesters can affect seals. However, they generally cause seal swell as opposed to seal shrinkage. Chemically resistant seals are recommended if using synthetic base oils manufactured with diesters.

3. **Polyolesters**

   Similar to diesters, but slightly more complex. Greater range of pour points and viscosity indexes than diesters, but some polyolester basestocks will outperform diesters with pour points as low as -90 degrees F and viscosity indexes as high as 160 (without VI additive improvers).

   The same seal swell characteristics exist with polyolesters as with diesters.

Other synthetic basestocks exist but are not nearly as widely used as those above - especially in automotive type applications. Most synthetics on the market will use a single PAO basestock combined with an adequate additive package to provide a medium quality synthetic lubricant. However, PAO basestocks are not all the same. Their final lubricating characteristics depend on the chemical reactions used to create them.

Premium quality synthetics will blend more than one "species" of PAO and/or will blend these PAO basestocks with a certain amount of diester or polyolester in order to create a basestock which combines all of the relative benefits of these different basestocks.

This requires a great deal of experience and expertise. As a result, such basestock blending is rare within the synthetic lubricants industry and only done by very experienced companies. In addition, although such blending creates extremely high quality synthetic oils, they don't come cheap. Many of these oils will cost in excess of $6 to $9 per quart whereas lesser quality synthetics may only cost $3 to $4 per quart. As I've said before, you get what you pay for.

CHEMICAL ADDITIVES

Although the basestock of an oil will be a major determining factor in the lubrication quality of an oil, chemical additives play a major part in making sure that it does all that it is supposed to do. In fact, the chemical additive package of an oil is just as important to insuring the quality of a lubricant as is the particular basestock used.

The chemical additive package of an oil is designed to perform a number of tasks and each task is performed by a particular type of chemical. The quality of the chemicals used and the manner in which they are blended plays a large part in determining how well the additive package does its job.

As you can well imagine, as the quality of the additive chemicals increases, so does the price. In addition, proper blending takes a great deal of research. This requires much time and, again, money. Therefore, manufacturers will, of course, charge more for motor oils which contain a high quality additive package than those with lower quality additive packages. They simply can't afford not to.

As mentioned above, each chemical within an oils additive package plays a different role in boosting the beneficial properties of it's host lubricant (basestock). Each of those roles is described below along with a brief description of the types of chemicals that are used to accomplish those roles.

IMPROVE VISCOSITY CHARACTERISTICS

Basestock lubricants have a certain temperature range over which they will flow adequately. The wider this temperature range the better. Cold temperature starting requires an oil that will flow well at low temperatures. The higher engine temperatures of todays smaller, higher revving engines requires an oil that will perform well under high temperature conditions.

Pour Point Depressants

In order to improve the flow characteristics of a lubricant basestock at low temperatures additives called pour point depressants are used. Because synthetic basestocks have inherently better low temperature flow characteristics, pour point depressants are typically unnecessary. Therefore, they are normally only used in conjunction with petroleum basestock lubricants.

Waxy contaminants within petroleum basestocks tend to crystalize in low temperature conditions. These crystalized structures absorb oil and increase in size. This leads to oil thickening and poor low temperature flow characteristics. Pour point depressants do not inhibit this crystallization, as is thought by many.

Instead, the pour point depressants are absorbed into the crystals instead of the oil, thereby lowering the volume of the crystals in proportion to the volume of the free flowing oil. This helps maintain the low temperature flow characteristics of the base oil even when crystallization occurs.

Higher quality petroleum basestocks have less need for pour point depressants because they have lower levels of wax contamination. However, complete dewaxing of a petroleum basestock is not very economical, so all petroleum basestocks require at least some level of pour point depressant. The only exception **might** be hydrocracked petroleum basestocks.

Viscosity Index Improvers

As a lubricant basestock is subjected to increasing temperatures it tends to lose its viscosity. In other words, it thins out. This leads to decreased engine protection and a higher likelihood of metal to metal contact. Therefore, if this viscosity loss can be minimized, the probability of unnecessary engine wear will be reduced. This is where viscosity index (VI) improvers (sometimes called viscosity modifiers) come in.

VI improvers are polymers that expand and contract with changes in temperature. At low temperatures they are very compact and affect the viscosity of a lubricant very little. But, at high temperatures these polymers "explode" into much larger long-chain polymers which significantly increase the viscosity of their host lubricant. So, as the basestock loses viscosity with increases in temperature, VI improvers negate that viscosity drop by increasing their size.

The higher the molecular weight of the polymers used, the better the power of "thickening" within the lubricant. Unfortunately, an increase in molecular weight also leads to an inherent instability of the polymers themselves. They become much more prone to shearing within an engine. As these polymers are sheared back to lower molecular weight molecules, their effectiveness as a VI improver decreases.

Unfortunately, because petroleum basestocks are so prone to viscosity loss at high temperatures, high molecular weight polymers **must** be used. Since these polymers are more prone to shearing than lower molecular weight polymers, petroleum oils tend to shear back very quickly. In other words, they lose their ability to maintain their viscosity at high temperatures.

Synthetic basestocks, on the other hand, are much less prone to viscosity loss at high temperatures. Therefore, lower molecular weight polymers may be used as VI improvers. These polymers are less prone to shearing, so they are effective for a much longer period of time than the VI improvers used in petroleum oils. In other words, synthetic oils do not quickly lose their ability to maintain viscosity at high temperatures as petroleum oils do.

In fact, some synthetic basestocks are so stable at high temperatures they need NO VI improvers at all. Obviously, these basestocks will maintain their high temperature viscosities for a very long time since there are no VI improvers to break down.

MAINTAIN LUBRICANT STABILITY

Lubricating oils are not only prone to viscosity loss over time. They are also susceptible to breakdown due to contamination and/or oxidation which decreases the useful life of an oil. Additives are often used in order to inhibit the susceptibility of a basestock to this breakdown over time.

Detergents and Dispersants

Contamination due to sludge and varnish build-up within an oil can often be one of the limiting factors in determining the useful life of an oil. If this build-up can be minimized and contained, the life of the lubricating fluid can be increased. Detergent and dispersant additives are utilized for this purpose. There is some debate as to whether those additives considered to be detergents actually "clean" existing deposits, but at the very least they aid dispersants in keeping new deposits from forming.

Detergent and dispersant additives are attracted to sludge and varnish contaminants within a lubricant. They then contain and suspend those particles so that they do not come together to form deposits. The more contamination within the oil, the more additive that is used up. Since synthetic oils are less prone to leave sludge and varnish, these additives are used up much more slowly within a synthetic lubricant.

Some oils use ashless dispersants which are more effective at controlling sludge and varnish contamination than metallic dispersants. In addition, some ashless dispersants are actually long chain polymers that serve a dual purpose as VI improvers in multi-grade oils. Detergents are all metallic in nature.

Anti-Foaming Agents

Although necessary for engine cleanliness, detergents and dispersants can have a negative effect on the lubricating fluid within your engine as well. Sometimes, these oil additives can play a part in oil foaming. In other words, air bubbles are produced within the oil. These air bubbles, if not neutralized, will reduce the lubricating qualities of the motor oil. Anti-foaming agents such as small amounts of silicone or other compounds are used to control this phenomenon.

Oxidation Inhibitors

As you probably can guess, oxidation inhibitors are additives that manage to reduce the tendency of an oil to oxidize (chemically react with oxygen). They are also called antioxidants. There are two types:

1. One type of antioxidant destroys free radicals. In fact, you may have heard of antioxidants which can be found in vitamin supplements. In human beings, free radicals can cause cell damage and even cancer. Antioxidants neutralize these free radicals in the body to reduce the chance of them causing any damage. In motor oil they serve a similar function by destroying free radicals that aid in the process of oxidation.

2. The other type of antioxidant reacts with the peroxides in the oil. These peroxides are involved in the process of oxidation. Reaction with the antioxidant removes them from the oxidation process, thereby lessening the chance of motor oil oxidation.

Oxidation inhibitors also serve one more very important purpose. They protect against bearing corrosion. You see, bearing corrosion is caused by acids within your motor oil. These acids come from combustion by-products, but they can also be the result of oxidation. So, by inhibiting motor oil oxidation, antioxidants also protect against bearing corrosion.

Corrosion Inhibitors

Although antioxidants prevent the acids caused by oxidation, they do nothing to neutralize the acids caused by combustion by-products. Therefore, other additives must be used in order to keep these acids in check and to protect engine components from their effects.

Some corrosion inhibitors are designed to protect non-ferrous metals by coating them so they cannot come in contact with acids within the oil. Other corrosion inhibitors are designed to actually neutralize the acids within the oil. The acid neutralizing capability of an oil is expressed by its Total Base Number (TBN).

Since diesel engines tend to have more acid build up within the oil, these oils generally have TBN between 9 and 14. Gasoline oil TBN levels are normally lower at 5 to 8. Generally, higher quality oils and/or those that are designed for longer drain intervals will have higher TBN numbers.

Synthetics will almost always fall at the high end of the scale for both gas and diesel oils, while petroleum oils will typically fall at the low end of the scale because they are changed frequently anyway. There is normally no need for petroleum oils to have high TBN values.

Anti-Wear Agents

Even with the best of oils there is always the possibility of metal to metal contact within an engine, however slight. Some oils (especially premium synthetics) will cling to metal surfaces better than others, but engines that are left to sit for any period of time may have very little lubricant protection at start-up. This is especially true in cold conditions when petroleum oils do not pump well. To minimize the engine component wear caused by these situations, anti-wear additives are used.

Additives such as zinc and phosphorus will actually coat metal surfaces forming a protective barrier against wear. They do not eliminate the metal to metal contact. They simply minimize the wear that occurs during those instances. Typically, zinc and phosphorus come as a package called ZDDP (zinc dialkyl dithiophosphate). They work together.

ALLEVIATE COMPATIBILITY ISSUES

Some additives are included in an oil to deal with compatibility issues between the oil and certain engine components. For instance, as was mentioned when discussing basestocks, there are certain types of lubricant basestock that will cause seals and gaskets to swell or to shrink. These effects have to be minimized. Sometimes basestock blending will alleviate the issue, but in other cases additives might be used.

Moreover, depending upon the particular application the oil will be used for, some additives may be left out while others may be left in. For instance, in order to meet API SJ fuel economy requirements, oils are now formulated with special friction modifiers. However, these friction modifiers *might* cause clutch slippage if used within motorcycle oils. So, motorcycle specific oils do not contain these friction modifier additives.

SEEING THE BIG PICTURE

When considered as a whole, lubricant oils are comprised mainly of basestock fluids. Only a small percentage of the oil is comprised of additive chemicals. However, as is evident from the information presented above, additives can play as important a role as the basestock fluid itself.

A high quality basestock blended with a cheap additive package is still junk oil. A high quality additive package added to a cheap basestock is no better.

Of course, a motor oil as a whole is far greater than the sum of its parts. In other words, even a high quality basestock combined with a high quality additive package isn't necessarily going to yield a premium oil. The company manufacturing the oil has to know how to correctly blend those basestocks and additives so that they perform well together.

If you want your engine to last, don't be cheap - Your vehicle wasn't. Spend the extra to get a high quality oil. If you're going to stick with a petroleum oil, don't by "John Doe's No-Name Cheapo Oil". It might meet API specifications, but that doesn't mean much.

The same goes for a synthetic oil. If you're going to spend the bucks, why purchase synthetic oil from a manufacturer that's only been blending synthetics for a few years? Wouldn't you rather purchase a synthetic oil from a company that's been doing it for a while.

As an example, if you were waiting to have triple bypass surgery, who would you want operating on you - the first year eager-beaver medical resident or the guy who's been doing it for 15 years and gets a write-up in a different medical journal every week for his expertise in the field? Do I even have to ask?

There are companies out there that have been manufacturing synthetic lubricants for over 20 years. Don't you think they probably know a little more about it than some company that just started selling synthetic oil a few years back to increase their bottom line? If you want the better oil, generally you can purchase it from the company that's been doing it the longest. Of course, that's not always true, but it is generally a good rule of thumb.

Better yet, read the rest of "The Motor Oil Bible" so that you can intelligently compare different oils to find what's best for you. Take the time to understand how to properly lubricate your engine. In the end, I guarantee your vehicle and your pocketbook will thank you.

Motor Oil Viscosity

When speaking of the properties of a motor oil, viscosity is of tremendous importance. Unfortunately, it also an area that is very confusing. The viscosity of an oil refers to its relative resistance to flow at differing temperatures. As has been previously mentioned, an oil must not only be "thin" enough to flow well at low temperatures, it must also remain "thick" enough to maintain adequate protection at high temperatures.

Ideally, an oil will maintain a consistent viscosity over a wide temperature range. The viscosity index of an oil is a measure of its tendency to change viscosity with temperature changes. The higher the viscosity index (VI) the more consistent an oil's viscosity is with temperature changes.

MONOGRADE OILS

Monograde oils such as 30 weight oils are designed for consistent temperature applications. For instance, you will find that most older lawn tractors and mowers call for a straight 30 weight oil (SAE 30). This is because it is assumed that these will be operating mainly in warm temperature summer months.

So, if you take a look at their viscosity index, you'll notice that most monograde oils have a low VI number. This implies that as you cool the oil it will thicken quite a bit. However, this is ok, because the oil is designed to only be used under warm conditions. Cold temperature thickening will not be an issue.

According to SAE J300 standards, to be classified as a certain SAE viscosity, an oil is heated to 100 degrees C (212 degrees F). It's kinematic viscosity at this temperature is measured. If it falls within a certain range it is classified as a particular viscosity. For instance, an SAE 30 oil must have a kinematic viscosity at 100 degrees C of between 9.3 and 12.5 cSt (centistokes).

MULTI-VISCOSITY OILS

Multi-viscosity (multi-grade) oils such as 0w30, 5w30, 10w40 and so on are oils, which are designed for applications where temperature changes may be significant. For instance, multi-viscosity oils might be used in northern US climates where temperatures can be -20 degrees F in the winter and +95 degrees F in the summer.

However, that does not mean they cannot be used for applications where the temperature remains more consistent. The fact is, monograde oils are becoming much less common as multi-viscosity oils are being substituted in applications which traditionally called for a monograde oil.

Nevertheless, monograde oils are still used in many super high performance racing applications, construction equipment that is used in only summer months and industrial engines that are kept indoors at a constant temperature all year round.

WHAT DO THE NUMBERS MEAN?

Most people believe that a 5w30 oil is good for cold weather use because it is a "5 weight" oil in cold temperatures and a "30 weight" oil at high temperatures. On the surface this might seem to make a certain amount of sense. Naturally, a "5 weight" oil would flow better than a "30 weight" oil. This would make it ideal for cold temperature operation.

Nevertheless, this is a profound misunderstanding of what the labeling means. The two numbers really have little to do with each other. The final number based upon the kinematic viscosity at 100 degrees C,

as we discussed for monograde oils.

So, if a multi-grade oil, when heated to 100 degrees C, falls within a certain kinematic viscosity it is classified as a certain SAE grade (the last number - like the "30" in 5w30). In other words, the kinematic viscosity of a 5w30 multi-viscosity oil falls within the same range at 100 degrees C as a monograde SAE 30 weight oil does.

A multi-viscosity oil also has to meet a "High Temperature/High Shear" requirement, but I'll talk about that in a minute.

The first number (the "5" in 5w30) is only a relative number which basically indicates how easily it will allow an engine to "turn over" at low temperatures. It is NOT a viscosity reference. In other words, a 10w30 is NOT a 10 weight oil in cold temperatures and a 30 weight oil in warm temperatures.

In fact, since SAE viscosity classifications only apply to an oil at 100 degrees C, it doesn't even make sense to label it as a certain SAE viscosity at any temperature other than 100 degrees C.

Besides, if you thought about it for a second, it wouldn't make sense for a 10w30 oil to be a 10 weight oil in the cold and a 30 weight oil in warm temperatures. What liquid do you know of that gets "thicker" as its temperature increases or "thinner" as the temperature decreases?

I would venture to say you probably can't come up with one. This holds true for motor oil as well. If a 10w30 was a 30 weight oil at 100 degrees C and a 10 weight oil at cold temperatures, that would mean it "thinned out" as the temperature dropped. That just doesn't make any sense considering what we know about liquids. It just doesn't happen like that.

The fact is that a 5w30 motor oil is **thicker** in cold temperatures than in warm temperatures. However, a 5w30 motor oil will be thinner than a 10w30 motor oil when subjected to the same low temperature conditions - because the "W" number is lower. This is an indication of better cold weather performance. In other words, a 5w30 flows better in cold weather than a 10w30 motor oil will. Think of the "W" as a "winter" classification instead of a "weight" classification.

Results from the Cold Crank Simulator (CCS) and Mini-Rotary Viscometer (MRV) tests are used to determine the oil's "W" grade. The better the engine "startability" of the oil at low temperature, the lower the W classification. Each W grade must meet certain "startability" requirements at a specified temperature.

For instance, a 0W grade oil must have a maximum CCS centipoise (cP) value of 3250 @ -30 degrees C as well as a maximum MRV cP of 60,000 @ -40 degrees C. A 5W grade oil must have a maximum CCS cP value of 3500 @ -25 degree C and a maximum MRV cP of 60,000 @ -30 degrees C. The lower the cP value for both specifications, the better.

Notice that the 0W grade oil is tested at a lower temperature on both tests AND must still have a lower CCS cP value than a 5W oil which is tested at a higher temperature. As a result, a 0w30 will allow your vehicle to start easier on a cold morning than a 5w30 will. Likewise, a 5w30 oil will pump easier in cold temperatures than a 10w30 oil will.

Nevertheless, at 100 degrees C, they all fall within the same kinematic viscosity range. Therefore, they are all classified as SAE 30 weight oils at 100 degrees C. In other words, after your engine has warmed up, a 0w30 and 10w30 motor oil are basically the same thickness (within a certain SAE specified range).

Of course, although this is true when the oil comes out of the bottle, we'll see in the next section that,

with petroleum oils at least, the viscosity that comes out of the bottle may not necessarily be the viscosity that you find within your engine after a short period of driving.

THE PROBLEM WITH MULTI-VISCOSITY OILS

Multi-viscosity oils provide a great deal more flexibility to protect an engine over a wider temperature range than monograde oils do. Obviously, this should be considered a good thing. However, there is a drawback to multi-viscosity oils. When manufactured from a petroleum basestock, they tend to "shear" back very easily. In fact, this was already alluded to in the previous chapter.

You see, the waxy contaminants within petroleum basestocks crystalize in cold temperatures causing them to "thicken" and become hard to pump. So, in order to allow for good flow characteristics at low temperatures, in addition to using pour point depressant additives, petroleum oils must start with a very "thin" basestock.

For instance, let's look at a 5w30 motor oil. In order to flow well enough to meet the 5W classification, a petroleum oil would start with a very thin basestock (maybe one that would be classified as an SAE 20 weight oil if heated to 100 degrees C). Then, that basestock would be combined with pour point depressant additives.

Remember from the last chapter that these pour point depressants help the basestock maintain its low viscosity even at low temperatures. They counteract the crystallization of waxy contaminants in the oil. Thus, the oil maintains it's viscosity instead of thickening up as the temperature drops.

But, in order to meet the requirements to be classified as an SAE 30 oil, something must be done to assure that this oil won't thin out to it's 20 weight basestock viscosity at 100 degrees C. The oil must be "built up" using the long-chain, high-molecular-weight polymers (called Viscosity Index Improvers) discussed in the previous chapter.

These polymers expand as temperature increases counteracting the natural thinning action of heating an oil. So instead of thinning to a 20 weight classification, the oil only thins to a 30 weight classification.

NOTE: Remember, don't let the 5W fool you. It's not a viscosity classification. It's a classification to establish that an oil will flow adequately at cold temperatures to protect your engine. The oil is still THICKER at cold temperature than it is at hot temperatures. The oil **will** thin as the temperature increases. The only question is how much. VI improvers reduce this thinning action to acceptable levels so the oil can meet both the 5W requirements and the SAE 30 requirements.

Now, let me just say that, the more you think about this issue of viscosity, the more your brain is going to hurt. Just remember that petroleum basestock viscosities are prone to significant change as the basestock is heated and cooled. As it cools, it "thickens" and as it heats it "thins".

To counteract that, petroleum oil manufacturers start with a basestock "thinner" than the "30" in "5w30" (or thinner than the "40" if they're manufacturing a 10w40 oil, etc.) and add pour point depressants so the oil stays as thin as possible in cold weather. Then they add viscosity index improvers that expand with increases in heat so that the oil will not thin out too much to meet the 30 weight classification at 100 degrees C. This is how they meet the multi-grade specification.

Unfortunately, long chain polymers (VI improvers) are more unstable the longer they are. The nature of petroleum basestocks necessitates that they be "built-up" using very long chain polymers. Therefore, these long chain polymers break down fairly quickly. In turn, over a short period of time, a 5w30 petroleum oil may actually "shear back" to a 5w20 (or lower) as these polymers break down. Obviously, this can lead to a decrease in engine protection.

For this reason, to assure at least a minimum amount of protection, the SAE J300 describes another requirement that a multi-viscosity oil must meet in order to be given its multi-viscosity classification. It must maintain a certain cP level on the High Temperature/High Shear (HT/HS) test (ASTM D 4683).

This test must be performed in order to label an oil as a certain multi-grade classification because automobile manufacturers use the physical requirement standards listed in the SAE J300 in order to establish which viscosity grades should be used in which vehicles. If automotive and lubricant manufacturers are not working off the same play book, it's your engine that's at risk.

But, let's get back to the HT/HS test. If the oil shears back too much on this high temperature test, it cannot be sold as a multi-grade oil. In fact, the test results from this test are very helpful in indicating the quality of the oil. Since they're required for achieving a certain SAE viscosity grade classification, the manufacturing company has the data. Make sure you get it.

The higher the HT/HS number the better because this indicates less shearing. Petroleum oils tend to have low HT/HS numbers which barely meet the standards set by the SAE J300 specifications.

Also, because the petroleum oils are made with a light weight basestocks to begin with, they tend to burn off easily in high temperature conditions which causes deposit formation and oil consumption.

As a result of excessive oil burning and susceptibility to shearing (as well as other factors) petroleum oils must be changed frequently.

THE SOLUTION FOR MULTI-VISCOSITY OILS

The good news is, not all multi-viscosity oils shear back so easily. Synthetic oils contain basically no waxy contamination to cause crystallization and oil thickening at cold temperatures. In addition, synthetic basestocks do not thin out very much as temperatures increase.

So, pour point depressants are unnecessary AND higher viscosity basestock fluids can be used which will still meet the "W" requirements for pumpability. In other words, it might be possible to meet 5W requirements with a synthetic basestock that would be classified as a 25 or 30 weight oil at 100 degrees C. Hence, little or no VI improver additive would need to be used to meet the 30 weight classification while still meeting 5W requirements.

The result is that very little shearing occurs within synthetic oils because they are not "propped up" with viscosity index improvers (long chain polymers). There simply is no place to shear back to. In fact, this is easy to prove by just comparing synthetic and petroleum oils of the same grade. Synthetics will generally have significantly higher HT/HS numbers. Of course, the obvious result is that your oil remains "in grade" for a much longer period of time for better engine protection and longer oil life.

Motor Oil Technical Specifications

When comparing two ore more oils for possible use in your vehicle, the most important thing to do is to compare the technical specifications of the oils. This is the only way to objectively determine which oil has the best protection and performance characteristics.

WHAT DOES EACH SPECIFICATION MEAN?

There are about 16 useful specifications that you might see on the technical data sheet for any given oil. These include:

1. Kinematic Viscosity @ 100 degrees C
2. Kinematic Viscosity @ 40 degrees C
3. Viscosity Index (VI)
4. Cold Crank Simulator Apparent Viscosity
5. Mini-Rotary Viscometer
6. Borderline Pumping Temperature
7. Pour Point
8. Flash Point
9. Fire Point
10. NOACK Volatility
11. High Temperature/High Sheer Viscosity
12. Four Ball Wear Test
13. Total Base Number (TBN)
14. Phosphorus % or PPM
15. Zinc % or PPM
16. Sulfated Ash Content

Unfortunately, most manufacturers only provide about two-thirds of the above specs (if that), and they won't always be the same ones. Some manufacturers might even throw in a few impressive looking stats that mean basically nothing and cannot objectively be compared to other oils anyway. This makes comparisons difficult, but not impossible. Keep reading to find out which specifications will be most important in your search for the best motor oil.

SPECIFICATIONS YOU'LL MOST EASILY FIND

Of the 16 motor oil specifications listed above, there is a sub-list of about 11 that might be found on an oil manufacturer's tech spec sheets, although it's more likely to be more like 8 or 9 on any individual sheet.

In many cases, at least two to three of these 11 specs will be absent from a particular motor oil company's tech sheets. Moreover, it won't always be the same specs that are missing. One company might leave out the NOACK. Another company might leave out the TBN value.

Sometimes a specification is left out because the company doesn't want you to know what it is, not because it is unavailable. Sometimes you can call or email the company to get the specs, but it may take some persistence to actually get the numbers.

Of course, there are also times when the spec is left off simply because the company doesn't feel that most people would know what it is anyway, or the company doesn't feel that information is pertinent based on the application(s) the oil was designed for. In these cases, if you contact the company, they're happy to provide the information.

Each of the specifications is found using a standardized ASTM (American Society of Testing and Materials) testing method and is assigned a certain ASTM test number. When comparing results make sure that the ASTM number is provided and that the two oils were tested using the same version of the test (matching ASTM testing numbers).

The most commonly found specs are kinematic viscosity at 100 degrees and 40 degrees C, VI (viscosity index), cold crank simulator apparent viscosity, mini-rotary viscometer, pour point, borderline pumping temperature, flash point, fire point, TBN (total base number), and the high temperature/high shear.

Although I believe the NOACK and Four Ball are just as important (or even more important - and I WILL discuss these), I'm going to list and define first the 11 that are most easily obtained. These will at least give you a **fair** idea of the performance characteristics of an oil.

Kinematic Viscosity @ 40 degrees C (ASTM D-445)

Although this test is not used specifically for classification of the oil as a certain viscosity, it is used for establishing the Viscosity Index of the oil. However, this determination has already been made, and the VI is likely listed on the spec sheet. You can safely ignore this specification, even though it's on all tech sheets.

Kinematic Viscosity @ 100 degrees C (ASTM D-445)

This test is really only useful for establishing the viscosity classification of the oil and for determining it's Viscosity Index. Since that's already been done, you really don't need it for anything, even though every tech sheet will have it.

Viscosity Index (ASTM D-2270)

We've already discussed viscosity index a couple of times in previous chapters, but I'll briefly outline the term again here. An oil's VI rating refers to its ability to maintain a consistent viscosity over a wide temperature range. The higher the VI, the better this ability. I wouldn't purchase an multi-viscosity oil that has a viscosity index below 130 to 140. The VI of a good monograde oil should be at least above

100 in my opinion.

One thing to keep in mind regarding VI numbers is that they only refer to an oil's ability to maintain consistent viscosity when new. They tell you nothing about how quickly the oil will lose this ability to maintain its viscosity over time. The fact is, even if an oil has a VI of 180, it may only hold that VI rating for a couple thousand miles. You just don't know.

One rule of thumb, though. Petroleum oils are much more likely to have declining viscosity indexes than synthetic oils. This is because synthetics require a far lower percentage of VI improvers to boost their VI numbers. VI improvers can break down very quickly, as was stated in the previous chapter. Hence, the less VI improver needed, the less likely an oil's VI will be affected over time.

This value should be there. Most tech sheets list the viscosity index. However, if it is not, check and compare the kinematic viscosity at 40 degrees and the kinematic viscosity at 100 degrees to another oil of the same SAE viscosity grade. The oil with the smaller difference between the two is the one with the high VI.

Cold Crank Simulator (CCS) Apparent Viscosity (ASTM D-2602 or 5293)

The Cold Crank Simulator measures the "startability" of an oil by measuring the speed at which a shaft can turn within an oil that is cooled to a certain temperature. In order for an oil to be classified as a multi-grade (multi-viscosity) oil, it must achieve a certain "score" on the CCS test as described in the SAE J300 Physical Requirements for Engine Oils specification.

When reading CCS numbers be careful not to assume that the score is a measurement of the speed of rotation of the shaft. If it was, a higher number would be better. This is not the case. You want a low score on the CCS test. The lower the better. It is a viscosity measurement.

The colder the temperature of the oil during the test, the more that CCS number will go up. Any time you see a CCS score, it should be accompanied by the temperature at which the test was done, because testing will not always be done at the same temperature. However, oils of like viscosity grades should have been tested at the same temperature in order to be classified as a particular viscosity under J300 specifications.

NOTE: The ASTM D-2602 was apparently updated in 1993 to use a more automatic procedure and given a new number of D-5293. However, I don't see any evidence that indicates the values from a 2602 test cannot be compared with the D-5293. In fact, both tests are still currently run. One is just a little easier to perform than the other because it has been automated.

Also of importance: As of December of 1999 the physical requirements listed on the SAE J300 (a table listing the requirements for different viscosity grade classifications) have changed for the CCS test. The testing procedure has not changed, just the specs required to meet certain viscosity classifications.

The CCS testing temperature has dropped by 5 degrees C for each "W" classification. In addition, the cP max value has basically doubled.

This change was introduced by the SAE to reflect changes in current automobiles. Present day engines will turn over at lower temperatures with higher viscosity grade oils than engines of the past. As a result, since automakers use the J300 to determine which viscosity grades should be used in their vehicles, the specs needed to be updated to reflect new engine technology.

Compliance with the new J300 specifications was not mandatory until June of 2001. So, any oil that has

not been reformulated since then does not likely have an updated tech spec sheet to reflect the new testing limits.

This is important when comparing two oils. If one is updated and another isn't, you might have to make a judgement call as to which is the better oil for cold temperature operation. An oil that scores a 3250 at -25 degrees C is probably better than an oil that scores a 3200 at -20 degrees C. Even though the CCS score is lower for the second oil, it was tested at a temperature 5 degrees warmer than the first oil. That can make a huge difference.

Since this test is required of multi-grade oils in order to be classified with a certain "W" rating, it should be available on any tech sheet. If it's not, see if the company will provide it. They'll have the data. They have to.

Mini-Rotary Viscometer (ASTM D-4684)

This test is a companion to the CCS test discussed above. The combination of the results of both of these tests helps determine whether an oil is classified with a certain "W" rating. Whereas the CCS test cranking ability of an oil, the MRV tests the pumpability of the oil. In other words, how easily will the oil flow through the engine instead of how easily will engine components turn through the oil.

As with the CCS test, though, a lower cP value on the MRV is better. No adjustments have been made to these requirements, so you should be comparing apples to apples as long as you're in the same general viscosity grade.

Similar to the CCS, this data should be readily available since it's a requirement for SAE multi-grade specifications. If it's not on the sheet, ask for it.

Pour Point (ASTM D-97)

The pour point of an oil is a temperature 5 degrees F above the temperature at which an oil shows no movement when its container is inclined for 5 seconds. In simple terms, the pour point is the lowest temperature at which an oil will actually flow. This does not mean that it would easily pump through an engine at this temperature - just that the oil still acts somewhat like a liquid at this temperature.

Keep in mind that in oils where pour point depressants are necessary (generally, petroleum oils), the pour point of the oil will rise slightly every time your oil sees cold temperature weather. This is because those pour point depressant additives are being used up. Synthetic oils do not use pour point depressants, so they will hold a consistent pour point for a much longer period of time.

This spec should be found on every tech sheet out there. Of course, if the oil is not designed for low temperature operation, this spec is obviously less important. But, if you're looking at the spec sheet for an oil that will see cold temperature operation, the pour point should be on there. If it's not, be leary.

Borderline Pumping Temperature (ASTM D-3829)

The borderline pumping temperature of an oil is the lowest temperature at which it will adequately flow through your engine to provide the necessary lubrication and protection.

To be sure an oil will adequately pump through your engine during cold weather, look for an oil that has a borderline pumping temperature at least as low as the lowest temperature you expect to see while using it. For instance, those living in northern climates might want an oil with a borderline pumping temperature of -20 degrees F or lower.

Although this specification is fairly common, you may still find a few tech spec sheets that don't list it. If you can't get the info, assume that this value is at least as low as the pour point and maybe 5 degrees or more lower.

Flash Point (ASTM D-92)

The flash point of an oil is the temperature at which the oil vaporizes enough for the gas to become momentarily flammable in the presence of a small flame. There are other conditions and requirements for this test, but the gist of it is that an oil reaches its flash point when it begins to significantly vaporize.

In today's modern engines a flash point under 400 degrees F is unacceptable. Look for an oil with a flash point of at least 420 degrees F if you want the good stuff. a good quality synthetic should be significantly higher than this.

If this specification is not available, find another oil. This is a specification that no sheet should be without. If it's missing, there's a reason. Look elsewhere for your oil.

Fire Point (ASTM D-92)

Fire point is similar to flash point. However, this test determines the point at which an oil gives off enough vapor to provide a continuous flame as opposed to a momentary one. Expect a fire point of at least 420 to 450 degrees for petroleum oils and near or over 500 for a synthetic oil.

This specification is less commonly found than the flash point and pour point. However, it is still found on many technical specification sheets.

Total Base Number (TBN) (ASTM D-2896)

This is another term which was discussed in the previous chapter. Basically, the TBN of an oil is a relative indication of how well it can neutralize acid build-up within an oil and for how long it can do it. The higher the number the better equipped an oil is to neutralize acids from condensation, oxidation processes and combustion by-products.

Generally, gasoline oils will have TBN values of 5 to 8 and diesel oils will have TBN values around 9 to 14. Most premium synthetics will have higher TBN values than petroleum oils - even when comparing synthetic gas engine oil to petroleum diesel oil, but this won't be true of all of them. Diesel oils will nearly always list a TBN value. Gasoline oils are less likely to provide this information, although it's still relevant.

High-Temperature/High-Shear (ASTM D-4683)

This test is a simulation of the shearing effects that would occur within an engine. In fact, it's actually designed to simulate motor oil viscosity in operating crankshaft bearings. The D-4683 is measured by the Tapered Bearing Simulator and simulates motor oil stress at temperature extremes.

You might recall that multi-viscosity petroleum oils tend to use long chain polymers to "beef" themselves up. Under high stress conditions where shearing can occur, these polymers break down. As they do, the viscosity of the oil decreases. This is what the High Temperature/High Shear test checks for.

The HT/HS test is measured in Centipoise (cP) as the Cold Crank Simulator test is. However, in this case, because you're hoping for the least loss of viscosity with an increase in heat and stress, you want the cP value to remain high (at least relative to the minimum set by the SAE J300 standards.

Each SAE multi-viscosity grade has a specific lower limit for the HT/HS cP value. If a multi-viscosity oil cannot achieve a cP value above that limit, it cannot be classified under that viscosity grade. For instance, according to the SAE J300 specifications, an oil must achieve an HT/HS cP value of 3.7 or higher in order to be classified at the 15w40 viscosity grade.

So, whether this data appears on a manufacturer's tech spec sheets or not, the company has the data. They have to in order to classify an oil as a certain multi-viscosity grade. Of course, this does not apply to monograde oils although some companies run this test on those oils as well.

LESS COMMON BUT STILL IMPORTANT SPECIFICATIONS

There are five other specifications which I believe also to be important when comparing motor oils. Two of them are very important and would be more useful if more companies were willing to publish the date. These are the NOACK and the Four Ball Wear Scar Test. The other three are still important, but shouldn't probably be a deciding factor unless all other specs are fairly equal. These last three are the zinc, phosphorus and sulfated ash content.

Noack Volatility Test (DIN 51581)

The NOACK Volatility Test is one that is becoming more common on motor oil tech sheets, but still is not always provided. However, in my opinion, it is one of the most important technical specifications you can look at to determine the quality of an oil.

It is a test which was originally established in Europe by an organization similar to the ASTM here in the US. DIN (as in DIN 51581) stands for Deutsche Industrie Norm (I know "Industry" is with a "y" not "ie" - try telling the Europeans that). To the best of my knowledge, the first company in the US to use this test was AMSOIL Inc. Since then the test has become more of an industry norm.

In fact, oil manufacturers now MUST run a NOACK test on their oils to meet current industry standards. For instance, diesel oils must have a NOACK score of 17% or lower to meet API CH-4 standards. To meet the latest API SL standards, gasoline oils must have a NOACK score of 15% or lower.

So, if you request a NOACK score and the manufacturer tells you they don't have it, you know they're lying. That had to run it to establish API specification levels. They may not want to provide it, but they've got the data.

The NOACK test exposes an oil to a high temperature environment of 250 degrees C (almost 500 degrees F) for one hour. Other standardized environmental conditions are also set to make sure that the test is always performed in the same manner. The test is designed to determine the amount of evaporation that will occur over the course of this one hour time period.

The final score is listed as a percentage of weight loss by the end of the test. Many petroleum oils will score well above 15% weight loss, while most synthetics will easily score below 10%. In a general sense, the lower the viscosity grade and/or the wider the multi-grade "gap", the more weight loss you are likely to see on the NOACK.

For instance, an SAE 30 will evaporate more quickly than an SAE 60 motor oil. Also, a 0w30 will evaporate more quickly than a 10w30. The difference may not be much, but there will almost certainly be a difference.

Keep in mind that this does not necessarily indicate less engine protection. More evaporation simply indicates how much oil consumption you will see over time, not how much engine wear will occur.

Four Ball Wear Test (ASTM D-4172)

According to the ASTM.org website (click here): "This test method covers a procedure for making a preliminary evaluation of the anti-wear properties of fluid lubricants in sliding contact by means of the Four-Ball Wear Test Machine."

So, the indication is that the Four Ball Wear Test is useful for establishing how well a lubricant will prevent wear in situations where there is sliding contact going on. Many companies that do not publish 4 Ball test results say that the test is not useful for testing engine oils because it doesn't recreate conditions that are actually found within an engine. I disagree.

There are multiple components of an engine that see sliding contact with other components and where excessive wear can occur if not adequately protected by a lubricant film. An excellent example is the camshaft, lifters and pushrods or the camshaft and rocker arms in an overhead cam engine.

There is also sliding motion between the piston and the cylinder, and I'm quite certain if they thought about it long enough, they'd think of multiple other locations in the engine where sliding contact occurs.

I fail to see how the anti-wear properties of a lubricant would not be relevant in these areas. In fact, I'd be willing to go out on a limb and say that the reason most companies don't publish and won't provide 4-ball data is because it would make them look bad.

How is it performed?

The four ball wear test is performed by rotating one ball bearing on three fixed bearings. The motor oil is used to form a film between the bearings. The test can be done at a variety of temperatures, pressures and RPM.

For instance, some tests will be done at 40 kg of pressure, 75 degrees C and 1200 RPM while others might be done at 60 kg of pressure, 150 degrees C and 1800 RPM. Obviously, the latter test has higher pressure, higher temperature and a faster rotating ball bearing - all of which place more stress on the lubricant.

At the end of the test, the wear scar is measured on each of the three stationary balls and averaged for a final "wear scar measurement" in millimeters. The smaller this number, the better an oil will protect an engine at any point of sliding contact.

Be careful, however, to be sure you're comparing equivalent test results. Testing done at lower temperature, pressure and rpm is likely to show a much smaller wear scar than testing at the higher levels.

This test, like the NOACK, seems to be catching on in the industry, but I wouldn't call it an industry standard yet. Many companies, although I'm nearly certain they run this test, don't publish the data. And, since this test is not currently required for any particular certification, you can't be certain that a company has run it.

Phosphorous Content in PPM or %

The phosphorous content of an oil is important in that it is one part of a tag team called ZDTP (or ZDDP) which boosts the anti-wear properties of an oil. ZDTP stands for zinc dithiophosphate. ZDDP is similar and stands for zinc dialkyl dithiophosphate. Same thing really. Of course, as the name suggests, zinc makes up the other half of the additive team, and we'll talk about that in a minute.

Basically, ZDTP is used to prevent or reduce engine wear due to metal to metal contact. The higher the concentration of ZDDP in your oil, the longer it will be able to provide this added protection benefit.

In addition, ZDTP also acts as an oxidation and corrosion inhibitor. So, as you can see ZDTP's are powerful additives that are very important within an oil. Having a good level of ZDTP in your oil helps to reduce oxidation of the oil, corrosion of engine components and engine wear due to metal to metal contact.

The level of ZDTP in your oil is listed as two separate components, zinc and phosphorous. These levels are indicated on some, but not all, technical specification sheets. They will either be listed as a percentage such as .09 or as a ppm value like 920 ppm. These two values represent the same amount of phosphorous in your oil.

API Restrictions on Phosphorous

Current API specifications limit the amount of phosphorous in certain weight oils (0w20, 5w20, 0w30, 5w30 or 10w30) to .10% or 1000 ppm (these are one and the same). This is done because some manufacturers believe that high levels of phosphorous will prevent catalytic converters from doing their job for the full 150,000 miles that the EPA requires.

The problem with this theory is that this is only a problem when the oil burns. If the oil doesn't burn, the problem really doesn't exist. That's where the NOACK (which we've already talked about) comes in. As I've already indicated, most synthetic oils have NOACK scores that are half what their petroleum counterparts are.

Studies indicate a direct correlation between the NOACK, oil consumption levels and the amount of phosphorous that ends up leaving the engine with exhaust gases. So, logic indicates that a synthetic oil with half the NOACK score and twice the phosphorous would cause no more damage to a catalytic converter than a petroleum oil with twice the NOACK score and half the phosphorous. So, low NOACK oils can increase their levels of ZDTP without harming catalytic converters.

In this way, the wear properties of the oil, as well as the oxidation and corrosion inhibiting properties, can be increase significantly. However, this means that an oil which utilizes these higher ZDTP levels cannot be "certified" with the API. It can be tested and shown to meet all other relevant criteria, but the API will not certify it.

Zinc Content as PPM or %

As I already indicated, zinc is the other half of the ZDTP in your oil. Typically, the amount of zinc will not differ significantly from the amount of phosphorous. Normally, the zinc level will be higher for an API certified oil because the phosphorous level will have to be below .10%.

Since the zinc is not restricted, manufacturers will raise the amount of zinc. However, there has to be somewhat of a balance. You won't see 2000 ppm zinc and 1000 ppm of phosphorous. But, some premium synthetics which do not submit for API certification bypass this so that both the phosphorous and zinc levels will be elevated. These oils are always tested to make certain they meet all other relevant API testing requirements.

Sulfated Ash Content as a %

The sulfated ash content of an oil is important because it can be an indicator of how much deposit build-up an oil will leave in your engine. However, this number can be deceiving, so be careful. The amount of sulfated ash is directly related to the level of detergency additives in your oil.

You see, detergent additives contain metallic derivatives which are common sources of ash in an oil. When the oil burns, the ash is left behind as deposits within the engine. So, in general, you want an oil with lower ash content to reduce deposit build-up.

But, here is something to consider. Ash deposits are normally left behind by detergent additives, and detergent additives are necessary to maintain a clean engine. So, having a very low or no ash formulation to reduce ash deposits can actually lead to build-up of sludge and deposits from other sources because there is nothing in the oil to clean them out. So, there is a fine line to be walked here.

Also, keep in mind that I indicated the ash build-up occurs when the oil burns. An oil with a low NOACK score burns less than one with a higher NOACK score. So, an oil with a low NOACK score will leave behind fewer ash deposits than an oil with comparable detergent additives and a high NOACK score.

The conclusion should be obvious, and very important. Oils with low NOACK scores can have higher levels of detergent additives without raising the probability of ash deposit build-up. So, low NOACK synthetic oils can maintain a cleaner engine even while possibly having higher sulfated ash numbers. Bear this in mind when you're reading the tech specs near the end of the book

WHAT TO LOOK FOR

In my opinion, the NOACK and Four Ball Wear Test listed above, in addition to the HT/HS test, are the most important specifications you will find to indicate the relative stability and protection benefits of any given oil, if you can get your hands on them. All of these tests are designed to simulate conditions that would be found within at least a portion of your engine. They may be somewhat more severe in some cases, but they are still very useful for comparing one oil to another.

If you manage to get the technical data for a particular manufacturer's oil, keep in mind that every piece of information that is missing from their tech sheet is **possibly** one more reason to assume you're looking at an inferior oil. You can be sure that all of the tests listed above have probably been conducted, with the exception of **maybe** the 4-ball.

So, if the information is left out it could be because the manufacturer didn't think the results were worth of publishing, although it is **possible** that the manufacturer simply didn't feel the information would be something you'd be looking for.

Or, the company might feel that you'll misinterpret the data. For instance, if you didn't understand the importance of NOACK volatility in interpreting the values for zinc, phosphorous and sulfated ash, you might see a high ash oil and figure it's of low quality and will leave behind excessive deposits. Or, you might see the high levels of phosphorous and think that your catalytic converter will be harmed.

So, there are some tech specs that might be left out only because they don't want people misinterpreting the data in light of false understandings of those test results.

For instance, the Amsoil company provides a fairly complete technical specification sheet for all their oils, including both the NOACK and 4 Ball test scores. However, they leave off the zinc, phosphorous and sulfated ash numbers for all but their motorcycle oils.

Amsoil synthetic gasoline oils tend to have an ash content of about 1% (approx. 1.5% for diesel oils) whereas many other petroleum based non-diesel rated oils (and a few synthetics) have ash content that is closer to .6 or .8%. If a person didn't understand why higher ash content is allowable in some oils, they might steer clear of Amsoil products as a result. That would be unfortunate.

The same kind of thing could occur if they listed their zinc and phosphous numbers which are well

above API limits. Because of the low volatility of Amsoil oils, the high levels of phosphorous will not harm catalytic converters. But, potential customers who didn't know any better might think otherwise. I'm certain that other companies may be in the same boat. Some tech specs are omitted by one company or another simply because the company feels customers might be more confused by the data than helped. Certainly, this isn't always the case, but I imagine it is sometimes true.

MEETS OR EXCEEDS ALL REQUIREMENTS

Other companies might list a test specification (standard or non-standard) and then put something like "Meets or Exceeds All Requirements". That's a cop-out. Most any oil on the market should meet or exceed any standardized requirements, otherwise, it shouldn't be on the market.

Look for oils manufactured by companies that are not afraid to publish the results of STANDARDIZED testing for comparison to other oils. Also, be aware that some companies will utilize non-standardized testing procedures so they can provide information which looks impressive but can't be compared to other oils in the industry. The next chapter will discuss this in more depth.

Non-Standard Motor Oil Testing

In the descriptions provided in the previous chapter regarding technical specifications, I tried to indicate the standard environmental variables used within each test if they were relevant. However, certain tests can be performed with differing environmental variables.

If this is done, the differing variables should be listed along with the test description and results. For instance, the 4-Ball Wear Scar Test, the CCS and the MRV can all be run with differing variables (although the CCS and MRV should be the same within each viscosity grade). If testing variables are not listed, you should be able to assume that the testing was done using the environmental settings that I indicated (as long as an ASTM # is given).

In addition, if you see test results that do not provide ASTM numbers, you have to assume that the testing is bogus (or you need to contact the company to verify). Without an ASTM number there is no way for any testing company, competitor or customer to verify the findings of the test because it is not reproducible. Some companies will include testing descriptions and results which sound like comparable tests, but without ASTM numbers you have to assume the testing is non-standard. You just can't be certain.

As an example, there is a synthetic oil manufacturer that lists a specification for "Viscosity Increase" of their 5w30, 10w30 and 10w40 motor oils. Then they state that for this "test" a 375% increase is allowed. Their test results show only a 6% increase. WOW!!! That's awesome!

But wait, what sort of test is this? Who sets the standards for how the test is administered? Who set the 375% limit? Is this test designed for motor oil or vegetable oil? There are simply too many unanswered questions for this information to be useful in any way.

I hope that you see my point. There is no way that I could list all of the ways that companies try to color the truth with potentially misleading information. Just be careful. Don't let clever wording and hype sell you on an oil. Focus on whatever standard specifications the company will provide and compare them to those of other oils. There is no better way to justify the claims of a motor oil manufacturer.

Synthetic vs. Petroleum

Oil is the lifeblood of your vehicle's engine. Without motor oil, there is little likelihood that any of your vehicles would make it past the end of your street each morning. For decades conventional petroleum oils have been providing **adequate** protection for all of our vehicles.

Notice the key word here: adequate. Petroleum oils, for the most part, have done an adequate job of protecting our engines from break down. If you change it often enough, you can be relatively sure that your car will last 100,000 to 150,000 miles without a serious engine problem - maybe even longer.

My question is this: Why are you settling for adequate when something better has been available for about 30 years? Do you ask your mechanic to simply keep your vehicle from breaking down, or do you want him/her to keep it running in tip-top shape? The fact that you are reading this book suggests the latter.

It is perfectly reasonable to expect top performance from your vehicles. You are certainly paying for it. It's tough to buy a vehicle for less than $15,000 to $20,000 anymore. That's a great deal of money to shell out for adequate performance.

Today's engines are built for better performance, and, although petroleum oils are designed for better protection and performance today than they were 10 or 20 years ago, there is only so much that can be done. Today's engines need high performance lubricants, and **synthetics are the only ones that fit the bill**.

WHY PETROLEUM OILS ARE INSUFFICIENT

Conventional petroleum oils are insufficient for use in today's vehicles primarily because they are manufactured from a refined substance, as was discussed in Chapter 2. Petroleum oil basestocks contain paraffins (wax), sulfur, nitrogen, oxygen, water, salts and certain metals. All of these contaminants must be refined out of the basestock in order for it to be useful for use within a lubricant.

Unfortunately, no refining process is perfect. Impurities will always remain when any refining process is done. It simply isn't economical to continue to refine the oil again and again to remove more impurities. If this was done, petroleum oils would cost as much as synthetic oils do.

Thus, there are many components of petroleum oil basestocks which are completely unnecessary for protecting your engine. They do absolutely nothing to enhance the lubrication properties of the oil. In fact, most of these contaminants are actually harmful to your oil AND your engine.

PRONE TO BREAK-DOWN

Some of the chemicals in conventional petroleum lubricants break down at temperatures well within the normal operating temperature range of your engine. Others are prone to break down in these relatively mild temperatures only if oxygen is present. But, this is invariably the case anyway, especially since oxygen is one of the contaminants within petroleum basestocks.

These thermally and oxidatively unstable contaminants do absolutely nothing to aid in the lubrication process. They are only present in conventional petroleum oils because removing them would be impossible or excessively expensive.

When thermal or oxidative break down of petroleum oil occurs, it leaves engine components coated with varnish, deposits and sludge. In addition, the lubricant which is left is thick, hard to pump and

maintains little heat transfer ability.

POOR COLD TEMPERATURE STARTS

In addition, as was previously mentioned, petroleum oils contain paraffins which cause dramatic oil thickening in cold temperatures. Even with the addition of pour point depressant additives, most petroleum oils will begin to thicken at temperatures 10 to 40 degrees warmer than synthetic oils.

As a result, petroleum lubricants will not readily circulate through your engine's oil system during cold weather. This may leave engine parts unprotected for minutes after startup. Obviously, significant wear can occur during this time frame.

MARGINAL HEAT CONTROL

Even when all conditions are perfect for conventional oils to do their job, they fall far short of synthetic oils. Part of the problem is that (because of their refined nature) petroleum oils are composed of molecules which vary greatly in size.

As the oil flows through your vehicle's lubrication system, the small, light molecules tend to flow in the center of the oil stream while the large, heavy ones adhere to metal surfaces where they create a barrier against heat movement from the component to the oil stream. In effect, the large, heavy molecules work like a blanket around hot components.

There is also another effect of the non-uniformity of petroleum oil molecules which reduces their effectiveness. Uniformly smooth molecules slip over one another with relative ease. This is not the case with molecules of differing size.

Theoretically, it might be somewhat similar to putting one layer of marbles on top of another (if this could easily be done). If the marbles were all of the same size, they would move over one another fairly easily. However, if they were all of differing sizes, the result would be much less efficient.

In the case of petroleum oils this inefficiency leads, ironically, to added friction in the system (the very thing that lubricants are supposed to reduce). Hence, petroleum oils are only marginally capable of controlling heat in your engine. Considering that motor oil does nearly 50% of the cooling of your engine, that's not a good thing. But, I'm sure you've already guessed that.

MAYBE ADEQUATE IS OK FOR YOU

I have to make something clear. Earlier in this chapter I indicated that petroleum oils are insufficient for protecting high tech engines in today's vehicles. I say this for one main reason - today's vehicles should easily be running for 300,000 miles without much more than a hiccup. Modern day vehicles are really built very well.

It is my contention that using petroleum oils shortens the useful life of a vehicle considerably. The problem is one of perspective. People still think 100,000 miles is pretty good when, in reality, 2 to 300,000 miles should be expected.

I suppose what I'm trying to say is that my belief that petroleum oils are inadequate stems from the knowledge that today's engines can run well for many more miles than they generally do. Since I'm one who likes to get my money's worth, I'm not satisfied with adequate performance for a measly 100,000 miles. I want my money to be well spent.

However, I would like to make it clear that petroleum oils ARE adequate for the purpose of protecting

your engine, if you don't mind a shorter vehicle lifespan, inconvenient oil changes, or decreased engine performance. Under normal circumstances, most vehicles lubricated with petroleum oil should run satisfactorily for 100,000 to 150,000 miles without serious incidence.

So, if you like the hassle of changing your oil regularly, and you are only looking for marginal performance for the next 100,000 miles or so, petroleum oils are definitely the way to go. By the way, if you're interested, I've got an old dishwasher for sale too. You have to rinse your dishes first, it's really loud and runs for about 3 hours, but it gets most of the food off of our plates. It's a steal at only $50. Let me know if you're interested.

On the other hand, if you aren't all that fond of pulling dirty dishes out of your dishwasher, I'm going to assume that you don't relish the idea of changing your oil every 3,000 miles or dealing with another pushy car salesman every 3 to 5 years either. If that's true, keep reading.

SYNTHETIC OILS ARE SIMPLY BETTER

There are five main areas where synthetic oils surpass their petroleum counterparts:

1. Oil drains can be extended

   Vehicle life can be extended

2. Costly repairs can be reduced

3. Fuel mileage can be improved

4. Performance can be improved

Synthetic basestock molecules are pure and of uniform size. This is because synthetic basestocks are designed from the ground up with the sole purpose of protecting your engine. Nothing is added if it does not significantly contribute to the lubricating ability of the oil.

In addition, in top-quality synthetics, no component is added which might be contaminated with any substance that might lessen the lubricating qualities of the oil. In other words, manufacturers of these premium synthetics implement very strict quality control measures to insure NO contamination.

Not only that, synthetic basestocks are designed so that the molecules are of uniform size and weight. In addition, synthetic basestock molecules are short-chain molecules which are much more stable than the long-chain molecules that petroleum basestocks are made of. This significantly adds to the lubricating qualities and stability of the oil.

EXTENDED OIL DRAINS

Stable Basestocks

Heat and oxidation are the main enemies of lubricant basestocks - especially of the contaminants in conventional basestocks. Once a lubricant has begun to break down, it must be replaced so that the vehicle is not damaged by lack of lubrication or chemical attack. However, since synthetic oils are designed from pure, uniform synthetic basestocks, they contain no contaminants or unstable molecules which are prone to thermal and oxidative break down.

Moreover, because of their uniform molecular structure, synthetic lubricants operate with less internal

and external friction than petroleum oils which have the non-uniform molecular structure discussed earlier. The result is better heat control, and less heat means less stress to the lubricant.

Higher Percentage of Basestock

Of course, there is also the issue of the additive package of the oil. First and foremost is the fact that synthetic oils contain a higher percentage of lubricant basestock than petroleum oils do.

This is because multi-viscosity oils need a great deal of pour point depressant and viscosity modifying additives in order to be sold as multi-viscosity oils. As was discussed in Chapter 2, pour point depressants are used to help a petroleum oil flow well in cold temperature conditions. Viscosity modifiers (or Viscosity Index Improvers), help petroleum oils maintain their viscosity in high temperature conditions.

Synthetic oils, on the other hand, require very little in the way of pour point depressants and viscosity modifiers. Therefore, synthetic oils can contain a higher percentage of basestock, which actually does most of the lubricating anyway. More basestock leads to longer motor oil life.

Additives Used Up More Slowly

In addition, Chapter 2 also discussed oxidation and corrosion inhibiting additives. Because petroleum basestocks are much more prone to oxidation than synthetic oils, oxidation inhibitors are needed in greater supply and are used up very quickly. Synthetic oils do oxidize, but at a much slower rate. Therefore, oxidation inhibiting additives are used up much more slowly.

No less important is the fact that combustion by-products tend to blow-by the rings and enter the oil. This causes acids to build up within the oil and corrode engine components. Therefore, additives are necessary to neutralize these acids and also to coat metallic components with a protective barrier to minimize corrosion.

Synthetic oils provide for better ring seal than petroleum oils do. This minimizes blow-by and reduces contamination by combustion by-products. As a result, corrosion inhibiting additives have less work to do and will last much longer than within a petroleum oil.

Excellent Heat Tolerance

Synthetics are simply more tolerant to extreme heat than petroleum oils are. When heat builds up within an engine, petroleum oils quickly begin to burn off. They volatize. In other words, the lighter molecules within petroleum oils turn to gas and what's left are the large petroleum oil molecules that are harder to pump.

Synthetics are resistant to this burn-off. They will tolerate much higher engine temperatures. As an example, most vehicles these days call for a 5w30 motor oil. In late 2000 I averaged the 5w30 flashpoints of seven major petroleum manufacturers (Amoco, Chevron, Havoline, Mobil, Pennzoil, Quaker State and Shell).

The average was 414 degrees F, with the highest being 423 degrees F for Formula Shell. One of them actually had a flashpoint of well under 400 degrees which is simply not enough protection for today's hot running engines.

I ran the same averages for most major synthetic 5w30 motor oils on the market (Amoco, AMSOIL, Chevron, Havoline, Mobil 1, NEO, Quaker State, Redline, Royal Purple, Shell, Synergyn and Valvoline).

The average flashpoint for these 5w30 motor oils was 453 degrees F. That's nearly 40 degrees higher than the petroleum oil average! And, since synthetic oils tend to help engines run at least 20 degrees F cooler than petroleum oils do, you could actually say there's about a 60 degree temperature differential between the two.

I think that it's quite obvious that these high-tech synthetic oils offer a substantial benefit when it comes to potential breakdown due to burn-off.

Therefore…

All of the above leads to one inevitable result: Synthetic oils can be used safely for much longer drain intervals than conventional lubricants. In fact, Amsoil and NEO synthetic oils have been guaranteed for 25,000 miles or one year since the early 70's. Red Line Oil has also recommended long drain intervals of up to 10,000 to 18,000 miles for many years. Mobil 1 had a 25,000 mile oil back in the 70's which they discontinued, but they are working on another extended drain oil currently. Other companies also offer extended drain oils.

Now, I should clarify by saying that not all synthetics will last quite that long. It is necessary to have a premium blended basestock and the highest quality additive package in order to offer 25,000 mile drains. However, most synthetics would probably easily last at least 7,500 to 10,000 miles or six months.

You might ask then, why other synthetic oil manufacturers are not recommending extended oil drains for their synthetics. In my opinion the answer is really very simple: money. They are afraid that if they recommend longer drain intervals, they won't sell enough oil - petroleum oil, that is.

You see, petroleum oil is their golden goose, and has been for years. The only reason large oil companies produce a synthetic oil is because a few small start up companies did it first, and they must please the small (but growing) percentage of the population which has already decided that synthetics are better and won't purchase anything else.

Petroleum oil is where the money is. With recommended oil drains of only 3,000 miles, many people are changing their oil 5 to 8 times per year. If everyone suddenly switched over to synthetics, they would begin to realize that it is possible to go 10,000 to 25,000 miles or more without an oil change (depending upon the oil). This is a scary thought for large oil companies and quick lubes who depend upon regular oil changes for their business.

EXTENDED VEHICLE LIFE WITH FEWER REPAIRS

Heat Reduction

More often than not, vehicle life is determined by engine life. One of the major factors affecting engine life is component wear and/or failure, which is often the result of high temperature operation. The uniformly smooth molecular structure of synthetic oils gives them a much lower coefficient of friction (they slip more easily over one another causing less friction) than petroleum oils.

Less friction, of course, means less heat in the system. And, since heat is a major contributor to engine component wear and failure, synthetic oils significantly reduce these two detrimental effects.

In addition, because of their uniform molecular structure, synthetic oils do not cause the "blanket effect" which was mentioned earlier. Since each molecule in a synthetic oil is of uniform size, each is equally likely to touch a component surface at any given time, thus moving a certain amount of heat into the oil stream and away from the component. This makes synthetic oils far superior heat transfer agents than

conventional petroleum oils.

Greater Film Strength

Petroleum motor oils have very low film strength in comparison to synthetics. As was mentioned in chapter 5 of "Exposing the Myth", the film strength of a lubricant refers to it's ability to maintain a film of lubricant between two objects when extreme pressure and heat are applied.

Synthetic oils will typically have a film strength of 500% to 1000% higher than petroleum oils of comparable viscosity. In fact, believe it or not, even though heavier weight oils typically have higher film strength than lighter weight oils, a 0w30 or 5w20 weight synthetic oil will likely have higher film strength than a 15w40 or 20w50 petroleum oil.

Thus, even with a lighter weight oil, you can still maintain proper lubricity and reduce the chance of metal to metal contact when using a synthetic oil. Of course, that means that you can use oils that provide far better fuel efficiency and cold weather protection without sacrificing engine protection under high temperature, high load conditions. Obviously, this is a big plus, because you can greatly reduce both cold temperature start-up wear and high temperature/high load engine wear using the same low viscosity oil.

Engine Deposit Reduction

In discussing some of the pitfalls of petroleum oil use, engine cleanliness is certainly an issue. Petroleum oils tend to leave sludge, varnish and deposits behind after thermal and oxidative break down. They're better than they used to be, but it still occurs.

Deposit build-up leads to a significant reduction in engine performance and engine life as well as increasing the number of costly repairs that are necessary. Since synthetic oils have far superior thermal and oxidative stability than petroleum oils, they leave engines virtually varnish, deposit and sludge-free.

Better Cold Temperature Fluidity

Synthetic oils and other lubricants do not contain paraffins or other waxes which dramatically thicken petroleum oils during cold weather. As a result, they tend to flow much better during cold temperature starts and begin lubricating an engine almost immediately. This leads to significant engine wear reduction, and, therefore, longer engine life and fewer costly repairs.

IMPROVED FUEL MILEAGE AND PERFORMANCE

As indicated earlier, synthetic oils, because of their uniform molecular structure, are tremendous friction reducers. It has already been stated that this is crucial to extending engine life, but it must also be mentioned that less friction leads to increased fuel economy and improved engine performance.

Of course, logic points in that direction anyway. Any energy released from the combustion process that would normally be lost to friction can now be transferred directly to the wheels, providing movement. Vehicle acceleration becomes swifter and more powerful while using less fuel in the process.

The uniform molecular structure of synthetic oils has another performance enhancing benefit as well. In a petroleum oil, lighter molecules tend to boil off easily, leaving behind much heavier molecules which are difficult to pump. Certainly, the engine loses more energy pumping these heavy molecules than if it were pumping lighter ones.

Since synthetic oils have more uniform molecules, fewer of these molecules tend to boil off. Moreover, when they do, the molecules which are left are of the same size and pumpability is not affected. Obviously, the end result is little loss of fuel economy or performance over time.

THOSE WHO KNOW, AGREE

According to a technical paper (850564.1985) by the Society of Automotive Engineers, "Laboratory engine dynamometer, vehicle chassis rolls and over-the-road field tests confirm the outstanding performance capabilities for optimized synthetic engine oils in passenger car diesel as well as gasoline engines, including severe turbocharged models...Vehicle testing under severe and extended drain conditions demonstrates the performance reserve available with these synthetic engine oils. In addition to excellent protection against critical high-temperature piston deposits, ring sticking, overall engine cleanliness and wear, these synthetic oils offer fuel savings and superior low temperature fluidity."

In 1989 (over a decade ago!), Mechanical Engineering Transactions had this to say in its Synthetic versus Mineral Fluids in Lubrication article: "Oil drain intervals in both industrial and automotive applications can be extended typically by a factor of four due to the improved oxidative stability of appropriately additized synthetics."

IT'S YOUR CHOICE

Ultimately, it does not matter what I say. You have to decide how important these factors are to you. If you don't mind changing your oil every 3,000 miles and you'd purchase a new vehicle every 2 or 3 years regardless of its condition, maybe you don't need synthetics.

Of course, the fuel savings and performance may still make the switch worth it unless you're a low mileage driver. Once again, though, the determination of whether to convert your vehicle over to synthetics can only be based on the relative importance that you place on any of these benefits. It's your call, be sure and make the right one. The life of your vehicle and size of your bank account depend on it.

Synthetic Oil FAQs

When making the switch to synthetics or even just deciding whether to make the switch, there are certain questions that often arise. In this chapter I hope to address some of the most common questions you may have that have not yet been answered in the previous chapters of "The Motor Oil Bible".

NEW CAR WARRANTIES & EXTENDED DRAINS

Many times when you make a change in your vehicle maintenance practices, dealers get a little ornery. In fact, in extreme cases, they may even tell you that your change in maintenance practices has now voided your warranty. This can be especially true in cases where you extend your oil drains. Don't be fooled. This practice is neither legal, nor ethical.

I can't stress this enough. Legally (by virtue of the Magnuson-Moss Warranty Act), no dealer or manufacturer can void your warranty simply because you have installed an add-on performance accessory or changed your vehicle maintenance practices. The only way that a warranty claim can be denied is if the dealership has proof that your maintenance practices caused the problem for which you are requesting warranty coverage. Chapter 13 contains a copy of this "extended drains & warranties" information along with a copy of the relevant portions of the M-M Warranty Act.

For instance, a dealer denying warranty coverage on your engine because you used 10w30 oil instead of 5w30 motor oil is no different than denying warranty coverage on your door handle because you installed new hubcaps. No direct relationship has been shown between your actions and the problem at hand.

If a connection can be shown, the dealer may have a leg to stand on. However, you always have the right to take the dealer to court (they pay all your court costs and legal fees if you win) or contact the FTC if you believe their decision is unfair. Generally, if a dealership knows they should be accepting your claim and you indicate your knowledge of your warranty rights, they'll give in. Just stand your ground.

Warranties are discussed again in chapter 15 with a little bit of extra information added.

SWITCHING FROM PETROLEUM TO SYNTHETIC

When switching from petroleum oil to synthetic oil, knowing the answers to a few simple questions will help you to be more comfortable with the switch and will make certain that you get the best results for your money.

COMPATIBILITY ISSUES

Synthetic oils, these days, are completely compatible with petroleum oils. This was not always the case, but the widespread use of synthetics now makes that compatibility a necessity.

So, technically, you could even mix your own semi-synthetic oil. However, you will see exponentially better results by using a full synthetic than by going with a semi-synthetic oil. You won't cause any damage - you just won't get the results your paying and hoping for with a semi-synthetic.

WHEN IS IT TOO EARLY TO SWITCH?

Unless the manufacturer has sent your vehicle from the factory pre-filled with synthetic oil, wait at least 3,000 miles on a gasoline engine and about 10,000 miles on a diesel engine before making the switch to synthetics. This helps make certain that everything is seated properly within the engine which will minimize the possibility of oil consumption.

Moreover, it allows time to make certain there are no factory defects within your engine that need to be repaired. If you make the switch too early and something goes wrong, you've only provided the dealer with one more excuse to try and deny a warranty claim. You may be in the right, but you might have made your life a little more difficult than was necessary.

WHEN IS IT TOO LATE TO SWITCH?

Any vehicle under 8 to 10 years of age or 100,000 miles is a perfect candidate for a switch, as long as the vehicle is mechanically sound. If, however, the vehicle is more than 8 to 10 years old or over 100,000 miles, there is some debate as to whether you should make the switch. Although the risk is slight, older vehicles have been known to leak around seals and gaskets after the switch from petroleum to synthetic oil.

Personally, I switched a 1992 Ford Escort over to synthetic oil after 120,000 miles of petroleum oil use and saw nothing but increased fuel mileage and improved performance. But, others have not been so happy with the results of switching a high mileage vehicle to synthetic.

It is my opinion that those who had problems are generally much more vocal about their experiences than those who were happy with the switch. This is why we tend to hear so many horror stories about older vehicles switching to synthetics. However, my experience has shown that for every person who had a problem there are a hundred more who didn't. You'll have to make your own judgement regarding the switch of an older vehicle to synthetic lubricants.

More information on this issue is in chapter 15.

IS THERE A SPECIAL PROCEDURE NECESSARY?

If your vehicle is under 20,000 miles, just remove the old filter, drain the old oil, install a new filter and pour in the new oil. You're good to go.

However, if your vehicle is over 20,000 miles and you're switching from petroleum to synthetic oil, I would first recommend that you perform an engine flush to remove any possible deposits within the engine. This will minimize the risk of oil contamination after you make the switch which should help you avoid the possibility of elevated oil consumption. There is a catch, though. Most engine flush products on the market are comprised of very harsh chemicals that have the potential to actually damage engine components.

For instance, many engine flush products contain kerosene. I don't know about you, but I wouldn't pour kerosene into my engine regardless of who told me to. And guess what? My opinion doesn't magically change when that kerosene is repackaged in an impressive looking engine flush bottle that says it'll spit shine my engine and have it running like new. It's still kerosene.

Just be careful what you use. If the bottle or can says anything about a chemical that you wouldn't pour into your engine from any other container, don't buy it. There are at least two engine flush products available that contain no kerosene. One is manufactured by Gold Eagle. The other by Amsoil. There may be other companies that make similar engine flush products. This is the type I would recommend.

Most engine flush products are added to the old oil and then the engine is idled for a certain period of

time. Just make sure that your engine oil sump is already a half quart low to accommodate the added volume of the engine flush. You don't want to over fill the crankcase.

One way to be sure you've got room for the engine flush is to install a new oil filter to do the flush. This is a good idea anyway because you may end up with a much higher percentage of contaminants in the oil than normal. Your old filter will already be saturated with dirt and debris. A new filter will be much more likely to remove the contaminants from the oil as they are cleaned off of engine components by the engine flush.

Once the car has been idled for the specified period of time, remove your filter and drain the oil while the engine is still warm. This will remove the majority of contaminants from your engine. Then, install a new oil filter and pour in the correct amount of synthetic oil based upon your owner's manual recommendations.

WILL OIL PRESSURE DROP AFTER THE SWITCH?

It is actually possible that your oil pressure may drop slightly after a switch to synthetic oil. However, this normally is a good thing - as long as the drop is not severe. You see, oil flow and oil pressure are two totally different things. Oil flow, in many ways, is far more important than oil pressure.

As long as oil flow is good, engine components are getting proper lubrication. If oil pressure drops slightly, it is most likely a result of the fact that the synthetic oil simply has better flow characteristics than your petroleum oil did. This is creating better oil flow throughout the engine and less resistance (which lowers oil pressure).

Nevertheless, if you notice a marked drop in oil pressure, you might want to contact your mechanic just to be sure there are not other issues that might need to be dealt with. It is always better to be safe than sorry.

SO I NEED SPECIAL FILTRATION?

In a word, maybe. It all depends upon how you define "need". If you mean is it absolutely necessary to use a special filter to use synthetic oil, the answer is no. Synthetic oils will perform very well even with a cheapo off-the-shelf oil filter.

Even oils which are designed for long drain intervals such as AMSOIL & NEO'S 25,000 mile oils can be used with standard oil filters. Just make sure you change the filters every 3 to 5,000 miles and top off the oil system.

Now, you may remember that my original answer was "maybe" you'll need special filtration. If you are using synthetic oil, it would seem that you're looking for the best protection for your engine. If so, you'll want to purchase a high efficiency oil filter. There are more and more coming on the market every day. You can read more about these filters and their benefits in Chapter 10.

MY OIL IS DARK, SHOULD I CHANGE IT?

This is a huge misconception about motor oil which needs to be addressed. The fact that your oil is dark does not in any way mean your oil is necessarily ready for a change. Although it is possible that it is overdue, this visual indicator alone is not sufficient to determine this.

A large percentage of the contaminants within your oil are smaller than one micron. These particles can easily give your oil its dark color. However, since the clearances within your engine are generally

between 5 and 20 microns, these contaminants pass right by without causing any wear to engine surfaces. Hence, there is no immediate need to change the oil due to these particles being present within the oil.

Although oil analysis is the best way to determine whether an oil change is necessary, there are a couple of other non-technical methods you can use to assess whether an oil change is necessary. Just bear in mind that these are primitive in nature and should be verified with oil analysis.

Rub the oil between your fingers. Does it feel gritty? If so, your oil filter is probably either not doing a very good job or is completely saturated. Change your oil and filter. Smell the oil. Does it smell burnt? If so, your oil is beginning to break down under the high temperature conditions within your engine. It needs to be changed.

Exposing the Myth of the 3,000 Mile Oil Change

The necessity of 3,000 mile oil changes is a myth that has been handed down for decades, and it's time someone introduced the public to the possibility of extended oil drains. I guess, for you at least, that someone is me.

I will tell you up front that I'm partial to synthetic oil, in case you hadn't already guessed. There are, of course, certain instances when petroleum oil will be a better choice, but under most circumstances, synthetic oils provide much more bang for your buck than petroleum oils do - you just have to know how to use them to your benefit.

Now, if you're one who thinks that synthetics are just a marketing ploy to make more money off the same bottle of oil, I hope you'll take the time to read through this information and judge for yourself.

You see, I believe the whole point of using a synthetic oil is peace of mind. I like knowing that I can trust the oil in my car to protect my engine. I like knowing that 300,000 miles down the road, I won't necessarily have to start looking for another vehicle (unless I'M ready). I also like knowing that when 20,000 miles rolls around, I still have a few thousand miles left to find time to change the oil.

Now, you're probably saying to yourself, "This guy is nuts! There's no way that an oil could possibly last for 20,000 miles. And, if he's not nuts, he's some sort of snakeoil salesman."

Well, if you don't mind, I'd like to take a little time to, first of all, prove that I'm not in need of psychiatric care. And secondly, I hope that you'll allow me to explain why I believe that a premium synthetic oil CAN last for 20,000 miles or more.

By the way, you won't find any links from my book to sell you motor oil either - just in case you were still wondering when I was going to get around to selling you some oil.

A LITTLE BIT ABOUT ME

I used to be a pretty regular 3,000 mile oil changer. I had a very hard time believing that an oil could possibly last longer than 5,000 or at best 7,000 miles. Changing at 3,000 miles was very safe and "assured" me of no mechanical breakdowns.

When I started looking at synthetics, my perspective changed a little. I figured, if I was going to go out and buy a $20,000 new car, I wanted to get the most for my money. Just protecting against breakdown for a couple hundred thousand miles wasn't enough. I don't take my car to the mechanic and hope he doesn't break it. I take my car to the mechanic so that he can make it better. The same can be true of your oil.

Let's talk about oil changes first. If it's necessary to change oil every 3,000 to 5,000 miles, then so be it. We should just do it, and accept that it's an integral part of keeping our vehicles from breaking down. But, if it's not necessary, why do it? Just because our Daddy did? My Dad used to listen to 8-track tapes too. Now we've got these nifty little CD's that sound clear as a bell and last pretty much forever. Am I going to listen to 8-track tapes? Probably not.

I don't change my oil every 3,000 miles anymore either.

WHY DO WE CHANGE OIL?

There are only a few basic reasons why it is necessary to change your oil, and they all, in the end, have to do with decreased protection of your engine and decreased performance. If these elements can be minimized, then there will be little or no reason to change the oil.

Oil Break-Down: What Really Causes It?

First off, all oil breaks down. That generally will include basestocks and additives (actually additives are really "used up" rather than broken down - but that's getting a little picky). Without focusing on performance characteristics, the most significant difference from one oil to another is how quickly breakdown occurs. Although there are many factors that contribute to the breakdown of an oil, temperature is one of the most important. Depletion and decreased effectiveness of oil additives is also important, but that will be discussed later.

Petroleum oil begins to break-down almost immediately. A high quality synthetic, on the other hand, can last for many thousands of miles without any significant reduction in performance or protection characteristics. Synthetics designed from the right combination of basestocks and additives can last indefinitely with the right filtration system.

HEAT TOLERANCE

As alluded to above, the first major difference between petroleum and synthetic oil is heat tolerance. Flash point is a technical specification referenced by most oil manufacturers which is an indicator of heat tolerance.

More Motor Oil Flash Point Info: MOB Chapter 5

The lower the flash point of an oil the greater tendency for that oil to suffer vaporization loss at high temperatures and to burn off on hot cylinder walls and pistons. This leads to oil thickening and deposit build-up on critical engine components.

So, the higher the flash point the better. 400 degrees F, in my opinion, is the absolute MINIMUM to prevent possible high consumption and oil thickening due to burn-off.

Today's engines are expected to put out more power from a smaller size and with less oil than engines of the past. Therefore, the engines run much hotter than they used to. That puts an increased burden on the oil. Synthetics are up to the task. Petroleum oils are a little overmatched.

Nevertheless, even though synthetics are MUCH less prone to burn-off than are petroleum oils, there is still a small amount of burn-off during extremely high temperature operation.

MOTOR OIL BURN OFF

Thus, it becomes important to discuss the manner in which petroleum and synthetic oils burn off. As a refined product, petroleum oil molecules are of varying sizes. So, as a petroleum oil heats up, the smaller molecules begin to burn off. Deposits and sludge are left behind to coat the inside of your engine.

In addition, as smaller particles burn off, the larger, heavier molecules are all that is left to protect the engine. Unfortunately, these larger particles do not flow nearly as well and tend to blanket the components of your engine which only exacerbates the heat problem as friction builds-up.

Synthetic oils, on the other hand, because they are not purified, but rather designed within a lab for lubrication purposes, are comprised of molecules of uniform size and shape.

More Motor Oil Manufacturing Info: MOB Chapter 3

Therefore, even if a synthetic oil does burn a little, the remaining oil has the same chemical characteristics that it had before the burn off. There are no smaller molecules to burn-off and no heavier molecules to leave behind.

Moreover, synthetics contain far fewer contaminants than petroleum oils since they are not a refined product. As a result, if oil burn-off does occur, there are few, if any, contaminants left behind to leave sludge and deposits on engine surfaces. Obviously, this leads to a cleaner burning, more fuel efficient engine.

As a side note (as it really has little bearing on when to change your oil), synthetics do a much better job of "cooling" engine components during operation. Because of their unique flow characteristics, engine components are likely to run 10 to 30 degrees cooler than with petroleum oils. This is important, because the hotter the components in your engine get, the more quickly they break down.

More Motor Oil Cooling Info: MOB Chapter 7

WHAT ABOUT THE ARCTIC FREEZE?

This is an issue that some people really don't think about when it comes to oil changes. Most people understand that at cold temperatures, an oil tends to thicken up, and many people know that synthetics do a better job of staying fluid. However, many people don't realize **why** petroleum oils tend to thicken up. More importantly, though, they don't realize that this thickening process can wreak havoc on not only their engine, but also their oil.

You see, because most petroleum oils contain paraffins (wax), they tend to thicken up considerably in cold temperatures. Additives are used to help keep the oil from thickening too much due to these waxy contaminants.

In areas where the temperature remains below zero for any period of time, these additives are used up very quickly. As a result, the oil begins to flow less easily in cold weather temperatures. Of course, the result is harder cold starts and tremendously increased engine wear. Thus, the oil must be changed in order to provide the cold weather engine protection which is necessary.

Synthetic oils, on the other hand, contain no paraffins. Therefore, they need little or no additive to help with cold temperature operation. Moreover, even without the additives, synthetics flow at far lower temperatures than petroleum oils. For instance, most 5w30 petroleum oils have pour points of about -30 to -40 degrees F. Many synthetic oils, without any pour point depressants, have pour points below -60 degrees F. That's a big difference.

Since synthetics contain no additives to aid with cold temperature flow, synthetics maintain their cold temperature flow characteristics for a long period of time. Additive depletion is not a factor in the cold temperature flow of synthetic oils. And, as was indicated earlier on this page, synthetics do not thicken due to burn-off. So, this is not a factor in cold temperature flow either. Of course, the obvious result is that you don't need to change synthetic oil as often to regain adequate cold temperature flow.

More Motor Oil Additive Info: MOB Chapter 3

Another part of cold weather driving that is extremely tough on an oil is condensation. Because it is so cold, it takes a fairly long drive to get the engine warm enough to burn off the condensation that occurs inside the engine. As a result, vehicles routinely driven short distances in cold weather will build up condensation within the oil. If left to do its dirty work, this build up of water would cause acids to be created within the oil and corrosion would begin within your engine.

So, there are additives in the oil which are designed to combat these acids. Synthetics contain higher quality and a higher quantity of these additives in order to properly neutralize these acids for a longer period of time. These additives do deplete over time, but it takes longer with synthetic oils than with petroleum oils.

What About Additive Depletion?

Additive depletion is also an issue which comes into play when discussing oil drain intervals. If additives are depleted, the oil cannot effectively do it's job. So, the oil must be changed.

Now, first of all, I need to make it abundantly clear that I am not speaking of "Miracle Oil Additives" such as Duralube, Prolong and the like, when I refer to oil additives. I am speaking of the additives that are in your oil right from the original bottle that you pulled off the shelf.

Many people swear by the "miracle" additives I mentioned above, but I am a firm believer in independent lab results. Every independent test I've seen regarding special oil additives such as those mentioned above has given no indication that they provide ANY measure of increased engine protection. In fact, in some cases they may even increase engine wear.

However, this is a whole different story that deserves a complete article. So, for the sake of remaining on topic, I am going to return to the article at hand and leave you to study this oil additive issue a little further on your own.

It is true that the additives in many oils begin breaking down after only a few thousand miles. What needs to be recognized is that there are different quality "grades" of additives just as there are different quality grades of just about any other product that you buy.

Making a blanket statement that additives in motor oils die after only 2 to 3,000 miles is like saying that automobile tires will only last for 30,000 miles. To be sure, there are plenty of tires on the market that can only last for 30,000 miles, and then they're toast. But, there are many tires on the market nowadays that will last over 75,000 miles.

The same scenario holds true for motor oils. Many oil companies are using the same additives in their oils as all of the other companies because they are cheap. That's why the oil costs less. You get what you pay for.

If they were willing to spend the money on top-quality additive packages for their oils, every synthetic on the market would be recommended for extended drain intervals, and they would all be more expensive. The technology has been around for years. The problem is that oil companies make more money selling a cheaper grade oil and making sure that you change it more often.

So, what do the oil additives in your oil do? Why are they used? Well, let's see...

1. **VISCOSITY RETENTION** -- Additives are used to maintain a stable viscosity over a wide temperature range. Synthetics need less of these additives than petroleum oils do because synthetic basestocks maintain a fairly stable viscosity by themselves. Also, the additives that are used are more stable than those used in petroleum oils.

   As a result, petroleum oils must be changed often because they quickly become unable to retain the viscosity levels necessary to protect your engine (their high temperature viscosity drops off). Synthetic oils don't really have that problem because both the basestocks and the additives are more stable.

   NOTE: It was mentioned earlier that petroleum oils tend to thicken due to burn-off. The statement above is not contradictory to that. It just indicates that petroleum oil is vulnerable to two opposing types of breakdown, which, in the end, cause great stress to an oil and leave your engine lacking the protection that it needs.

2. **CONTAMINANT CONTROL** -- Additives are also used to keep oil contamination in check and to keep it from damaging your engine. These additives keep potentially wear causing contaminants suspended and contained in your oil so they don't cause excessive wear or deposit build-up within your engine before your filter can remove them.

   Synthetics generally have higher additive treat rates than petroleum oils (in addition to using higher quality - more expensive - additives as mentioned earlier), so they can perform this contaminant control function for a much longer period of time than a petroleum oil can.

3. **ACID CONTROL** -- Total Base Number (TBN) describes the acid neutralization ability of an oil, with higher TBN oils providing longer lasting acid neutralization. Synthetics nearly always have higher TBN values than petroleum oils do. The result: longer and better acid neutralization capability allowing for extended drain use.

The above is only a short list and brief description of what types of additives are used in motor oils to better protect your engine. More information about these oil additives and others (what they do, what materials are used, what types there are, etc.) can all be found in the full version of "The Motor Oil Bible". You can use the link below to upgrade.

How Does Oil Contamination Occur?

Of course, additive depletion and degredation of oil basestocks are not the only things that cause an oil to need changing. There is also the issue of contamination.

Oil will be contaminated in three major ways. One will be through debris that comes in through the air intake. Once it makes it through the air filter, it ends up in your oil. Once in your oil, it starts damaging your engine.

The second source of contamination will be metal shavings from the inside of your engine. The lesser the quality of the oil, the higher percentage of these shavings because there will be more wear inside the engine.

The third source of contamination will be from combustion by-products. Combustion by-products will generally raise the acidity of your oil, which causes corrosion in your engine. In addition, they will be left behind as the engine oil burns off and will collect on the inside of your engine as deposits. To maintain the viability of your oil as well as protection of the engine, the contaminants have to be removed or neutralized.

TAKING AFFIRMATIVE ACTION

One of the best ways to help with this process is to keep most of the contaminants from ever getting inside the engine in the first place. That's where your air filter comes in. Conventional paper air filters do a decent job. But, consider the number of times that you've removed your air filter only to find that you could write your name in the dust that collected around the air intake? That's just the stuff that was left behind. Imagine what actually entered the engine.

Part of the problem is that traditional paper filters do not fit all that snugly in the air intake compartment. They've improved, but they're still not great. More importantly, though, they let way too much debris shoot right through the filter element itself. As a side-note, they do not provide for very good air flow either.

You see, as a compromise to allow enough air flow for your engine to run "properly", surface type air filtration media have to allow certain sized particles to flow through. If they made the filtration media any more tightly woven, not enough air would pass through quickly enough to keep your vehicle running.

As a result, most paper filters won't catch anything smaller than about 20 to 40 microns with any real efficiency. In most cases, the more expensive the filter, the lower the micron level of filtration - the lower the better, of course.

20 to 40 microns is pretty small. A human hair is about 100 microns in diameter. The problem is that the majority of engine wear is caused by particles between 5 and 20 microns (most likely because there is so much more of these particle sizes). If you don't keep that stuff out, it'll eat away at your engine.

Because this is such an important issue to the protection and performance of your engine, I highly recommend looking into a better air filter for your vehicle. But, be careful. Some performance air filter manufacturers are screeming about better air flow, which is great for performance. However, they're not saying much about filtration efficiency.

The simple fact is, if you let more air into your engine as a result of better air flow, you NEED to also have better filtration efficiency. Otherwise, you WILL let more dirt into your engine. There's just no getting around that.

So, if you're looking to extend oil drains, don't just look for better air flow. In fact, although it would be nice to get better air flow AND better filtration efficiency, if you can only get one or the other, go for efficiency. Air flow at the expense of engine protection is only an acceptable option for race vehicles. If you plan on keeping your vehicle for awhile, always opt for protection before performance, if it has to be a choice.

More information about high efficiency air filtration (including a discussion of oil wetted foam and cotton gauze filters) can be found in the full version of "The Motor Oil Bible". You can use the upgrade link below to order your unlocking password.

Engine Wear Particles Cause Oil Contamination

Ok, so we've taken care of the air intake, but what about metal particles from engine component wear? Well, there are a couple of things going on here that lead to better protection from a synthetic oil. One aspect that proves to be very important is cold weather starts.

Now, all of us have heard about cold weather starts for years from oil additive manufacturers. We've all heard, "Just put our additive in your crankcase and it will form an impenetrable layer over engine components that will protect your engine against wear, especially at start-up. In fact, it's so good, you could even drain the oil from your engine and drive it around the track a million times at 60 mph."

Hogwash. Just about all of the companies that have made claims like this over the years have been brought up on charges by the FTC. They're full of it. However, they were right about one thing. Cold-weather starts are killing your engine. Consider this:

COLD WEATHER STARTS: AGENTS OF DOOM

The pour point of an oil is 5 degrees F above the point at which a chilled oil shows no movement at the surface for 5 seconds when inclined. That's tech-talk which basically means that the pour point of an oil is the point at which it ceases to be "pourable". This measurement is especially important for oils used in cold climates.

A borderline pumping temperature is given by some manufacturers. This is the lowest temperature at which the oil will pump and maintain adequate oil pressure within an engine. This is not given by a lot of the manufacturers, but can be anywhere from 5 to 15 or 20 degrees F above the pour point. So, the lower the pour point the better.

For cold weather operation, most vehicles should be running a 5w30 or 10w30 motor oil. Most 5w30 petroleum oils have pour points in the range of -30 to -40 degrees F. That means that their borderline pumping temperature is, between -35 and -15 degrees F when they come out of the bottle. In most cases, closer to the warmer end of the scale.

In a cold climate where every day is 0 degrees or lower, the pour point depressant additives in a petroleum oil are used up quickly. As these additives are used up, the pour point (and borderline pumping temperature) of the oil rises. In addition, after the engine heats up the oil is subjected to high temperature conditions that burn off the lighter molecules in a petroleum oil, causing it to thicken.

So, if you're running a petroleum 5w30, expect **decent** cold weather starts when the oil comes out of the bottle. But, after a thousand miles or so, don't expect to go out and start your car at -10 degrees and have it purr like a kitten. It's going to spit and sputter and kick and scream for a few minutes.

Why do you think that is? It's not getting any oil up into the engine. It's like trying to suck molasses through a tiny straw in an Alaskan January. There's literally nothing keeping the metal components in your engine from tearing each other apart. Every time you start your engine in conditions like this, your engine dies a little bit more. Your oil is dying, and it's taking your engine with it.

Synthetic oils, on the other hand, routinely have pour points around -50 degrees F or colder. Some have pour points as low as -60 to -70 degrees F. Granted, there are very few of us who will ever have to start our car at this temperature, but imagine how well these oils lubricate at -20, if it they still flow at -70. And, because synthetics don't need additives to maintain their low temperature fluidity (as we discussed earlier), they continue to flow at these extremely low temperatures for a much longer period of time.

Now, I know that some of you live in areas where you almost never see temperatures under freezing. For you folks, the pour point of your oil may be a little less important, but it still serves to prove a point about the protection differences between petroleum oils and synthetics.

SUPERIOR FILM STRENGTH

There is one other major advantage synthetics have over petroleum oils when it comes to engine protection: film strength. You might hear synthetic oil manufacturers throwing this term around quite a bit, and with good reason - it's important.

You see, the film strength of an oil represents its ability to maintain lubrication between moving parts as pressure is applied and the lubricant film "thins" out. Does the oil eventually get "wiped" away under high stress conditions or does it maintain itself and prevent metal to metal contact?

Synthetics have much higher film strength than petroleum oils do. So, a lighter weight synthetic oil that provides for good low temperature protection can still provide good protection under high heat, high load conditions. Obviously, this will reduce engine wear. And, less engine wear means less oil contamination. Hence, longer oil life.

More Motor Oil Film Strength Info: MOB Chapter 7

On a side note, lets get back to that impenetrable barrier over your engine components that oil additive manufacturers sputter about all the time. Although, there is no scientific testing that proves this will really occur in actual automotive applications when using an oil additive, synthetic oils do provide something similar to this.

It's certainly not impenetrable, and I wouldn't go draining your oil after installing 6 quarts of synthetic just to see if your engine still runs, but it does serve a purpose. Your engine should virtually NEVER see metal to metal contact, whether in hot or cold climates. That's something that a petroleum oil can't do.

As a result of these enhanced protection capabilities, synthetic oils routinely perform better on standardized ASTM wear scar tests. This would indicate a higher level of engine protection and would certainly lead to fewer engine wear particles in an engine. Hence, fewer contaminants in the oil to necessitate changing it.

Combustion By-Products Cause Engine Damage

Only one type of contaminant left to discuss: combustion by-products. These little buggers can wreak havoc in an engine. Not only can they form deposits on the inside of an engine which will rob it of performance and, ultimately, life expectancy, they will also tend to raise the acidity of the lubricant. Higher acidity levels in your oil can lead to severe corrosion and break-down of engine components. In turn, this break-down leads to more oil contaminants and the necessity for an oil change.

Three things keep these contaminants in check: the TBN of the oil, high efficiency oil filtration and tight ring seal. The most important of these three is ring seal. If the number of combustion by-products entering your oil can be reduced, there will be less necessity to remove or neutralize them.

Poor ring seal allows combustion by-products to pass from the combustion chamber into the crankcase where they contaminate the oil. Tight ring seal keeps them out. Synthetic motor oils encourage a tighter ring seal than petroleum motor oils do.

As we discussed earlier, TBN (total base number) is a measure of how well a lubricant can neutralize acidic combustion by-products. The higher the TBN, the better the protection against these acidic by-products and the longer that protection will last. Hence, the possibility of longer oil drain intervals.

Oil filtration is the last component that must be discussed when making the case for extended oil drains. The next chapter in this series addresses this critical component.

Efficient Oil Filtration Highly Recommended

Now, on to oil filtration. Even having taken care of all other issues relating to oil contamination, there is still a certain amount of dirt and debris in your oil which must be taken care of. Hence, there is a necessity to maintain adequate oil filtration in order for a lubricant to remain viable. Even though the extra dispersancy additives in a synthetic oil keep dirt and debris surrounded and impede contact with engine components, those contaminants must still be removed. This is where your oil filter comes into play.

First of all, the statistics previously mentioned regarding engine wear haven't changed. Studies have shown that the majority of all engine wear is caused by particles between 5 and 20 microns. Unfortunately, most standard oil filters are only marginally efficient down to 20 microns or so. That means the stuff that causes the most wear is still left in there.

The actual filtration efficiency of a particular filter really depends upon the filter manufacturer, and it is sometimes very difficult to get any specific numbers from them regarding their filters' actual filtration efficiency at any micron level.

In some cases there is good reason they won't give a micron rating. But, they should at least provide some industry standardized testing numbers to give some indication of their filters' efficiency level.

MICRON LEVELS NOT GREAT FOR COMPARISON

If you do any research on your own, you'll find that most manufacturers no longer use micron levels to rate their filters at all. This, I believe, is a result of some manufacturers' shady representation of their filters using micron ratings. You see, some filter manufacturers would indicate that their filters remove x micron particles and leave it at that ("x" being whatever arbitrary number they chose to print). Of course, consumers would take this to mean that all particles larger than this micron level would be removed, which is not necessarily the case.

The truth is that chicken wire will remove 5 micron particles. It will even remove 1 micron particles. BUT, it will not do so with very good efficiency. The key is, how **efficient** is the filter at removing x micron particles. If you don't know how efficient it is at a certain level, the micron rating means nothing.

So, most companies have gotten away from micron ratings (to avoid the confusion) and have gone to an overall efficiency rating. In other words, one of a number of industry standard tests is used in which oil is contaminated with a certain number of particles of varying micron sizes (or a certain amount of a particular "grade" of dust). At the end of the test, there is a measurement taken to determine the total percentage of ALL contaminants that were removed by the filter. That percentage is then stated as the overall filtration efficiency of the filter.

Some companies use a single pass efficiency test, others a cumulative efficiency test and still others use a multiple pass test. All three are perfectly valid and will give you an excellent way of determining how well a filter will do its job, but you should not try to compare results from one to another. You'd be comparing apples and oranges. In any case, high efficiency filters will rank in the low to upper 90's for overall filtration efficiency. Off-the-shelf, cellulose type media filters will generally rank in the mid 70's to mid 80's for overall filtration efficiency.

IF MICRON LEVELS ARE TO BE USED

Nevertheless, you may still want to compare filters using micron ratings. If this is the case, the following is a good rule of thumb. A filter is considered nominally efficient at a certain micron level if it can

remove 50 percent of particles that size. In other words, a filter that will consistently remove 50% of particles 20 microns or larger is nominally efficient at 20 microns.

A filter is considered to achieve absolute filtration efficiency at a certain micron level if it can remove 98.7% of particles that size or larger. So, if a filter can remove 98.7% of particles 20 microns or larger, it achieves absolute efficiency at 20 microns.

Now, it is worth noting that absolute and nominal efficiency ratings are normally applied to bypass oil filtration systems, but they are sometimes used to rate full flow spin on oil filters as well.

Bypass Oil Filtration System Info: MOB Chapter 11

Most off-the-shelf filters are based upon a cellulose fiber filtration media. Most of these filters are, at best, nominally efficient at 20 microns. They won't generally achieve absolute efficiency until particle sizes reach well over 30 microns. Be careful in interpreting what you read. You'd be surprised what some manufacturers consider to be "good efficiency".

As an example, although a major filter manufacturer's website indicates that their automotive oil filters remove "essentially all the contaminant particles larger than 25 microns", upon contacting a representative I found that they gave a nominal rating of 20 microns for the filter that fits my Windstar.

Another major oil filter manufacturer that had a nominal efficiency of 22 microns had an absolute efficiency rating of 45 microns. The same trend would likely hold true for any filter designed with a cellulose filtration media. So, apparently, "essentially all contaminant particles" is about 50 to 60% of them (at least for one manufacturer).

High efficiency oil filters have filtration media made of a combination of at least two of the following: glass, synthetic fibers and cellulose fibers. Those that use all three are generally the best in terms of filtration. Those that use only two will fall somewhere in between. The best of these high efficiency filters will likely achieve absolute efficiency down to about 15 to 20 microns and will be nominally efficient down to around 5 or 10 microns.

It is difficult to give exact numbers in this regard since most manufacturers of high efficiency oil filters have moved away from using micron ratings. They are now defining their filters' efficiency using the overall percentage rating that I spoke of earlier.

There is also an issue of capacity. The fact that an oil filter has good efficiency, does not necessarily mean that it has good holding capacity. In other words, it might not hold very much contamination. Thus, it would need to be changed often.

You'll find more information about oil filters (including more detail on capacity issues, AC Spark Plug/Detroit Diesel testing showing a correlation between improved filter efficiency and significant reductions in engine wear , filter recommendations, etc.) in chapter 10 of "The Motor Oil Bible". The upgrade link below will allow you to purchase a password to unlock the chapters of "The Motor Oil Bible".

Synthetic Oils Offer Greatly Extended Drains

Well, if this info doesn't at least get you thinking about switching over to synthetics, I'm not sure what will convince you.

There are a few oil companies out there that are manufacturing oils which are good for extended oil drain intervals. I'll speak more about the specific companies in the next chapter. However, since many people use Mobil 1 and believe it to be the best synthetic available (mainly because it is the most recognizable name), I thought I might spend a little time touching on that particular company.

In my opinion **Mobil 1** oils are most likely good for 10,000 to 15,000 miles or six months, but the company does not make that recommendation. I have known of many people who do very well running **Mobil 1** for these intervals (and some even longer), but it has not been designed specifically for extended drain use. Moreover, the company might not back you if you had any mechanical problems resulting from such extended drain use, since they only recommend "manufacturer recommended change intervals".

In light of the information above, I would like to leave you with a few notes of importance. If a synthetic oil is not specifically recommended for extended drain use, and you choose to attempt extended drains, you do so at your own risk. Extended drain synthetic oils must be formulated with special long-life additives and blended basestocks so as to maintain their lubricating properties for an extended period of time.

In addition, in order to get the full benefit from extended drains, it is most beneficial to be using high efficiency oil and air filtration as well. If you are using traditional filtration methods, you will likely have to change your oil more often and will end up with reduced engine protection. If you're going to do it, do it right. It will cost you less in the long run, and probably in the short run too.

Very Few Companies Offer Extended Drains

Now, you may be saying to yourself, "This is all great, but there is something I just don't understand. If there are oils out there that will last for 25,000 miles - and have been for over 25 years - why am I still being told to change my oil every 3,000 miles? Either someone is lying or someone just doesn't have all of the facts.

Well, I believe that it is a little bit of both. You've probably heard that 3,000 mile oil changes are necessary from friends, family, possibly your mechanic and definitely your local quick lube operator. The problem is, most of them are just reiterating what they've been told for years - and it has served them pretty well.

Most of them simply do not understand lubricants nearly as well as they think they do. Even those mechanics who are brilliant when it comes to automotive engines are not necessarily experts on lubrication. Lubrication technology is much more involved than most of them thinks.

Nobody can know everything, but in order to give people the most accurate advice, it pays to make sure that you have all of the relevant information.

I believe that there are even a large number of quick lube operators that don't know nearly as much about lubricants as they'd like to think. However, I also believe that some of those same quick lube operators that are telling you to change your oil at 3,000 mile intervals might very well be using synthetic oil for extended oil drain intervals in their own vehicles.

WHAT DOES THE INDUSTRY SAY?

It's sad, but true. Oil companies and many quick lube operations know that synthetic oils are capable of extended drain intervals but are too afraid of lost revenue to admit it. In fact, here are a few quotes from different people in the automotive and lubrication industries which should illustrate what I mean:

According to GM's Mike McMillan, "Certainly there is technology available to raise the standard and extend the drain interval without compromising engine durability or removing the performance cushion ... Europe is already at a 9,000 mile drain interval and is seriously considering twice that".

Most other auto manufacturers agree. In the May 1996 issue of Lubes 'n' Greases representatives from the three major US auto makers detailed how lack of knowledge about available lubricant technology led to an unsatisfactory PCMO (Passenger Car Motor Oil) upgrade.

In "GM's Tough Agenda for Lubes," Lubes 'n' Greases reports that extended drains are a customer service issue. "...We're very concerned about engine durability and oil drain intervals particularly as they impact reducing the amount of maintenance our customers are required to perform. Customers want to minimize their vehicle maintenance time and changing engine oil is their single biggest remaining maintenance item. Addressing that issue is very important to us."

In response to this issue, GM has even come out with an oil life monitoring system for many of it's vehicles. Although it does not actually test the oil to determine its viability, it does monitor important system information to establish whether the oil is being exposed to conditions that would require a more frequent or less frequent change interval. The system isn't perfect, and it doesn't account for the long drain capability of synthetic oils, but it's at least a step in the right direction.

Even quick lube operations know that the technology exists to extend oil drains well beyond the 3,000 mile mark. Some are embracing extended drain technology as a way to increase customer satisfaction

as well as company profits by working WITH the improvements in lubrication technology, instead of against them.

Dennis Brooks, Vice President of SpeeDee Oil Change and Tune-Up, implied as much in a statement he made in the November 1996 issue of National Oil & Lube News, a respected periodical in the lubricants industry.

In regard to the extended drain issue Brooks said, "I believe there will be greater potential to move into selling a higher percentage of synthetic oil."

Others in the quick lube industry, however, are running scared. Jim Sapp, Convenient Automotive Services Institute (CASI) president, is quoted in the same article as saying, "For years, Jiffy [Lube] has preached the 3,000 mile or three month oil change interval. And fortunately for us, many motorists take it as gospel. But we need to do more as an industry ... It's not inevitable that intervals will expand to the point where we can no longer stay in business." (In other words, we **can** keep extended drains from becoming common in the marketplace).

In the October 1996 issue of Lubes 'n' Greases, Quaker State CEO Herbert M. Baum suggests, "We need to go on the offensive. Stop fighting with each other and go forward as a group; fight for regular oil changes. We have to build business as a group, and it's the role of our associations to promote the use of our products."

Nevertheless, Quaker State now is manufacturing and selling an oil which they say can last for 7,500 miles (although they neither recommend nor guarantee those intervals).

More recently, Marc Graham, the president of Jiffy Lube International, spoke with Lubricants World (a highly respected lubricants industry journal). In the September 2001 interview, Graham vehemently opposed extended drains.

Graham said, "There is a significant issue out there that affects anybody that utilizes lubricants, and that is extended drains...Everything we can do to bring the oil change interval back into a logistical time-frame, the better off we are."

Of course, Graham makes no mention of premium synthetic oils which provide better protection for longer periods of time than petroleum oils. But in his defense of 3,000 mile changes he does go on to say this:

"Jiffy Lube ... estimates that if we increased one car per day [per shop] in our system, that's $33 million in revenue...Looking at this from another angle, if we could move our customers to get one more oil change per year it's worth $294 million for the oil change alone and $441 million in revenue, when you include the ancillary products and services customers typically buy along with an oil change."

Of course, since Jiffy Lube is owned by Pennzoil-Quaker State (PQS), it should be of no surprise that what benefits Jiffy Lube, benefits PQS. PQS's bottom line is directly affected by how well Jiffy Lube promotes the 3,000 mile oil change.

The same is equally true of other major motor oil manufacturers who either own lube chains or set up arrangements with quick lubes to offer their products. Shorter drain intervals helps everyone but you, the vehicle owner. You're getting fleeced.

Now, in Marc Graham's defense, he does make one brief statement about his belief that when extending oil drains "past a certain mileage, emissions increase, gas mileage decreases and your engine suffers", which would seem to indicate that maybe he's concerned about the protection of your

engine. And, of course, he's right, but only in regard to petroleum lubricants. But, if protection of your engine was his main concern he wouldn't have spent three quarters of his interview talking about Jiffy Lube's bottom line profits, would he?

THE TIME HAS COME

As hard as motor oil manufacturers and quick lubes are fighting to maintain 3,000 mile oil changes, they're fighting a losing battle. You see, extended drains are happening and have been scientifically proven for nearly 30 years to be safe - as long as the oil used has been designed for extended drain use. As of April 2001, I know of at least 6 oil manufacturers that actually recommend extended drain intervals for their oils. The 3 most recognized are NEO, Amsoil and Red Line. There are also other, lesser known brands.

Most other "off-the-shelf" synthetic oils should last longer than 3,000 to 5,000 miles, but most oil manufacturing companies do not recommend, nor will they back such practices with any sort of warranty.

Amsoil recommends 25,000 miles or one year for most automotive gasoline applications. NEO also recommends 25,000 miles or one year. Red Line gives a range of 10,000 to 18,000 miles as the recommended change interval, depending upon your driving habits. NEO and Amsoil began manufacturing extended drain synthetic oils in the early 70's. Red Line followed in the mid to late 70's as I understand it.

Amsoil sells for about $6 per quart for 5w or 10w30 depending upon where you purchase it. They also have a wholesale buying program (like Sam's Club) that will get your price closer to $4.50 per quart. Red Line follows at an average of $7.50 to $8.00 per quart. NEO appears to be the most expensive of these three at $9 to $10 per quart. These prices are averaged from Internet website shopping areas selling the products.

Any way you slice it, if you choose to use 25,000 mile drain intervals, it would cost only about $50 to $100 per year for the convenience of having only one oil change and the piece of mind of knowing you're using premium synthetic oil in your engine. Might be worth thinking about, wouldn't you say?

More Info on Extended Drains

Because this topic is discussed in great detail in the preceding chapters, this chapter will be somewhat short. Nevertheless, there are a few issues which haven't yet been touched on, and they need to be addressed.

First of all, if you haven't read through the preceding chapters under the "3,000 Mile Change Myth" heading, please do so now. Some of what I say here may relate to information already presented there. If you haven't read it, you might get lost in the details or may wonder why more detail isn't provided.

Ok, now that you're up to speed, I'll briefly recap and then begin. Put simply, large oil companies and quick lubes have spent decades finding new ways to convince vehicle owners that 3,000 mile oil changes were a necessity.

Never have they made any distinction between synthetic and petroleum oil drain intervals even though just about every automotive trade journal has indicated that synthetics will last at least 2 to 4 times longer than petroleum oils. For an industry that seems to be all about service, this doesn't sound like customer service to me. It's all about money, and you're the one getting your pockets cleaned.

HOW FAR CAN YOU REALLY GO?

The complete answer to that question refers to both lubrication and filtration. Not only do you need a good oil, but it is also a good idea to have the best filtration you can find. It's not absolutely necessary, but it can help tremendously.

Believe it or not, there are vehicles that go hundreds of thousands of miles without an oil change. But, these vehicles are using special filtration systems called bypass filters. We'll talk more about them in a later chapter, but to give a brief explanation: These oil filtration systems siphon off only a small amount of oil at any given time and "super-filter" it to remove basically ALL contamination. By removing virtually all contamination, these systems allow the oil to last for years without changing.

However, it is advised that a person using bypass filtration still perform oil analysis at least once per year to determine if the oil is still good and if the filters are functioning correctly. Oil analysis is a very effective way of determining how well an oil is holding up under certain circumstances.

If you have been a regular 3,000 mile changer for years and intend on trying extended drains (but are a little uneasy about it), I recommend that you utilize oil analysis to confirm the possibility of extended drains. Do oil analysis any time you begin to get nervous about your oil or whenever you would normally have done an oil change. More times than not, the results will come back indicating that no corrective action is necessary.

Again, for more information about extended drains, please read the "3,000 Mile Change Myth" chapter.

High Efficiency Filtration

When speaking of high efficiency filtration, I am referring mainly to oil and air filtration. Other areas of filtration are important, but none more so than these two when it comes to engine protection and performance.

AIR FILTRATION

Your air filter is the guardian of your engine. It stands at the gates of your engine's air intake and wards off renegade dirt particles that want to wage war on your engine. The question is, who do you want standing at the gates, your best soldier or some guy who was just promoted from "boot boy"? I think the answer is clear.

So, as opposed to the standard paper filter that we're all so familiar with, consider an alternative air filtration device which is more like a sponge (actually, it's foam). Because foam is "squishy" it can be made slightly larger than the air intake compartment so that when installed it fits very snug with no room for air to by-pass the filtration unit.

In addition, it has millions of "tiny" channels through which air can flow, but these channels are not straight channels. They twist and turn through the filtration media. Air can pass through easily because these "tiny" channels are actually much larger than the channels through the paper filter we just discussed. This is possible because the paper filter only has one chance to get the dirt. This foam media has multiple opportunities to catch the dirt.

You see, as the air travels through these winding channels, it can turn this way and that with ease. However, the dirt particles that the air is carrying travel in a straight line until they hit something. Obviously, at every turn, the debris within the air hits a "wall".

You say, "Well, that's great, but why doesn't that dirt just bounce off the wall and keep right on going?" Good point. I tell you what, why don't we put a tacky substance in the foam so that when debris hits these "walls" it's stuck there like a fly to one of those sticky tapes. You say, "Yeah, that would work!"

Not only will it work, it will work far better than the paper air filter discussed above. Because of the depth-type nature of the foam filter AND the added tack oil, it will remove MUCH more dirt and MUCH smaller dirt particles.

Now, we've established that such a filtration media would seal up the intake compartment, should have better air flow, and we've established that it has more opportunities to catch the dirt, so less dirt makes it into the engine. The next question should be, will it hold as much dirt as the paper filter?

Well, of course it will. It's much thicker than a paper filter, and, because of the nature of the foam media, has a virtually limitless surface area over which to collect dirt. In fact, the more dirt it collects, the better the filtration (with minimal reduction in air flow). It's also much more durable than paper, so it NEVER needs to be replaced. Just wash it once a year, re-oil it and put it back in the vehicle.

WHERE CAN A PERSON GET ONE OF THESE?

Well, there are a number of companies out there that produce these foam filters, but many of them only produce them for motorcycle type applications. There are, of course, new companies sprouting up all the time with new filtration ideas or reworked old ideas, so some research might turn up a few I haven't yet heard of.

One company that I know produces these filters for automotive type applications is AMSOIL. They are a lifetime filter (guaranteed for the life of the vehicle) and must be washed with soap and water and re-oiled about once per year. They've been producing these filters for quite a long time now.

ITG also makes a foam air filter. It is not washable/reusable, but I have to assume it has similar filtration and air flow characteristics to the AMSOIL filter line. The ITG line includes filters for many small engine applications as well. AMSOIL air filters mainly apply to automotive applications.

The Amsoil foam filter has been tested on the industry standard SAE J726C test procedure and is shown to provide significant air flow and filtration efficiency increase over other air filter types. I haven't seen J726C test data on the ITG, so I'll focus on the AMSOIL filters at this point. Take a look at the ITG website for more info on these filters.

There are filters to fit most vehicles, although some have to be special ordered. If there isn't one to fit and you can't find another manufacturer that makes a similar type filter, try getting a paper filter with a foam wrap. This will at least help somewhat.

WHAT ABOUT COTTON GAUZE FILTERS?

Well, most of us know the most well known brand of cotton gauze filter. We'll call them "Brand X". Well, Brand X, appears to have pretty good air flow characteristics, at least significantly better than pleated paper filters. Also, their filters are guaranteed to last for 1,000,000 miles or 10 years - far longer than a paper air filter ever could. As a result, even though you pay quite a bit for them, you'll probably spend less over the life of your vehicle than you would on paper filters.

I do find it somewhat comical, though, that their warranty covers their air filters for 1,000,000 miles or 10 years. That's 100,000 miles per year. How many people do you know that can drive that many miles in a year? Most people won't get much more than 200,000 miles out of a Brand X filter under a 10 year warranty. Granted, that's still quite a long time and would offer significant long-term savings over conventional air filter purchases. But, you have to admit, it's not REALLY a 1,000,000 mile warranty for 99% of vehicle owners - most people will **never** drive that far. It's a marketing tactic, and a fairly good one, I have to admit.

AIR FLOW VS. FILTRATION EFFICIENCY

Brand X filters DO seem to provide enhanced air flow to your engine, thereby increasing horsepower. You wouldn't find so many racing engines using them if they didn't. So, if you're looking for performance, Brand X does offer that. In addition, they have kits for modifying your air box to provide even more air flow, as opposed to just using a drop in filter. Again, for performance minded folks, this is a bonus, I suppose.

Unfortunately, I find no conclusive evidence that a Brand X filter has any better filtration efficiency than a typical paper air filter element. In fact, until very recently (early 2002) there was no reference to filtration efficiency testing on ANY Brand X website I had been to - weather the company site or a distributor site.

I suppose that doesn't necessarily mean the data didn't exist, but if Brand X filters provide better filtration efficiency, why wouldn't it say so in their literature. It only makes good sense to publish positive information about such an important benefit. If I sold Brand X filters, I'd certainly be mentioning it, wouldn't you?

The truth is, although they talk incessantly about increased air flow and horsepower, any past reference I've ever seen to Brand X filtration efficiency stated something similar to: "Brand X developed an oil

impregnated cotton air filter gauze which exceeds the minimum filtration standards".

That's not too impressive to me. Standard paper filter elements achieve that. They basically have to in order to be sold in stores. And, although Brand X indicates that the filtration efficiency of their filters increases as they collect dirt, so does the efficiency of paper filters. Paper just happens to lose air flow much more quickly.

Important News Regarding "Brand X" Filters

As of March 2002, Brand X appears to have testing data on their website which indicates an initial efficiency of approximately 97% and a cumulative efficiency of just slightly over 99% on the SAE J726 air filter test. Of course, Brand X wants to brag about these results, but I'd like to make note of a few important issues.

First, the test data is from 1999. Now, I'm not saying that makes the information dated. If there have been no changes to the Brand X filter construction since then, the data is still valid. However, if the data has been around since '99, why is it just being published now? If it shows their filter to be so wonderful, wouldn't it have made sense to publish it back in '99, when the tests were run?

Second, the J726 test is only useful when put into context. Many variables within the testing parameters are adjustable depending upon the application the filter is being tested for, etc. For instance, there are two different air boxes that can be used on this test which could yield different efficiency numbers for the exact same filter.

In addition, you're not required to use the same contaminant every time you run the test. Not only is there the option of using either AC Test Dust or Glass Beads, but you can also choose the micron levels to test at. With glass bead testing, you can get very specific and only test beads of a very narrow micron range if you like. With AC Test Dust, there are numerous different "grades" of dust you can use which range from extremely coarse to extremely fine.

A "coarse" AC Test Dust will have very few particles under 20 microns, whereas a fine test dust will have a very high percentage of particulate matter under 20 microns. Although in years past many J726 tests were being run with coarse test dust, this trend is changing. Since it's been established that the majority of automotive engine wear is caused by particles in the 5 to 20 micron range, more and more of these J726 tests are now being run with fine test dust so as to more closely approximate the conditions the filter will encounter when in consumer vehicles.

So, I find the new Brand X filter test data to be of little use in the grand scheme of things. First, they've used the coarse grade test dust which doesn't really tell us how well the filter will remove the particles which are most damaging to your engine. Second, since there is no way to guarantee that other filter manufacturers have used the same parameters for their J726 tests, there is no way to compare the Brand X results to other manufacturers' test results.

If Brand X wanted to show their filter superior to other filters, they would have had their independent lab run the J726 on comperable competing filters using the exact same testing paramaters that were used on their filter. Then, at least you could see a side by side listing of efficiencies using the same testing specifications. In addition, if they wanted to show real world performance of their filters, they would have used fine grade test dust so the testing more accurately reflected actual engine conditions seen by most vehicles.

And, just for comparisons sake, I did an Internet search for J726 test data on pleated paper filters. I didn't find much, but I did find a couple filters with test data. Each showed initial efficiencies of just over 99% and cumulative efficiencies approaching 100%. Of course, testing for other pleated paper filters might not be as good, but these results are better than the Brand X filter results.

I could do some more research and make some phone calls to determine if these tests were run with coarse or fine AC Test Dust, but either way, the results are better than the Brand X results. And, if they **were** run with fine test dust, then the filtration efficiency of these filters seems significantly better than the Brand X filters tested.

Now, please remember, any comments I've made about the Brand X filters are my opinion only. But that opinion is based upon the information available, provided both by Brand X and other manufacturers. In addition, I've seen J726 testing which actually did pit the Brand X filter up against two comparable filters (one foam and one traditional pleated paper) using the same J726 test parameters for all filters. The Brand X didn't fare very well in this test. Do I know that those results weren't tampered with? No. Do I know the Brand X results weren't tampered with? No.

I have also seen more recent testing comparing the Brand X filter to comparable paper and foam filters using identical test parameters which shows the Brand X getting stomped by both filters in the efficiency category. However, it is important to note that this testing was not based upon the J726 test parameters. It was a more simplified testing apparatus. But, the logic behind the test seems sound, and all parameters were kept the same for each filter.

Take this information with a grain of salt and do some of your own research into this area. All I'm trying to say is that you might want to give a little more thought to using something other than Brand X if your concern is engine protection. I have my doubts as to whether the Brand X filter line will serve you as well in this category as a paper filter. Do I have conclusive proof? No. Do I have sufficient evidence to point in that direction? I think so. SO WHAT. BETTER AIR FLOW - NEARLY EQUAL FILTRATION

Of course, you might say, "So, what. If I can increase my performance by increasing air flow, while still maintaining nearly the same filtration efficiency, I'm still better off. Besides, I won't have to replace my air filter every 10 to 20,000 miles. Sounds like a good deal to me."

At first glance, that might seem to be the case. However, let's discuss what I said earlier in this chapter about the relationship between air flow, filtration efficiency and engine wear. I think you'll see the potential problem that I'm focused on.

MAKING SENSE OF AIR FLOW & FILTRATION

Let's just assume that there are 10 grams of dirt sized 20 microns ("coarse" test dust size) or greater per 10,000 gallons of air that enters your engine. And let's also assume the engine receives about 10,000 gallons of air every half hour.

It could be any ratio of air vs. dirt, it really doesn't matter for the purposes of this discussion. It's the comparison percentages that matter.

If the numbers above are assumed, let's also assume that a paper element is 99 percent efficient at removing particles of 20 microns or larger (J726 test data suggests that). It then stands to reason that every hour, 9.9 grams of dirt particles (99% of 10 grams) would be filtered out and 0.1 grams would be allowed to enter your engine.

Now, let's assume that the Brand X filter provides just 10% greater air flow than a paper filter, but the same filtration efficiency. That means that over the same hour, 11,000 gallons of air would enter the Brand X equipped engine (10% more air than the paper filter).

According to the assumptions made above, there would be 11 grams of dirt over 20 microns within this amount of air (at 10 grams per 10,000 gallons of air). At 99% efficiency (the same as the paper element), over the same one hour time period, 10.89 grams of dirt would be trapped by the filter

and .11 grams would enter the engine.

Now, that might not seem like much of a difference, .1 grams to .11 grams, but consider it as a percentage. That would be 10% more dirt entering your engine! Of course, when you think about it, that only makes sense. 10% better air flow with no real increase in filtration efficiency SHOULD lead to 10% more dirt in your engine.

IS THAT A BEST OR WORST CASE SCENARIO?

The Brand X website actually claims at least 50% more air flow than traditional paper air filters and the J726 test data suggests that, at best, Brand X offers slightly lower filtration efficiency than traditional pleated paper filters. So, I would say the numbers above are very conservative and indicate what I would consider to be a best case scenario using Brand X filters.

ARE YOU SCIENTIFICALLY CERTAIN OF THIS?

No. I should make it clear that I don't have any scientific studies on Brand X filters to indicate increased engine wear (although I have caught wind of some oil analysis testing which showed increased levels of "dirt" in an engine after a switch to Brand X). I also can't say with absolute certainty that Brand X filters don't have better filtration efficiency than a paper filter, since I don't have any recent J726 testing that compares them using the same test parameters. However, based upon the evidence I do have, I'd say it's likely that, at best, they filter almost as well as a traditional pleated paper filter.

So, if that's the case, no matter how much the Brand X filter increases air flow, the potential for engine wear would seem to increase just as much. If Brand X only gives a 5% increase in air flow, then you'll only see the potential for 5% more engine wear. But, if you only acheived 5% better air flow, is it even worth it? How about a 30% increase in air flow (which is unlikely in real world applications)? Is a potential 30% increase in performance worth the potential for increased engine wear? Not in my car.

OIL FILTRATION

Any debris that manages to pass by the air filter becomes the enemy of your oil filter. The less effective your air filter is, the harder your oil filter must work. So, it is in your best interests to maintain proper air filtration. Once that is done, you must focus on finding the proper oil filtration for your vehicle.

Before you go on to read the following, you might want to take a quick trip back to chapter seven of "Exposing the Myth" for some background information on oil filters. There's some good information in there, and the following might not make much sense, if you haven't read it.

HOW IMPORTANT IS BETTER EFFICIENCY?

The fact is, you would probably be amazed at how much engine wear could be eliminated simply by using more advanced oil filtration. In paper 881825 the Society of Automotive Engineers indicates that a joint study was performed between AC Spark Plug and Detroit Diesel Corp. The study found that finer oil filtration significantly reduced the rate of engine wear.

According to the paper, the tests regarding engine wear within a diesel engine were performed using four levels of oil filtration. They chose filters whose single pass efficiency rating was very high for particles of 40 micron, 15 micron, 8.5 micron and 7 micron sizes.

The same was done for gasoline engines, except that the relative sizes were 40 microns, 30 microns, 25 microns and 15 microns.

To make a long story short, the researchers had this to say:

"Abrasive engine wear can be substantially reduced with an increase in filter single pass efficiency. Compared to a 40 micron filter, engine wear was reduced by 50 percent with 30 micron filtration. Likewise, wear was reduced by 70 percent with 15 micron filtration."

So, for the sake of argument, based upon the numbers from the test above, if most off-the-shelf filters have an absolute filtration rating of 40 microns and a high efficiency filter has an absolute filtration efficiency of 15 microns, engine wear would be reduced by 70%.

In fact, although it takes a little extra math to figure this out, even if we give off-the-shelf filters a generous 30 micron absolute efficiency rating and consider high efficiency filters to achieve absolute efficiency at 15 microns, you'd still see a 40% decrease in engine wear.

End result, by moving from a standard oil filter to a high efficiency filter, you could reduce engine wear by 40 to 70%. Obviously, this would have a significant effect on engine longevity. Not bad, for simply using a different, slightly more expensive filter (we'll get to price in a little bit).

The fact is, if I was relegated to choosing **EITHER** high efficiency filtration **OR** synthetic oil for my vehicle, I would choose high efficiency filtration, hands down. For the money, you get more benefit from improved filtration than you do from improved lubrication with a synthetic oil.

However, I would also say, synthetic oils **do** still provide a significant increase in engine protection. So, since we don't have to choose between them, I would highly recommend the combination of a good synthetic oil and a high efficiency oil filter for maximum protection of your engine.

COMPARING FILTER EFFICIENCIES

Trying to compare different filters in terms of their filtration efficiency can be a daunting task. First, you have to understand what the test results mean. But, even if you understand their meaning, comparisons can still be difficult. The reason is, there are three different industry standardized tests which can be used to measure a filter's efficiency and all 3 are still commonly used by filter manufacturers.

Unfortunately, the results from each of these tests cannot be compared to the results of the others in any objective manner. But, it is still useful to understand what the test results mean, so let me explain each of the three tests briefly.

Single Pass Efficiency (SPE): This is measured by the HS806 test specification (sometimes noted as a J806 test). The resulting percentage efficiency of the filter is calculated by taking a certain amount (weight) of contaminant in the 10 to 20 micron range and passing it through the filter ONCE. Then, the weight of contaminant that comes out of the filter is compared to the amount that went in and an overall single pass efficiency percentage is calculated.

Cumulative Efficiency: This is also measured on the HS806 test specification, but is measured somewhat differently. This efficiency rating is calculated while running a filter capacity test. On this test, contaminant dust of a certain micron range is added continuously to the test oil and run through the filter in a cyclical manner. The test ends when the filter media becomes so saturated that the pressure build-up in the filter causes the bypass valve to open.

At that point, the amount (weight) of contaminant dust left in the oil is compared to the combined weight

of the dust added to the system up to that point. This information is used to calculate both an overall capacity in grams (how much contaminant dust could the filter hold) and an overall cumulative efficiency percentage (what total percentage of the contaminant dust was removed over the course of the test).

NOTES: The cumulative efficiency test provides more useful information than the SPE test, although both are valid methods of determining the effectiveness of the filter to do what it was designed to do. Some companies actually appear to refer to this as a multi-pass test, which it technically is, I suppose, but don't get it confused with the test spec listed below. Check the SAE number to be sure you know what you're looking at.

Multi-Pass Efficiency: This test specification (J1858) provides more specific information regarding a filter's efficiency at specific micron levels. It is similar to the HS806 cumulative efficiency test in that it uses "continuous contaminant injection" and allows the oil to recirculate through the filter multiple times. In addition, it does offer a procedure for determining capacity and pressure loss values.

However, the efficiency of the filter is calculated in a different way. The J1858 test equipment actually **counts the particles** in the fluid upstream and downstream from the filter simultaneously and at timed intervals as opposed to weighing the contaminants after the test is finished. The results are listed as a beta ratio at that micron level and can be converted to a percentage efficiency rating.

In other words, a filter tested at 10 microns that had 20,000 particles coming in and 1,000 coming out would have a beta ratio of 20 (20,000/1,000) at 10 microns. It would be written $ß_{10} = 20$. This could be translated into a percentage efficiency using the following mathematical calculation: (ß - 1)/ß x 100 = efficiency %. In this case, (20-1)/20 x 100 = 95%. So, this particular filter would be 95% efficient at 10 microns.

A filter which achieves a Beta ratio of 2 at a certain micron level achieves 50% efficiency, which is considered **nominal**. A filter which achieves a Beta ratio of 75 at a certain micron level achieves a 98.7% efficiency and is considered to have achieved **absolute** filtration at that micron level.

Currently, this filter test method seems to be used more for bypass filtration systems (which will be discussed later) than for full flow filters, but some manufacturers do utilize this test and provide the test results.

"Modified Version": Be careful when reading test results for certain manufacturers. Some companies will list test results for one of the methods listed above, but will make an off-hand reference to the fact that it is modified or adjusted or something similar. To know the true nature of these test results and whether they should be trusted, I would recommend contacting the company to ask exactly what portion of the test parameters was modified and why. If you can't get a straight answer, beware.

EFFICIENCY IS NOT THE ONLY IMPORTANT FACTOR

Of course, filter capacity and quality of construction are also important considerations when choosing a filter. If a filter has low capacity and high efficiency, it will filter well but clog up quickly. As a result, your oil will begin to bypass the filter completely and will become contaminated very quickly. Filters with high efficiency and low capacity should, in my opinion, be changed at 3,000 to 5,000 miles or 3 months - without question.

Filters which have high capacity but low efficiency will last longer without becoming saturated, but will not protect your engine as well. And, of course, filters with low capacity AND low efficiency are at the bottom of the barrel and should be avoided. Both the cumulative efficiency test (HS806) and the Multi-Pass Efficiency test (J1858) provide a method for measuring capacity information in grams. Generally,

you can call a filter manufacturer and ask them specifically what their filtration efficiency and capacity ratings are for your filter. They should have that information.

If they give you a micron rating, ask them how efficient their filters are at removing particles of that micron size. You might also ask them at what micron level their filters are nominally efficient (50% removal) and at what level they achieve absolute efficiency (about 99% removal). If they can't or won't provide you with a straight answer, I wouldn't purchase their filters.

If they give you an overall percentage efficiency rating, ask them if that is for a single pass test, a cumulative efficiency test or a multiple pass test or ask them for the SAE test numbers. That will be important if you are to compare those ratings with other manufacturers so that you'll be comparing apples to apples.

I DON'T WANT TO DEAL WITH ALL OF THAT

For those of you who just want to know what's best, here's a breakdown of the top 3, in my opinion. Mobil 1, Pure 1 and AMSOIL provide the greatest filtration efficiency in the tests I've seen. Mobil 1 and Pure 1 both achieved 93% overall filtration efficiency on the SAE HS806 cumulative efficiency test. AMSOIL scored a 94%. Virtually identical. There are other high efficiency filters on the market now, and I don't have their ratings yet.

In regards to filtration **capacity**, the Amsoil filter outscored Mobil 1 and Pure 1 by a fairly wide margin. In a comparison of filters recommended for the same application, the Amsoil could hold 21 grams of particulate matter. Comparable filters from Mobil 1 and Pure 1 held 18 grams and 15 grams respectively. So, the Amsoil filter held 17% more than the Mobil 1 and 40% more than the Pure 1.

However, a comparison of filters for a different application might not have shown the same capacity results. It's hard to say. It is common for one manufacturer to have a longer filter for one application than another manufacturer, but the comparison could potentially be flip-flopped for another application. The construction of the filtration media itself plays a role in capacity as well. So, a longer filter might not necessarily have greater capacity - it depends upon how similar the filtration media is.

The Amsoil filter appears to have a little heavier construction, but everyone seems to have different criteria they use to judge this. You'd have to cut the filters apart for yourself to make your own judgements in this matter.

The Amsoil company recommends (and guarantees) changing their filters at 12,500 mile or 6 month increments for gas engines. Based on their numbers, this seems reasonable. They have better capacity and stronger construction which should allow them to achieve longer change intervals.

And, although this might seem like a circular explanation, the fact that they have guaranteed 12,500 mile or 6 month change intervals for a number of years while other manufacturers recommend significantly less, lends at least some credibility to the capacity data mentioned above. Higher capacity filters with similar filtration efficiency should acheive longer media life.

However, if you decided to use these filters with a petroleum oil, they might be contaminated more quickly. I'd change them more often in this case, although I don't believe AMSOIL makes a distinction.

Mobil 1 and Pure 1 recommend changing their filters at your vehicle manufacturer's recommendations. That generally means change the filter at each oil change which amounts to changing the filter every 3,000 to 7,500 miles depending upon driving conditions. Because of the lower capacity of the Pure 1 filters, I'd recommend changing them closer to 3 to 5,000 miles. In my opinion the Mobil 1 would probably last 5,000 to 7,500 miles with good results.

As a side note, you can determine if your oil is bypassing your oil filter by touching your filter after at least 45 minutes to an hour's worth of driving. If the filter is hot, you're probably in good shape. If it's not, the oil is likely bypassing the filter (the filtration media is too saturated with debris to do it's job effectively), and it is time for a change.

WHAT ABOUT THE PRICE?

Let's assume you drive 25,000 miles per year. The Pure 1 is about half the price of the AMSOIL or Mobil 1 in most cases, and runs about $5.00 for a filter for a 96 Ford Taurus 3.0L (in my area - Michigan). However, I recommend that it be changed more often due to a lower filtration capacity. With changes at 5,000 miles you're looking at five filters x $5 = $25. If you decide to play it a little safer and change at 3,000 miles (which I'd recommend), you're looking at about eight Pure 1 filters x $5 = $40 for the year.

The Mobil 1 and AMSOIL filters will run you roughly $10 for a filter for that same application. If you take the Mobil 1 to the high end at 7500 miles, that amounts to about 3 filter changes or $30. Playing it a little safer at 5,000 miles puts you at five Mobil 1 filter changes or $50 for the year.

If you use AMSOIL's recommended filter changes (12,500 miles), that amounts to two $10 AMSOIL oil filters or $20 for the whole year. Obviously, this is the best price overall.

However, let's consider a lower mileage driver. Let's say you drive 12,500 miles per year. That's 3,125 miles every 3 months. In this case the Mobil 1 and Pure 1 filters should likely be changed at 3 to 4 month intervals. They might be good for longer than that, but the manufacturers don't generally guarantee it. The AMSOIL filter could go to six months.

So, over the course of a year, you'd need 4 Pure 1 or Mobil 1 filters. You'd still need two AMSOIL filters. In this case, the Pure 1 filters end up costing you the same as the AMSOIL filters - $20. The Mobil 1 filters would run $40. So, AMSOIL and Pure 1 win on price. You'd only need to change the AMSOIL filter twice which saves you some labor, but the Pure 1 filters are available on any auto parts shelf. You'd have to decide which is a bigger benefit to you.

IMPORTANT NOTE: There are other high efficiency filters available on the market as well. New ones come out all the time. Feel free to look around. I think you'll be hard pressed to find any that really filter significantly better than those listed above. I think price would likely be the main factor. So, consider your driving habits and do a few calculations based on change interval recommendations of each filter manufacturer.

A NOTE ABOUT PURE 1: Pure 1 is a high efficiency filter. However, it has come to my attention that the Pure 1 filter does not use a synthetic and glass fiber media blend. It appears to be strictly a paper element. As such, the enhanced filtration ability of the filter is achieved by an incredibly tight weave and more and deeper pleats.

In most regards, this is a good thing. But, the pleats, in my opinion, are packed in there so tightly and so close together, it might be difficult to get good oil flow. This would be especially true as the filter became saturated with contaminants. So, I'd recommend either using a different filter or making absolutely certain you change this filter very often (3,000 miles).

The recommendations made in the above paragraph are not based upon scientific testing but only upon visual inspection of a Pure 1's filtration media. Don't take this as the gospel truth, only as one man's opinion (well, there are at least a few other people who would agree).

One last item to note is that AC Delco has come out with an UltraGuard Gold high efficiency oil filter

which looks like a good bet. I don't have any HS806 test data on this filter to compare to those discussed above.

WHAT ABOUT OIL STARVATION?

Of course, the first question that comes to mind when most people hear of high efficiency filtration is oil starvation. How can an oil filter remove particles that much smaller than conventional filters and still provide adequate oil flow to critical engine components?

Well, again I refer back to the high efficiency foam air filter we talked about earlier in this chapter. You'll remember that it is designed to have a much thicker filtration media that will trap particles throughout the entire media instead of only on the surface as with a paper air filter.

This is also how high efficiency oil filters work. Instead of trapping all of the oil contaminants on the surface of a paper (cellulose) type filtration media, high efficiency oil filters have a depth type media which will trap contaminants throughout the entire filtration media. This, combined with the different type of materials used for the filtration media allows high efficiency oil filters to remove more and smaller particles without restricting oil flow - just as high efficiency foam air filters remove more and smaller particles without restricting air flow.

OTHER FILTRATION OPTIONS

There is also the option of using magnetics to help with filtration. Some filters are magnetically charged so that they hold engine wear particles within the filter, no matter what the size. These are not necessarily a bad idea, but they do not necessarily remove (with high efficiency) other oil contaminants which are not metallic in nature. In addition, most magnets do not appear to be strong enough to remove a significant amount of metallic debris, so be careful what you choose.

There's actually a great deal involved in establishing whether magnetics will really benefit you much in the way of oil filtration, but they won't likley hurt your filter in any way, so as long as you don't pay an arm and a leg for one, magnetics **might** be worth a shot.

Bypass Oil Filtration

High efficiency full flow oil filters are a huge improvement over the conventional paper element oil filters of the past, but they still leave behind too much that can cause damage. Although wear can typically be reduced by a wide margin simply by making the switch to these high efficiency filters, there is more that you can do.

BYPASS FILTERS OFFER BETTER FILTRATION

Another type of oil filtration system is called a bypass system. In this type of setup, a certain percentage of your oil sump (normally about 10%) is passed through a special super-high efficiency filter system and then returned to the oil sump having been ultra-cleaned. Although there are different types of bypass filtration systems, most will remove the bulk of oil contaminants 5 microns or larger. Some will remove virtually everything larger than 3 microns.

Even high efficiency full flow filters will only be significantly efficient at 10 to 15 microns. However, since tolerances within your engine can be as tight as only 5 microns, anything larger than this size is likely to cause engine wear. By removing all particles larger than 3 to 5 microns, virtually all contamination that could cause engine wear is removed.

HOW IS PROPER OIL FLOW MAINTAINED?

Because this type of system is not filtering the entire oil flow at any given time, it can be designed to filter out a much smaller particle range without affecting oil flow to critical engine parts. A full flow spin on oil filter cannot do that. If a full flow oil filter was designed to remove such small contaminants oil flow would be restricted to the point of oil starvation, and the engine would fail. Alternatively, if oil flow and/or oil pressure dropped to far, the filter's bypass valve would kick in and the oil would skip the filtering process altogether.

WHO'S USING THEM?

Bypass oil filtration systems have long been accepted within the diesel trucking industry as an excellent way to extend oil drains and increase engine life expectancy. In fact, Cummins recommends that vehicles have both a full flow filter and a bypass filter installed for maximum protection of an engine.

More and more vehicles are installing bypass oil filtration systems to extend oil drains and engine life. Even in passenger car applications bypass systems are becoming much more common. It is not uncommon to see passenger vehicles with bypass systems lasting for well over 300,000 miles without serious engine troubles. Large diesel trucks will very often go 1,000,000 miles or more without an overhaul.

In addition, most of these systems allow for oil drains approaching and exceeding 50,000 miles or more - even on passenger cars. However, bear in mind that oil drains of this length require the backing of oil analysis to make certain that the oil and filters are holding up well.

DIFFERENT TYPES

Bypass filtration systems come in many different types these days. All will remove a bulk of the contamination within your oil, but they don't all work quite the same way. Some are only available for commercial, industrial applications. Nevertheless, they all can be fairly well classified as one of the

following:

1. **Depth element**: Oil is passed through cellulose fibers, which have been packed very tightly in order to form a thick maze. Dirt is trapped within the fibers.

2. **Pleated paper element**: This filtering system appears to be very similar to traditional full flow paper element filters. The difference is that the paper has more pleats to provide greater surface area and may also be more tightly woven to allow for more efficient filtration.

   This is more of a surface type filtration media because contaminants are only trapped on the surface of the paper media. Depth type filtration systems allow contaminants to be collected throughout a thicker filtration media. More often than not, this allows for more efficient filtration and greater filter holding capacity than a surface type filter.

3. **Stacked disc element**: Generally, a combination of the depth and surface types which uses a relatively thick paper cut in a special pattern to increase surface area.

4. **Motor driven centrifuge**: Very large and very expensive systems (thousands of dollars) which are driven by electric motor. The oil is spun at very high speeds and contaminants are "flung" to the outside of the canister and removed later. There is no filter element.

5. **Self-powered centrifuge**: Similar to the system above, but much smaller and spun by a high-speed turbine powered by oil pressure within the engine. Much less expensive than the motor driven version. Still designed for commercial/industrial applications, though.

SO HOW DO YOU CHOOSE?

There are many different factors to consider when deciding whether to purchase a bypass system. First, you must determine if a specific type system is even available for your vehicle type. Some of those on the market specifically target commercial/industrial applications and don't have versions available for passenger car applications. Those listed below appear to all have systems available for passenger car & light duty truck applications.

Most every system has a slew of testimonials praising the effectiveness of their system. Although testimonials are not very scientific and can easily be manufactured - don't discount them entirely. They can still be a valuable tool in making your decision.

In addition, there is the price. Depending upon the application, some will cost as little as $150 while those at the top end of the scale are about $250. Also, if the system requires a filter element (as most do), you must determine how often this filter element must be changed and how much the cost of each replacement will be.

I've provided a cost analysis for the systems below for comparison. If you're one who wants the cheapest price, regardless, go with the Frantz system. It is by far the cheapest - in the short run and in the long run. It might be a little messier to do filter changes though. You'll see what I mean when you read about it below.

Although I couldn't get exact filtration efficiency standards for the Frantz system, my instinct (along with speaking with a few different people in the industry and reading a slew of testimonials) tells me that it probably filters very well. There just isn't any way to be absolutely certain of HOW well.

SOME MORE RECOGNIZED SYSTEMS

In order to save you some time and headache researching these systems, I've compiled a list of the most recognized bypass systems on the market. For each listing I've attempted to gain as much information as I can to help you decide which would work best for your vehicle. If information is missing it is because I could not find it on their website, could not get the information from a company representative and/or never received a reply from the company regarding my information request.

PREMO PLUS

This system is a modified version of a depth element system. In this case, a depth type bypass filtration element has been coupled with a "heater" of sorts. Solid contaminants are removed by the depth type media first. Then, the filtered oil is passed through this heater where liquid contaminants such as water, fuel and glycol are evaporated off. Then the clean oil is returned to the system.

Your full flow spin on filter would remain in it's typical location and this system is mounted in the remote location of your choosing. The full flow spin on filter should be changed once per year, while the bypass filter element has a recommended change interval of 30 to 50,000 miles. Oil analysis should be done at regular intervals to determine viability of oil.

The Premo Plus bypass system has a Beta3 rating of 75 on the SAE J1858 test. The beta ratio referred to here is a single pass test (the filter gets one chance to remove contamination). In that test equipment is used to count the number of particles of a given size "upstream" from the filter. Then, the equipment is used to count the number of particles of that same size "downstream" from the filter.

To calculate the beta number, the number of particles upstream is divided by the number of particles downstream. So, if 20,000 3 micron particles went in and 266 came out, the beta ratio at 3 microns is 20,000 divided by 266, or 75.

To find the percent efficiency for a certain beta rating, take the rating and subtract 1. Then divide that by the rating itself. Multiply the final number by 100. So, for Beta3 = 75, (75-1)/75 x 100 = 98.7%. That means that a filter with a Beta3 rating of 75 it is 98.7% efficient at removing particles 3 microns or larger. This is an industry standard measurement to determine how well a filter removes contaminants.

A typical system for a 12 quart sump or smaller is $250. Larger vehicles with sump capacities over 20 quarts are about $600. Replacement costs for the filter element range from about $15 on the smaller system to over $30 on the larger system. Premo Plus filter elements should be replaced every 30 to 50,000 miles while the full flow spin on filter should be changed once per year (as recommended by Premo Plus).

It appears they recommend oil analysis every 10,000 miles or so. Oil sampling is made easy with a sampling valve that comes with the system installation kit. Oil sampling can be purchased for $12 per kit.

The company indicates a belief that even a petroleum oil would last indefinitely with their system. I'm not sure this is absolutely accurate because cold and warm temperature operation will still cause some oil degradation. However, I am willing assume at least a year for the oil change interval using petroleum oil.

Most people don't put more than 25,000 miles per year on a vehicle, so we'll stick to that estimate. Including oil and full flow spin on filters (assuming petroleum at $1.00 per quart and spin on filters at $5.00 per filter) the cost estimate for using the Premo Plus system would be the following for a passenger car application:

ONE YEAR:

$249 for the system itself
$ 5 for one full flow filter to start
$ 6 for 6 quarts of oil
==========
$260 for the year

NEXT FOUR YEARS COMBINED:

$ 60 for four Premo replacement filters
$ 20 for four spin on replacement filters
$ 28 for 28 quarts of oil *
==========
$108 for next four years
==========
$368 for five year total

* Includes 6 quarts for each oil change and 1/2 quart top off for each replacement filter.

CONTACT INFO: www.premolube.com**, 1-813-854-2228,** info@premolube.com

FRANTZ

This system has been around for decades in one form or another. It was originally invented by John Frantz back in the 50's I believe. There are actually at least 3 or 4 companies that manufacture and market these bypass systems around the world under the same or different names. However, to avoid confusion, I'll stick with George Walker Enterprises based in Oregon.

You may have heard of the Frantz bypass filter system and just didn't know it was a Frantz. This depth element system uses a toilet paper roll as the filter element. So, in other words, you install a bypass filter mount in a remote location of your choice that has a stainless steel canister on it. Within the canister you put a toilet paper roll. Your full flow filter remains in its standard location.

According to Mr. Walker, there was testing done back in the 60's, 70's and 80's that indicated very good filtration efficiency ratings for these systems, but there is no recent testing available. Hence, I won't provide any specific numbers here. Water is also removed - apparently, up to about 6 ounces or so.

Filtration would appear to be at least commensurate with other systems being listed here, but I have no concrete data to back that with. Another consideration would be that not all toilet paper rolls will be made exactly the same so filtration efficiency might change from one filter to the next. That change is probably not all that significant as long as the level of filtration remains good down to at least 3 microns. Again, no concrete testing available.

A typical system for most passenger applications runs $165 currently. Systems for larger vehicles may be as much as $205. Since toilet paper is the actual filter element, the cost will vary somewhat. There are factory rolls that you can buy, but it sounds like, as long as you stick with 500 sheet, 2-ply, facial quality rolls, you should be ok purchasing from anywhere. I would guess your average price would be about 50 cents.

It appears you should replace toilet paper rolls every 3 to 5,000 miles. Periodic oil analysis is recommended after 3 or 4 TP changes. This will indicate whether an oil and/or full flow filter change is necessary. As with the Premo Plus system, at least for gasoline engines, Mr. Walker indicates that the oil should be good indefinitely. For diesel engines, he says that the oil and full flow filter should be

changed every 3 to 4 TP changes unless you have oil analysis done, which indicates otherwise.

In order to maintain an apples to apples comparison of all of these systems, I'll continue to assume one year for petroleum oil changes no matter what. We'll also stick with 3,000 mile toilet paper changes to be certain no breakdown of the TP rolls occurs.

Therefore, the costs (still at 25,000 miles per year) including oil and full flow spin on filters (assuming petroleum at $1.00 per quart and spin on filters at $5.00 per filter) would be the following for a passenger car gasoline application:

ONE YEAR:

$165 for the system itself
$ 4 for eight toilet paper rolls
$ 15 for three spin on replacement filters
$ 12 for 12 quarts of oil *
==========
$196 for the year

NEXT FOUR YEARS:

$ 17 for thirty four toilet paper rolls
$ 55 for eleven spin on replacement filters
$ 46 for 46 quarts of oil **
==========
$118 for next four years
==========
$314 for five year total

* Includes 6 quarts to start and 1/2 quart top off at each TP change and filter change.
** Includes 6 quarts for each oil change and 1/2 quart top off at each TP change and filter change.

CONTACT INFO: www.wefilterit.com**, 1-503-631-4567,** gwalker@easystreet.com

PURIFINER

The Purifiner system appears to be similar to the Premo Plus in most respects. It uses a depth element filter in combination with an evaporation chamber for getting rid of liquid contaminants. Again, the standard full flow filter remains in its current location and the bypass system is mounted in the most convenient location you can find.

Although there are references to filtration down to 1 micron, there is no indication of the filter's efficiency at that level on the website. Neither could I find any reference to industry standard testing on the website for verification of their reference to the 1 micron filtration.

The company was unavailable for contact at the time of this writing. If more information is made available, registered owners of "The Motor Oil Bible" will receive this information via email.

An interesting twist to the Purifiner system is that their filtration elements can be purchased with slow release additive tablets or without. Since additives are somewhat depleted over time even in analytically clean oil, this is meant to give the additive package a "boost". I'm not certain weather this is a good idea or not.

They indicate compatibility with the additive packages of all motor oils. However, because modern motor oils are blended in a very strict manner to achieve maximum results from the additives used, the introduction of a foreign additive might not be wise. I have no scientific data to base this opinion on - it is only speculation. Nevertheless, their filters can be purchased without the additive tablets as well - no drop in price, though.

From what I can gather, the price of a typical passenger car system is about $240. Larger systems can range up to 4 or $500 or more. Additional replacement filters must be purchased in cases. For the small system, a case contains 12 filters for around $120. Larger systems have more expensive replacement filters.

The company recommends changing the Purifiner bypass element at manufacturer recommended intervals - which would generally be about 5,000 miles. They recommend changing the standard full flow filter once per year or every 60,000 miles.

Again, for a price comparison, I'll continue to assume one year for petroleum oil changes no matter what.

Therefore, the costs (still at 25,000 miles per year) including oil and full flow spin on filters (assuming petroleum at $1.00 per quart and spin on filters at $5.00 per filter) would be the following for a passenger car gasoline application:

```
ONE YEAR:

$240 for the system itself
$ 40 for 4 Purifiner elements
$ 5 for one spin on replacement filter
$ 9 for 9 quarts of oil *
====================================
$294 for the year

NEXT FOUR YEARS:

$200 for 20 Purifiner elements
$ 20 for 4 spin on replacement filters
$ 36 for 36 quarts of oil **
====================================
$256 for next four years
====================================
$550 for five year total

* Includes 6 quarts to start and 1/2 quart top off at each filter change.
** Includes 6 quarts for each oil change and 1/2 quart top off at each filter
change.
```

CONTACT INFO: www.puradyn.com**, 1-800-488-0577,** info@puradyn.com

AMSOIL

The AMSOIL bypass system is a stacked disk element system. This allows for both depth type and surface type filtration. It also allows for greater water holding capacity. The AMSOIL bypass element can hold up to one pint of water which can be extremely useful to low mileage drivers.

The AMSOIL bypass element has a Beta3 ratio of 75 as with the Premo Plus system. As was said before that means that it filters 98.7% of 3 micron particles. This percentage, of course, increases as micron size of contaminants increases. The AMSOIL filter has a Beta1 ratio of 2, which amounts to a 50% efficiency rating at 1 micron.

The AMSOIL filter does not have any sort of evaporation chamber for evaporating fuel or glycol from the oil. However, the AMSOIL company assumes that you'll be using their premium grade synthetic oil with their filtration system (although you CAN use petroleum oil).

Since synthetics tend to enhance ring seal, the chance of fuel getting into the oil will be minimized. In addition, AMSOIL synthetics have very high TBN values which allows them to better neutralize the corrosive acids formed by fuel in your oil. Any water in the system is trapped by the filter media.

One feature that sets the AMSOIL system apart from the others in the list is its easy installation and maintenance - as well as a decent price. The AMSOIL BMK-13 dual remote system allows the mounting of the bypass AND full flow elements on the same mount. In other words, both of your filters will be mounted side by side. You don't have to climb under your vehicle anymore for filter changes - at least not if you put the BMK-13 mount in a convenient location.

This is accomplished by using an adapter plate which screws on where your normal spin-on full flow filter would be located. Then, your in and out hoses are run from this adapter plate to the bypass system mount. Of course, this makes for a very quick and easy installation. Other systems generally require you to install some plumbing at your oil sending unit location for a line "out" of the engine. Then another line must be run from the bypass system back to your oil pan, oil fill cap, etc.

The price is reasonable, but not cheap. The BMK-13 system is about $200 plus the cost of the full flow and bypass filter elements. Different size elements can be used, but for most systems the BE-90 bypass element and SDF-15 full flow element should work fine. The BE-90 retails for just over $25, and the SDF-15 will run you about $10.

AMSOIL recommends changing the AMSOIL full flow filter every 12,500 miles or six months. The bypass element should be changed at every other full flow change.

Although AMSOIL recommends using AMSOIL synthetic oil, petroleum can be used. Therefore, again, for a price comparison, I'll continue to assume one year for petroleum oil changes no matter what.

Assuming 25,000 miles per year, $1.00 per quart for petroleum oil, the price comparison for a passenger car gasoline application would be as follows:

```
ONE YEAR:

$235 for the system itself (with both filters)
$ 10 for one SDF-15 full flow replacement
$ 7 for 7 quarts of oil *
====================================
```
$252 for the year

```
NEXT FOUR YEARS:

$100 for 4 bypass elements
```

$ 80 for 8 spin on replacement filters
$ 30 for 30 quarts of oil **
==========
$210 for next four years
==========
$462 for five year total

* Includes 6 quarts to start and 1/2 quart top off at each filter change.
** Includes 6 quarts for each oil change and 1/2 quart top off at each filter change.

CONTACT INFO: Any AMSOIL Dealer. They're pretty easy to find. Try doing a search on the Google search engine for bypass oil filtration.

OIL GUARD

Another depth element filtration system in which cotton fibers are wound around a stainless steel core. Again, this system mounts one bypass filter element in a remote location while the standard full flow filter element remains in the standard location.

According to charts on the OilGuard website, the OilGuard filter is about 99% efficient at removing particles of 6 to 7 microns or larger. Thus, this could be interpreted as a Beta7 = 75 rating.

Have not yet been able to get pricing or filter change interval information - not available on website - haven't been able to reach anyone at the company yet. If this information can be found at a later date, it will be sent to all "Motor Oil Bible" owners.

CONTACT INFO: www.oilguard.com**, 1-800-671-0777,** oilguard@oilguard.com

Oil Analysis: What is It & Do You Need It?

Even though most of us don't know much about oil analysis, it is probably one of the best tools available for preventing premature engine failure and for significantly reducing maintenance costs.

The information gained from a properly performed oil analysis can tell you how well your oil is holding up AND if your oil filter and/or air filter is ready to be changed. It is possible that your oil is still in good condition, but your filters are allowing too much contaminant to pass by. Changing your filters may be all that is necessary to correct the problem.

In addition, depending upon what type of contaminants are found within your oil (water, fuel, metals, acids, soot or other solids) it can normally be determined if there are certain components within your engine that are deteriorating prematurely. It may also be possible to specify **why** they are deteriorating.

Of course, being able to predict impending component failure and correct the cause can often reduce repair costs considerably. In addition, although oil analysis may indicate that an oil change is necessary, it may also indicate that your oil does not need to be changed nearly as often as you thought. Obviously, this may very well save you money on frequent maintenance issues.

WHO USES OIL ANALYSIS?

Believe it or not, oil analysis is not a "new" thing. As early as the 1940's oil analysis was used by the railroad industry in order to foresee the need for repairs before breakdown occurred. This allowed them to schedule repairs when they were necessary *and* more convenient which saved significant amounts of time and money.

At present you'll find that a large percentage of fleets are using oil analysis in one way or another. Over-the-road trucks, taxi services, governmental organizations, construction equipment, industrial equipment, high performance vehicles and many others all use oil analysis in order to reduce maintenance costs and costly breakdowns.

Moreover, they don't just analyze their engine oil. Also analyzed are transmission fluids, gear lubes, hydraulic fluids, etc.

WHAT IF I DON'T OWN A FLEET OF VEHICLES?

The same benefits that large fleets have been taking advantage of for years can also be had by people with only one or two vehicles. One of the greatest benefits that oil analysis provides to the regular commuter is peace of mind.

By utilizing oil analysis it is possible to know precisely how well your oil is performing and for how long it will continue to do so. You don't have to worry about potential failures that might slip by. You'll know about them before they occur.

Even if you're using a premium synthetic oil with extended drains, oil analysis can still be an effective tool for reducing costs even further. For instance, AMSOIL and NEO synthetic oils are recommended for 25,000 miles **or one year** (whichever comes first) for most gasoline applications. Some other oil companies have similar extended drain intervals. However, what if you only drive 10,000 miles per year? Do you then have to change out your expensive synthetic oil every year anyway?

Not necessarily. Many people use oil analysis to extend oil drains to well beyond a single year. BUT, AMSOIL and NEO only recommend their oils to 25,000 miles or one year. Therefore, oil analysis is

necessary to make certain the oil is still good for continued use.

Even the most expensive extended drain oils are around $9 per quart while others can be found for under $6 per quart. At that price, you could get an extended drain oil change for $30 to $50. So, even if you do your oil change yourself, a $10 to $20 oil analysis may prove to be less costly if it shows that your oil is good for continued use.

SO WHAT'S THE PROCESS?

Oil analysis consists of three procedures. First a sample of your oil must be taken. There are certain methods recommended for this sample to make sure it is representative of the oil flowing through your engine. You'll need at least 2 to 3 oz. to send in. Most labs will provide you with a clean test kit to collect the sample.

Second, the sample is sent to a lab for analysis. There are a number of labs around the country that will do oil analysis. They don't all charge the same rate, and they don't all provide the same information. You want to get a report which is as complete as possible while still providing a "laymans' terms" explanation of the results and what corrective actions might be necessary.

Prices could range from $10 to $25 for a single test. Of course, if you have a fleet of vehicles you can normally get volume pricing. In general, more complete testing will cost more while more basic test results will be less pricey.

JUST ONE?

Although a single analysis is useful for determining whether your oil needs to be changed and can be helpful for detecting major impending engine failure, continuing analysis can be much more useful - especially for fleet maintenance programs.

Trend analysis is the process of comparing multiple oil analyses for the same vehicle over a certain period of time. This type of analysis, obviously, requires oil analysis to be done at regular intervals. You decide what those intervals should be, but most often, after you've done trend analysis for awhile, these analyses will be a better judge of how often oil analysis should be done.

If trend analysis shows that your oil generally lasts for 35,000 miles, and this particular piece of equipment is in good working order, you might be able to limit your analyses to once every 30 to 35,000 miles (if you're using petroleum oil, these intervals would be much shorter).

However, trend analysis might show that your particular application takes a toll on your oil, and changes are necessary every 15,000 miles. In this case, you might want to do your oil analysis every 15,000 miles. Or, you may make a judgement call and decide to do an analysis every other oil change. It's your choice, but trend analysis can help in the decision-making process.

HOW SHOULD SAMPLING BE DONE?

In order for your oil analysis to give an accurate picture of how well your oil and engine are doing, the sample must be taken correctly. Here are a few guidelines for making sure you do it right.

First, you need to know where to take the sample from. There are a few options. You can use a sampling pump which can be inserted into your oil system to "pump" the oil out and into your sample container. Normally, you shouldn't have to pay more than $20 to $30 for one of these - including the suction hose - and they come with complete instructions for use.

Another option is to install a sampling valve or petcock valve. Then you can just wipe the valve clean, turn the "knob" and allow the oil to flow into your sampling container. These are convenient, but you probably won't have a place to install one unless you are running some sort of remote filtration system.

The third option is to take the sample from an oil drain plug. You'll want to thoroughly clean the area around the plug. Then, once you've removed the plug, allow the oil to drain for a few seconds. Then place the clean sample bottle into the oil stream to catch the amount of oil needed (between 2 and 4 ounces normally).

The sample should only be taken from the drain pan plug if the other options are unavailable because it is the least reliable method (contaminants in the bottom of the drain pan can cause irregularities in the sample).

Of course, once you've sealed the bottle nice and tight you'll want to clean it off. Nobody at the lab wants to deal with a greasy, oily bottle when it arrives at their establishment.

And, with any of these methods you'll want to be sure that you take the sample immediately after you shutdown the vehicle. This makes certain that all contaminants are equally distributed throughout the system. However, be careful. The oil will still be hot. Make sure to wear protective covering to avoid getting burnt.

WHAT WILL THE ANALYSIS REPORT CONTAIN?

As I mentioned earlier you will normally get what you pay for. If you purchase a cheap $10 analysis, you'll probably get cheap $10 results. Most likely this type of test will only contain information about the most common wear metals via Spectrographic Analysis. Amounts will be listed in PPM (parts per million), and there should be some explanation within the report for helping to understand the results.

If all you get is a wear metal report, you probably won't be able to glean much information about your oil. Wear metals are more useful for determining whether you have any specific engine troubles that need to be dealt with.

More advanced tests will also include physical properties of your oil and information regarding oil degradation. Such tests will indicate whether glycol, water, fuel or solid contaminants were found in the oil and in what percentages. They will indicate Kinematic viscosity levels which will tell you whether the oil's viscosity is remaining constant.

In addition, soot levels and oxidation and nitration percentages will be reported which are critical indicators of how well an oil is holding up. TBN might also be included in the analysis which will indicate the remaining acid neutralizing capability that your oil has.

If you intend on using oil analysis as a way of establishing oil change intervals, you'll need to get a more expensive test that contains most all of the information listed above. The more information that is missing, the less accurately you will be able to assess the condition of your oil.

For most users the best value in oil analysis right now comes from a company called Oil Analyzers. They are a well established oil analysis company that provides as complete analysis as you will find. In addition, they provide very easy to understand recommendations regarding what corrective actions (if any) must be taken based on the results of the analysis.

Depending upon what company you choose for your oil analysis needs, you can get an oil analysis for

anywhere between $10 and $20.

IS OIL ANALYSIS WORTH IT FOR ME?

Only you can decide whether you think the cost is worth the benefits. If you're using petroleum oil, oil analysis for most passenger car vehicles won't do much for extending oil drains. Generally, an oil analysis will tell you that a change is necessary by at least 5,000 to 7500 miles (probably sooner). Besides, for the cost of an oil analysis you could just change your oil.

However, oil analysis is still useful for helping to catch engine problems before they become failures. On new vehicles this might not normally be an issue, but it has been known to happen. At least if you find out about it before failure, you won't be stranded on some deserted road with a broken down vehicle. In this case, it's a matter of cost vs. the security of knowing that your vehicle is in good working order.

Environmental Issues

Each year, U.S. citizens dump more than 24,000,000 gallons of oil down sewers or into landfills. If you use petroleum oil and drain your oil every 3,000 miles, you will use about 40 quarts of oil (over 25,000 miles).

The environmental issue is often framed in the language of behavior. Are we a selfish civilization whose quest for instant gratification trashes the natural world and leaves a mess for our children? It's an argument intended to provoke guilt. And we resist guilt.

But consider this account by the New York Times, using as its source the Environmental Protection Agency (EPA) and the American Petroleum Institute (API): "Each year, 1.2 billion gallons of lubricating oil are used in vehicles; 600 million gallons are burned up in engines, and 600 million gallons are removed at oil change time. Drivers who change their own oil account for 350 million of the removed gallons, and they improperly discard 240 million gallons of used oil." [1]

Dumping 240 million gallons of oil is nearly the same as two Exxon Valdez spills each month. Improperly dumped waste oil seeps through landfills into ground water, disrupts bacterial digestion in sewer treatment plants (causing even more pollution), and washes into lakes and harbors. And we have no confident estimate of what happens to properly discarded waste oil. In 1989, there were only four refiners left in the U.S. They processed a total of only 50 million gallons of the 600 million gallons theoretically possible. [2]

Are we drowning in waste oil? Drowning is, of course, overly dramatic. But, do we have a serious problem? Are we trashing the world we leave to our children? And, most important, shouldn't we be doing something about it right now? Certainly. And the first thing we can do is not create so much waste oil to begin with.

[1] The New York Times, Oct. 28, 1989 2 Hazmat World, Nov. 1989

NUMBERS AND SOLUTIONS

There are a number of synthetic oil companies that I know which manufacture synthetic oils recommended for extended drains. A few are NEO Synthetic Oil, Redline Synthetic Oil and Amsoil Synthetic Oil. There are others as well.

NEO and Amsoil recommend 25,000 miles or one year for most gasoline applications and somewhat shorter drains for diesels. Redline recommends 10,000 to 18,000 mile drain intervals depending upon type of vehicle and type of use. You can find information about extended drains and find companies that offer extended drain intervals by doing an internet search for "extended oil drains" or "long drain intervals" or something similar. Search the following search engines for the search phrase "extended oil drains": **AltaVista** | **Google** | **Goto** | **HotBot** | **Yahoo**.

Most automotive experts recommend drain intervals of 3,000 to 6,000 miles for petroleum motor oils. This is about 4 to 8 times shorter than the 25,000 mile drain intervals recommended by Amsoil and NEO. Assuming you use petroleum oil, travel 25,000 miles annually, and have a 5-quart oil system, you will dump 15 to 35 quarts of used oil over the course of a year. That's a lot of oil.

It's easy to see how 25,000-mile/1-year drain intervals can reduce your personal contribution to oil pollution. But, if 25,000 miles still seems too unbelievable to attempt with your "baby", even using an off-the-shelf synthetic would likely get you between 7500 to 10,000 miles or more on an oil change. Just that would cut oil disposal levels in half.

In fact, there's even more you can do. A number of companies on the market today offer bypass oil filtration systems of some sort. Each of these systems allows for extended drains approaching 50,000 to 100,000 miles or even much further - backed by oil analysis. Some are easier to install and maintain than others, but they are all effective to some degree.

If your car goes 100,000 miles on petroleum oil, and you follow the recommended drain intervals, you will generate between 85 and 165 quarts of waste oil. That's alot of oil. In fact, with nearly 150 million registered passenger cars & light duty trucks, that easily amounts to between 10 and 20 BILLION quarts of waste oil.

With a bypass filtration system and a premium extended drain oil, each registered vehicle would instead generate little more than a gallon or two of used oil over 100,000-plus miles of use. That's an environmental alternative that saves money!

IT'S UP TO YOU

In the end, it comes down to you. How committed are you to leaving your children a healthy environment to live and work in? Are you committed enough to at least try extended oil drain intervals?

For over a quarter century, hundreds of thousands of motorists have been extending their oil drain intervals far beyond the standard 3 to 5,000 miles without any decrease in engine protection or performance. They're saving money, saving time, extending the life of their vehicles **and** protecting the environment.

How many environmentally friendly alternatives have you run across that provide such savings and convenience? Isn't it worth giving it a shot?

The Truth About Motorcycle Oils

The most common question among motorcycle owners when discussing the upkeep of their "baby" seems to be what motor oil they should use. Of course, from this central question other important and related ones arise. What viscosity should you use? How long should they leave your oil in? What filter should you use? Etc.

Unfortunately, there is a great deal of misinformation circulating throughout the motorcycle community - much of it propagated by motorcycle manufacturers and dealers in order to increase their bottom line. And guess who's being bled dry? YOU!

In this article, I hope to dispel some of the myths that are so prevalent among motorcycle owners and shed some light on the REAL issues that must be considered when choosing a motor oil for your pride and joy. Although some of what I say in this article will apply to other motorcycle applications, most of it will focus on wet-clutch applications - since these are where most of the confusion lies.

SYNTHETIC VS. PETROLEUM OIL

One question that invariably arises when deciding on which oil to use in your motorcycle is whether to use synthetic oil or petroleum oil. Although the answer lies in what your expectations are for your motorcycle, here are a few issues you should consider when making your choice:

HIGH TEMPERATURE PERFORMANCE

I believe this is generally a well known fact, but synthetic oils will, in general, perform much better in high temperature applications than petroleum oils will. There are a number of reasons for this that I could spend a few pages on. However, without going into a great deal of detail, here's the Reader's Digest Version.

The synthetic basestocks that synthetic oils are manufactured from have much higher flash points than petroleum oils typically do. In layman's terms, the flash point of an oil is the point at which it begins to vaporize. The higher this flash point, the better the oil will hold up in high temperature environments.

In addition, because synthetic oils are made up of particles of uniform size, they have less "internal friction" than petroleum oils (which are made up of particles varying greatly in size). This lowers the temperature of the oil, thus improving the cooling qualities of the oil. Of course, the end result is cooler engine temperatures.

Secondarily, synthetic oils do not cause the "blanket effect" that petroleum oils do. Because petroleum oils are made up of particles of varying sizes, the smaller particles tend to flow freely through the center of the oil galleries within your engine while the larger sized particles will be pushed to the "outside" of the oil stream - next to engine components. These large particles, for the most part, remain there and do not distribute heat from engine components back to the oil.

The uniform particles within a synthetic oil will **all** flow just as easily through oil galleries. Larger particles are not present to "blanket" engine component surfaces. Therefore, heat is distributed into the oil and carried away.

The end result is that a good quality synthetic oil can lower engine temperatures by as much as 20 to 50 degrees F. That can significantly extend the life of critical engine components. In addition, less stress is put on the oil, which extends its useful life as well.

Of course, the harder you run your bike, the more important these issues will be. Leisure riders will not have as much problem with this issue, but the issue does still exist.

SLUDGE AND DEPOSIT FORMATION

Petroleum oils are very prone to leaving behind sludge, varnish and other deposits while synthetics are not. You see, petroleum basestocks contain many impurities right from the factory. This is because they are a refined product. The refining process is designed to take out impurities. However, no refining process is 100%, and to achieve a level even close to that for a petroleum oil is a very expensive process.

Therefore, to keep petroleum oil prices down, motor oil manufacturers have to find a "happy medium" between high cost and high impurity levels. The end result is a "fairly clean" petroleum basestock. However, a number of impurities still are present.

Synthetic oils do not have this problem with impurities. The only thing in a synthetic oil is what the chemists put into the oil blend - and they don't add anything unless it improves the quality of engine protection and performance offered by the oil.

As motor oil burns off, any impurities within the oil are left behind to cling to engine component surfaces. Since petroleum oils are more prone to high temperature degradation than synthetic oils are AND contain higher levels of contamination in the first place, they leave behind much higher levels of engine deposits.

This is especially true within an air cooled engine which runs at higher temperatures than a water cooled engine because a petroleum oil is more apt to burn off under these temperature extremes. As a result, expect higher levels of deposit formation within a motorcycle application than with an automotive application if using a petroleum oil.

Obviously, the effect of having higher levels of deposit formation within your engine is seen in multiple areas. First, performance will obviously be decreased. Top end speeds will decline. Your bike won't get the same "jump" out of the starting blocks that it once did. I think you get the picture.

A second and related area of concern is fuel mileage. If you gum up the works, your mileage will decrease - without a doubt. Of course, this mileage decrease occurs over time, so it is less noticeable. Most people seem to expect a mileage drop over time as just a fact of life. However, it doesn't have to be that way. Synthetic oils will offer you better fuel mileage to begin with AND will maintain that high level of fuel efficiency much longer than a petroleum oil will.

A third area of concern, if your bike is a wet-clutch application, should be your clutch faces. Any deposit formation on these faces from your motor oil will likely cause clutch slippage to some extent. The more deposit formation, the more slippage that will occur. So, since synthetic oils leave fewer deposits than petroleum oils, they are the superior choice if you wish to avoid potential clutch slippage.

Now you might say, "How would I know if I were experiencing clutch slippage anyway?". Well, to be honest, it's not always easy. If you were experiencing clutch slippage, it is likely that your top end speed would be up to 10 to 20 mph slower than if you were not having any slippage.

However, the only way to know for certain if you've got clutch slippage due to deposit formation would be to check your top end speed. Then, have your bike in to be serviced, and have them check your clutch faces. If there is no deposit formation, then you know you're not experiencing clutch slippage due to deposit formation. However, you MIGHT be experiencing clutch slippage due to another issue that we'll get to in a little while.

If there ARE deposits on your clutch faces, have the issue taken care of. Then, check your top end speed again (using the same oil). If your top end speed has increased significantly, then you know that the deposits were likely the problem. At that point I'd be draining the oil and replacing it with a good synthetic that won't leave those deposits.

LONGER OIL LIFE

As much as this issue is debated, most people agree that synthetics hold up better than petroleum oils. In fact, many people even believe that synthetic oils will probably last longer than petroleum oils "in theory". However, in practice, very few people actually put this theory to the test.

They worry about ruining their engines. They are concerned that even if the oil is in good shape it may be carrying too much debris to adequately protect your engine. The fact is that these worries are really unfounded. There is plenty of evidence to indicate that just about any synthetic oil will outlast a petroleum oil by about 2 to 3 times.

You might want to continue to change your filter at the old 3 to 5,000 mile interval (unless you're using a high efficiency filter designed for extended change intervals), but the oil will still be good for continued use long after 5,000 miles. Most any synthetic oil will be good for at least 7500 miles, even in an air cooled motorcycle application. Some synthetics will even be good for 10 to 15,000 miles or more.

In the end, using extended oil drain intervals could save you a great deal of money without sacrificing engine protection. Of course, you have to do what you're comfortable with, but the facts are in. Synthetics WILL last longer than petroleum oils, no matter what kind of filtration you're using.

BEARING SLIPPAGE

Talk to many motorcycle manufacturers/dealers (especially HD), and you'll find that they might tell you to avoid synthetics in your bike. That trend is slowly changing, but I wouldn't be surprised if you run across someone who tries to tell you that synthetics will ruin your bike.

Most of them refer to bearing slippage. They say that synthetic oils are "too slippery" to maintain enough friction for bearings to roll as they are supposed to. As a result, the say that using synthetic oil will cause your bearings to "slip" instead. Of course, if that were to happen, flat spots would occur on bearings.

That is a bunch of nonsense. Of all the motorcycle mechanics I've ever spoken with, I've never had one of them say that they've seen any flat spots on bearings in bikes that used synthetic oil. It just doesn't happen.

TYING IT ALL TOGETHER

Basically, the story on synthetic vs. petroleum oil for motorcycles comes down to this. If you're not going to own your bike for more than a few years and you don't expect to ride it hard, petroleum will work just fine. However, if you intend on keeping your bike for the long haul and want to maintain its performance characteristics for more than a couple of years, there is no question that you should be going with synthetic.

And, if you intend on running your bike hard, only a quality synthetic can guarantee you proper protection and performance. Petroleum oils simply don't cut it in these types of situations.

Now that we've covered the question of whether you should be using synthetic or petroleum oil, we come to the issue of whether to use a motorcycle specific oil or not. You'll hear varying opinions on this. I'm going to lay out the facts for you, and you can decide what to do with them.

Speak with just about any motorcycle manufacturer rep or dealer and you'll hear the following rhetoric: Don't use any oil that has an API rating higher than SG. Some will even go so far as to say no higher than SF.

In case you don't know what those letters mean, the American Petroleum Institute (API) comes out with new standards for motor oils every few years. Each time they come out with a new standard, the bar is raised. Fuel efficiency must be better, protection benefits must be increased, cold temperature performance must be improved, etc.

So, the higher the second letter of the "code" the "better" the oil. In other words, you should expect an SH oil to be better than an SG oil, and an SJ oil is better than an SH oil, etc. As a side note, gasoline oils are always rated as an Sx, with the "x" being the level of the rating. Diesel oils are always rated with a Cx. Sometimes there will even be a number after the Cx, such as with a diesel CG-4 or CH-4 specification. Again, the higher the second letter, the better the oil. An oil that meets both the API gasoline specs and the diesel specs will likely carry both API ratings.

Motorcycle manufacturers have come up with a very clever way to avoid meeting the newer and more stringent API standards while still selling their oils as premium "motorcycle-specific" lubricants. Most motorcycle-specific oils haven't been tested for the latest API standards in the past decade or so. They are still rated SF or SG, which, according to motorcycle manufacturers and dealers is better for your bike. Many times they'll even go so far as to say that they'll void your warranty if you use an oil that is SH or SJ rated.

That makes it easy to scare you into thinking you need their oil because you don't feel like you have much choice. As a result, motorcycle manufacturers have been able to charge many motorcyclists $3.00 to $5.00 per quart or more for old, outdated petroleum motor oil formulations that would sell for about 50 cents in an auto parts store.

Do you think they're making a killing on these products? Do you think they're going to shoot straight with you if they can keep raking in the loot? I think we know the answer to those questions.

Just to set the record straight, they can't legally void your warranty for using an SH or SJ rated oil unless they can prove that use of such oils actually caused the mechanical failure in question. That's not to say they might not try, but if you stick to your guns, they really don't have a leg to stand on. They don't have any way of knowing that you used such oils anyway.

If you want to see the legislation that outlines these warranty coverage issues, head on over to Chapter 13 and read the section titled "New Car Warranties and Extended Drains". Or, simply click here.

The truth is that many automotive oils are actually better for your bike than some motorcycle-specific oils. Let's take a look at some of the flaws in their arguments and see if we can't wade through the mumbo-jumbo.

ZINC AND PHOSPHORUS LEVELS

One of the reasons that motorcycle manufacturers and dealers say that you shouldn't use an SH or SJ rated oil is because these oils supposedly have less zinc and phosphorus than SF and SG oils. This is really only half true. But first, let's talk about the purpose of zinc and phosphorus in your oil to begin with.

Zinc and phosphorus are actually almost always added to an oil in combination and in closely related amounts. They work as a tag team to help minimize wear due to metal-to-metal contact. In essence, if there is ever a time when your engine components are under significant stress and the oil can't maintain a film of lubricity between metal components, metal to metal contact will occur.

Under these conditions, without some extra measure of protection, this would cause severe wear within your engine. However, the addition of zinc and phosphorus to your oil minimizes this risk. The zinc and phosphorus will actually form a thin "plating" over engine components preventing actual metal to metal contact - thereby preventing metal to metal wear. This is a VERY good thing, and very desirable.

Keep in mind a couple of things, though. First of all, the amount of zinc and phosphorus in your oil does not determine "how well" your engine will be protected against metal to metal contact. More zinc and phosphorus does not mean better protection. However, it does mean "longer" protection. The more zinc and phosphorus you have in your motor oil, the more times it will be able to prevent engine wear from metal to metal contact.
With that said, let's move on to the fallacy of the argument against SH and SJ oils for motorcycle use. First, it must be understood that most motorcycle applications call for a 10W-40 or 20W-50 viscosity grade, especially for larger engines and V- twin applications. So, in determining whether you can safely use an automotive oil in your motorcycle engine, only those two grades really need to be considered (or some similar grade like 20W-40 or 15W-50).

So, here's the deal. API SH and SJ specifications have indeed lowered the maximum acceptable limits for zinc and phosphorus content of an oil. However, two things are important to note here. First of all, anything over a 30 weight oil (ie. anything other than a 0W-30, 5W-30 or 10W-30) is NOT required to meet the zinc and phosphorus limit imposed by the SJ specification. In other words, a 10W-40 or 20W-50 motor oil can be rated SJ without being limited to the lower zinc and phosphorus levels.

Therefore, many oils in this viscosity range contain as much zinc and phosphorus as they did before meeting the API SJ specifications. Moreover, it is interesting to note that many of the motorcycle-specific SF and SG rated oils on the market have zinc and phosphorus levels that are UNDER the limits set by the API SJ specs AND under the levels of many standard automotive oils.

In other words, there is no reason that they could not have been formulated for SJ consideration without changing their zinc and phosphorus levels at all (although, as I said, they wouldn't be required to meet those requirements anyway). This makes it pretty clear that their only motivation for not meeting SJ specifications is to save money on reformulation and relabeling.

FRICTION MODIFIERS

Motorcycle manufacturers and dealers also refer to "friction modifiers" as being another reason not to use API SJ rated automotive oils. This MIGHT be the only somewhat valid point they make. However, it is not justified in all cases. Let me explain the issue more fully.

API SJ specifications mandate increased fuel economy over previous API ratings. In order to meet this qualification, motor oil manufacturers must add friction modifiers to their motor oil formulations. It is believed that these friction modifiers MAY cause clutch slippage, although I have not seen any specific scientific testing to validate this claim.

I have spoken with some motorcycle owners who switched from an automotive oil which may have contained friction modifiers to a synthetic motorcycle specific motor oil and noticed a significant increase in top end speeds (10 to 20 mph) immediately. This could be an indication that there was clutch slippage occurring before the switch. However, it is also possible that this increase is due to simply switching to a better formulation of oil which provides better performance. I have no way to say one way or the other.

What is important to note is this: Just as 10W-40 and 20W-50 weight oils are exempt from the zinc/phosphorus limits put in place by API SJ specifications, these same grade oils are exempt from the fuel efficiency mandates that the SJ rating requires. Thus, it is not necessary for motor oil manufacturers to add friction modifiers to their 40 and 50 weight motor oils.

Therefore, it cannot be assumed that just because an oil meets API SJ specs it must contain friction modifiers. It doesn't have to. Some automotive 10W-40 and 20W-50 motor oils may contain no friction modifiers whatsoever. This could only be determined by speaking with the manufacturer themselves. Unfortunately, if that manufacturer also carries a motorcycle specific brand of oil, it is likely that they would point you that direction and avoid answering the question. This is because their motorcycle specific oil generally costs more and makes them a better profit.

So, in the real world, here's where you stand. Just because a 10W-40 or 20W-50 automotive oil meets SJ specs, that doesn't mean that it contains friction modifiers, although it might. There is no scientific evidence that indicates that friction modifiers cause clutch slippage, although some anecdotal evidence suggests that it is possible.

Therefore, if you want to take the risk, you could use any automotive oil you wish (although preferably synthetic) and take your chances in regards to clutch slippage. If slippage does occur, you'll likely need repairs sooner than if no slippage occurred. If you don't want to take the risk, but don't mind making some phone calls, you might be able to find an automotive oil which you can be certain does not contain friction modifiers. This might take some digging though.

If, on the other hand, you don't want to waste your time on all that research but don't want to risk clutch slippage, find a good motorcycle specific oil that won't cost you an arm and a leg and stick with it. However, look for motorcycle specific oil that is still SJ rated. This assures you that you've got the latest in motor oil technology but designed for wet-clutch compatibility.

There is a wide range in pricing for motorcycle specific oils. Petroleum based products can range in the $2.00 to $5.00 or more depending on who you purchase from. Keep in mind they are still petroleum oil - nothing all that special, but at least you'll be sure there are no friction modifiers. Synthetic based motorcycle specific oils range from about $6.00 up to $12 per quart.

Believe it or not, the best of the pack is the least expensive of any of them and offers extended drain intervals to boot.

WHAT VISCOSITY SHOULD YOU USE?

Now that you've hopefully established what type of oil you are planning on using - or at least have established criteria for making the final decision - there is still the question of what viscosity grade to use. Many owner's manuals will recommend both a 10W-40 and 20W-50 for your bike. So which one do you choose, and why?

For what it's worth, this is what I recommend. If you are going to stick with a petroleum oil, I highly recommend going with the 20W-50, especially in a V-Twin engine. In MOST cases, if you have the choice between a 10W-40 and 20W-50 of the same brand of oil - both designed for the same type application - the 20W-50 will offer better engine protection.

However, if the issue of lifter "bleed down/pump up" is one you'd like to avoid, the 10W-40 will generally allow the lifters to pump back up more quickly. This can reduce the "ticking" that you hear at engine start-up.

If you decide to stick with a synthetic oil, then it's probably much less important which grade you use (10W-40 or 20W-50). Both will likely provide plenty of protection for your engine - even a V-Twin engine. You'll still see your lifters pump back up much more quickly with a 10W-40 than a 20W-50.

As far as temperatures go, once you get into a good quality synthetic, high temperature issues are much less important when selecting a viscosity grade. They actually become more important when selecting the brand of oil that you use. Some brands of synthetic are somewhat low quality and have flash points only slightly higher than petroleum oils of the same grade.

If you plan on doing any cold weather riding, the 10W-40 will be the better choice in just about all circumstances. As I said, if comparing oils within the same brand, if the 20W-50 is a good quality oil with good flash points, the 10W-40 will likely be also. Therefore, you can somewhat forget about the high temperature issue and focus on what will be better for cold temperature operation.

HOW LONG CAN I EXTEND OIL DRAINS?

This is a question that will probably be debated for some years to come. The old adage of "3,000 mile oil changes" is so prevalent that many people don't even consider the possibility of extended drains. The most common reasonings for NOT extending oil drains are "too much oil contamination", "high temperature degradation" or "additive depletion". Although these issues are important to consider, they apply differently to different oil types.

The fact is, that with a petroleum oil and standard filter, you are probably well served to continue 3,000 mile oil changes. If you're using a premium high efficiency oil filter with standard petroleum oil, you might extend to 4,000 or 5,000 miles. If you step up to just about any synthetic on the market, you can probably extend oil drains to 6,000 miles or so even with a standard filter. Use synthetic AND a high efficiency oil filter, and you're probably ok for about 7,500 to 9,000 miles.

Believe it or not, you can extend oil drains even further than that with the right oil and filter. The oil should be synthetic and it must be properly additized for extended drain use. There aren't many oils on the market that are formulated for such use, and those that are, generally are VERY expensive and/or not designed for motorcycle use (especially wet-clutch).

However, there is at least one oil on the market that is very reasonably priced and designed for such extended drain use. Amsoil manufacturers a motorcycle specific oil in a 10w40 and 20w50 grade as mentioned a little earlier in this article. These oils cost about $6.00 per quart. If you are using a standard oil filter, then you should be able to get about 10,000 miles out of Amsoil motorcycle oils without any trouble in touring bikes. Really high revving, high performance racing bikes and such, might consider slightly shorter intervals.

Neo motorcycle oils may also be ok for extended drains. They have a 10w40 and a 20w50 which appear to be wet-clutch compatible. Neo's other oils are designed for extended drain use. I'm guessing that their motorcycle oils would be also although I haven't been able to confirm this from their website information. The cost is about $10 per quart, which is still very reasonable for a synthetic, extended drain motorcycle oil.

There may very well be other motorcycle oils available for extended drain use as well. A little extra research would tell you for sure. Just do an Internet search for "synthetic motorcycle oil" and then check for extended drain capability.

If you choose to use a high efficiency oil filter (there are number of brands out there including an Mobile 1, Pure 1, AC Delco and an Amsoil brand oil filter, as well as others), you could very likely extend your oil drains even further because your oil would remain much cleaner than with a conventional filter.

Please keep in mind, though, all these recommendations are rough estimates. Check with the oil manufacturer to determine the actual mileage they recommend for change intervals and then see if you can get the tech department to give you an off-the-record estimate, if you're speaking with a mainstream oil manufacturer who's making good money recommending short change intervals.

General Motor Oil FAQ's

Although many questions have been answered throughout the rest of "The Motor Oil Bible" in the main chapters, there are a few lingering questions that may not necessarily deserve their own chapter, but are still frequently asked. So, if you have a question that has not yet been answered, don't despair. You may yet find your answer among these FAQ's.

This question and answer chapter has been compiled from thousands of emails I've received regarding motor oil and my responses. Those listed in this chapter were the ones asked and answered most often. Hopefully, they will be of use to you as well. No names have been used in order to protect the privacy of those who requested answers to these questions.

A few of these sections have actually been discussed in other portions of the eBook, but you may have missed them. Therefore, I'm repeating some of the information here as well.

SHOULD I USE AN OIL ADDITIVE?

The infomercials you see would have you believe that by putting these products in your engine it will become a "super engine" of sorts. However, unfortunately for consumers, their claims have no basis in reality.

In fact, in the electronic version of The Motor Oil Bible there are a few links to releases from the Federal Trade Commission with regard to the effectiveness of different oil additives. Each link opens in a new window. When finished reading each piece, simply close the window to return to this eBook (note: you must be connected to the Internet to use these links). The links refer to the following products.

Valvoline Engine Treatment
Slick 50 Engine Treatment
STP Engine Treatment
Dura Lube Super Engine Treatment
Dura Lube Advanced Engine Treatment
Motor Up Engine Treatment
Prolong Super Lubricants

In short, the FTC releases above indicate that all of these companies have used deceptive advertising in order to mislead consumers into believing that their products offer advanced engine protection and performance over motor oil alone.

The truth is that not one of these companies has been able to offer any test results which prove conclusively that any benefit is gained from their products' use. Doesn't it make you wonder just a little?

It's possible that at some point there may be an oil additive manufactured that does what the company says it does, but up to this point I've seen no conclusive evidence of this for any oil additive currently on the market (backed by scientific study from an independent lab).

The sad fact is that many oil additives on the market contain materials, which can be very detrimental to your engine. You might say, "Then why do so many racers use these products?". First, keep in mind that not all big time racers are "Honest Abes". There are certainly going to be at least a couple that are willing to say just about anything for a buck (or a couple million bucks).

Others truly believe in the products. However, the reasons that they believe in them aren't the same

reasons that you would want to believe in them. The simple fact is that most racing engines are rebuilt after every couple of races (in some cases after EVERY race). So, engine wear is not necessarily of primary concern. Performance is.

With that in mind, understand that some oil additives on the market MAY provide some benefit in terms of horsepower gains. To most people, the amount of gain would be imperceptible, but to a racing organization even a 1 horsepower gain is enough to make it worth the possibility of a little extra engine wear.

For the rest of us, who actually have to pay for the vehicles that we drive, the potential for increased engine wear or the possibility of engine failure is not an acceptable risk for such a minimal improvement in performance.

PTFE (Teflon) BASED ADDITIVES

Oil additives that contain PTFE (Teflon) haven't been shown to offer any significant benefits in scientific testing. However, it has been shown that PTFE can settle out of your oil and clog your filter. This causes your filter to become saturated much more quickly than would otherwise be true. The result is that your oil begins to bypass your filter altogether and receives no filtration whatsoever until you change the filter. In addition, Teflon flakes can actually clog oil galleries causing oil starvation to critical engine components. Of course, this has the possibility of causing premature engine failure.

CHLORINE BASED ADDITIVES

Chlorinated aftermarket oil additives are no better. In testing performed by Oil Analyzers Inc. the motor oil treated with the additive Prolong (which is a chlorinated oil additive) actually formed gels when subjected to oxidation testing. Non-treated motor oil did not. These gels appear to cause sludge formation, which is a very unhealthy thing for your engine.

In addition, when motor oil samples treated with chlorinated aftermarket oil additives were subjected to the industry standard Four Ball Wear Test, they showed 11% more wear creation than motor oil samples of the same motor oil run through the same tests but untreated with any oil additive.

These two tests, although not yet proof of a correlation between chlorinated oil additives and engine wear, are certainly compelling evidence that increased engine wear is possible if one chooses to use a chlorinated oil additive in his or her engine crankcase.

Why Use Chlorine? Quite simply, chlorine is an excellent extreme pressure agent and will stand up to immense pressures. In fact, chlorine used to be used in some high pressure applications. However, it's use was discontinued because it is so volatile when put into in internal combustion engine.

When all of the fuel and water contamination, combustion and blow-by gasses and wear debris are combined with the catalytic effect of metallic surfaces within an engine, they form a very adverse environment for the introduction of chlorine into the system. In fact, when chlorine is added to the system it tends to form hydrochloric acid and other by-products, which can be very corrosive within an engine. Excessive engine damage is a distinct possibility.

Non-Corrosive Chlorinated Oil Additives. No such thing - at least not for a long period of time. The only way to make a chlorinated oil additive non-corrosive is to use corrosion inhibitors. However, these corrosion inhibitors are used up relatively quickly. Once they are gone, the problem of corrosion is once again present and potentially deadly to your engine.

ARE ALL ADDITIVES CHLORINE OR PTFE BASED?

No, there are some additives which are not based upon PTFE or chlorine chemistry. To my knowledge none of these additives have yet been brought up on charges by the FTC. However, these types of additives have not been on the market nearly as long either.

In all honesty I cannot make a judgement one way or the other regarding these other types of additives. It is possible that some of them might function as promised, although I have no personal knowledge that this is the case. I also have seen no scientific proof that they perform as advertised.

I have heard anecdotal evidence from some people that certain additives do work. However, it is sometimes difficult to distinguish if these are objective viewpoints or if they are simply wishful thinking. Let's face it, for as much as a person pays for some of these additives, you go into the deal hoping that they will work and searching for any sign that they did. Otherwise, you'll know you just wasted your hard earned cash on another pipe dream. Hardly an objective means of determining the relative usefulness of a product.

THE FINAL ANALYSIS

In the end it really comes down to this. If you want better protection and performance stick with something that has been proven to work without potentially causing damage to your vehicle. Go with a good synthetic oil and a high quality filter. All the benefits, none of the risks. Sounds like a win-win to me.

WHEN TO USE WHAT VISCOSITY

This is another very commonly asked question. Many people change viscosity grades every winter to a lower grade oil and then switch back to a higher grade oil in the summer. Others use a high viscosity oil year round because they believe it must protect better than a lower viscosity oil. Is this necessary? Is it effective? Let's find out.

THE CHANGING OF THE SEASONS

Are you one of those people who switches back and forth between viscosity grades as the temperature changes each summer and winter? Well, you're not alone. A large percentage of vehicle owners switch to higher viscosity grade over the summer months in order to increase protection and drop to a lower viscosity oil in the winter for cold weather start-up protection.

The good news is that this may not be such a bad idea - if you're using a petroleum oil. However, if you're using synthetic, you're probably making the switch unnecessarily. Before you continue, if you haven't done so already, you should read our chapter on Motor Oil Viscosity by clicking here.

You may be holding on to some common misconceptions about motor oil viscosity that need to be corrected before the following information will mean anything. You can return to this chapter for the rest of the story.

When you're using petroleum oil, 5w30 is a god-send in the winter months. It will provide you with the best cold weather start-up protection of any of the other viscosity grades offered in a petroleum base. If you live in any of the northern states you would be well served to use 5w30 in the cold winter months to avoid prolonged periods of oil starvation at engine startup. This alone will eliminate a significant amount of unnecessary engine wear.

In the summer months, a 5w30 motor oil is probably still sufficient. In fact, Ford Motor Company has recently changed its motor oil recommendations so that all gasoline powered makes, models and years carry a motor oil viscosity grade recommendation of 5w30 year round. Some 2001 models even call for

a 5w20 (we'll talk more about this in a minute).

However, you may see less oil consumption if you move to a 10w30 petroleum motor oil during the summer months. Many mechanics have noted that they have a great many more customers complaining of oil consumption since moving to API SJ rated 5w30 motor oils. That's just the nature of the beast. Petroleum 5w30's tend to consume much more quickly than higher viscosity motor oils. This would be especially true if you run your vehicle hard.

In addition, if you own an older vehicle in which the engine tolerances might be a little more sloppy than they used to be, a 10w30 or 10w40 motor oil might not hurt. I'm not sure I would recommend running a 10w40 motor oil in any newer vehicle unless the owner's manual specifically indicates that 10w40 is an acceptable weight, but I'll touch on this issue in a minute.

WHAT ABOUT SYNTHETICS?

Synthetic motor oils are a notable exception to the idea of switching viscosity grades based on the weather. As you've probably figured out by now from reading the rest of "The Motor Oil Bible", synthetics are designed to stand up to extreme temperature variances with little or no loss in protection or performance. Thus, it's easy to use a quality synthetic oil for year round protection.

In addition, using a lighter weight oil such as a 5w30 or 0w30 (you won't find a 0w30 in a petroleum oil) is unlikely to cause any significant increases in oil consumption because even these light weight oils stand up to extreme heat much better than petroleum oils - even higher viscosity petroleum oils.

So, if you're using synthetic oil in your engine, stick with the same weight year round. Moreover, unless you have some specific reason for not doing so, go with a light weight oil. It will hold up just fine and will offer better fuel economy and enhanced cold weather start-up protection.

THE THICKER THE BETTER

Not so fast, there. This isn't always true - even when using a petroleum oil. Although it is true that heavier viscosity oils (which are generally thought of as being thicker) will hold up better under heavy loads and high temperatures, this doesn't necessarily make them a better choice for all applications.

NOTE: When I refer to higher or heavier viscosity oils, I'm referring to the "second" number of a multi-viscosity specification. In other words, a 10w40 would be heavier than a 10w30 because 40 is higher than 30. I'm not making any reference to the "w" rating because this doesn't come into play unless you're referencing cold temperature performance.

You see, on many newer vehicles only 5w30 or 10w30 motor oils are recommended by the manufacturer. If you choose to use a higher viscosity oil than what is recommended, at the very least you are likely to reduce performance of the engine. Fuel economy will likely go down. Engine performance will likely drop.

In the winter months I would highly recommend that you not use a heavier grade oil than what is recommended by the manufacturer. In cold start conditions you could very well be causing more engine wear than when using a lighter viscosity oil. In the summer months, going to a heavier grade is less of an issue, but there are still some things to be aware of.

Moving one grade up from the recommended viscosity is not likely to cause any problems (say from a 10w30 to a 10w40 oil). The differences in pumping and flow resitance will be slight. Although, as was mentioned, efficiency of the engine will decrease, the oil will likely still flow adequately through the engine to maintain proper protection. However, it will not likely protect any better than the lighter weight

oil recommended by the manufacturer.

Moving two grades up from the recommended viscosity (say 10w30 to 20w50) is a little more extreme and could cause long term engine damage if not short term. Here's the thing. Although the oil will still probably flow ok through the engine, it is a heavier visocosity oil. As such it will be more difficult to pump the oil through the engine. More friction will be present than with a lighter viscosity oil.

More friction will be present than with a lighter viscosity oil. More friction means more heat. In other words, by going to a heavier weight oil in the summer months, you may actually be causing more heat build-up within the engine. You'll still be providing adequate protection from metal to metal contact in the engine by going with a high viscosity, but the higher viscosity will raise engine temperatures.

Over the short run, this is no big deal. However, over the long term, when engine components are chronically run at higher temperatures, they WILL wear out more quickly. As such, if you intend on keeping the vehicle for awhile, keep this in mind if you're considering using a heavier weight oil than the manufacturer recommends.

The key is to generally stay away from viscosity grades that are not mentioned in your owner's manual. Sometimes vehicle manufacturers will make reference to the possibility of using a 10w40, 15w40 or 20w50 motor oil, even though they might recommend a lighter weight oil for most situations.

If this allowance is made, you'll be ok using a heavier grade of oil. You'll probably see a drop in mpg using the heavier oils, but you will not likely cause any long term engine problems. I would recommend, however, to stick with the lower weight recommendations if using a synthetic oil, even if you're running the engine in higher temp climates. I think you know why by now.

If the manufacturer does not make allowance for heavier weight oils, it would be my recommendation that you DO NOT use a heavier weight oil in your engine. Under most circumstances, stick with a viscosity grade that is recommended by the manufacturer. And, if you do choose to use a heavier weight oil, at least make sure that you only move up one grade. Never move up two grades.

AN EXCEPTION TO THE ABOVE RULE

Well, now that I've made it clear that you shouldn't use heavier weight oils than recommended by your vehicle manufacturer, I'm going to confuse the issue a little. We're going to talk about 5w20 motor oils.

For the 2001 and 2002 model years, Ford and a number of other vehicle manufacturers are moving to a 5w20 viscosity recommendation for at least some of their vehicles. They say that you'll maintain adequate engine protection while getting better fuel economy with the 5w20. Well, technically, this may be true, but let's dig a little deeper.

The fact is, the engines did not really change between the 2000 and 2001 model years. So, the lubrication requirements of the vehicles did not change. But, Ford, and possibly other manufacturers, were having trouble meeting the CAFE standards set by the government. 5w20 is their answer to this problem.

You see, the only reason 5w20 was specified for your engine is to increase the CAFE (Corporate Average Fuel Economy) reported to the Federal Government. CAFE is the combined average fuel economy of all of a vehicle manufacturer's product line. Minimum CAFE levels are specified by the Federal Government.

In order for a vehicle manufacturer to continue selling profitable large trucks and SUV's, which typically have poor fuel mileage, and still meet mandated CAFE requirements, they must also sell smaller cars

which have much better fuel economy ratings to offset the poor fuel economy ratings of the larger vehicles. Sometimes, that's not enough.

For model year 2001, the change to 5w20 oil will allow a vehicle manufacturer's overall CAFE to decrease by a very small amount, typically in the tenths of a mile per gallon range. 5w20 oil is a lighter viscosity than a 5w30 oil and therefore has less internal engine frictional losses, or less drag on the crankshaft, pistons and valve-train.

This decrease in frictional power loss promotes increased fuel economy. But, the minimal increase fuel economy is virtually undetectable to the average consumer without the use of specialized engine monitoring and testing equipment when compared to a 5w30, 10w30 or a 0w30 viscosity motor oil.

So, the 5w20 offers you a fuel economy increase that you'll never notice. What about engine protection. The truth is 5w20 oil has less film and shear strength than a 5w30, 10w30 or a 0w30 motor oil. This **can** lead to increased engine wear under today's demanding heat and high-stress engine performance conditions.

Of course, since vehicle manufacturers know that most consumers don't expect to keep their vehicle longer than 100,000 miles or so, that's ok. You'll receive **adequate** protection in order to keep your engine running for 100,000 miles. But, beyond that is another story.

So, if you're not really going to see any significant fuel mileage increase and engine protection is likely to suffer, do you have to use a 5w20 motor oil to maintain your warranty?

NO.

Vehicle manufacturers recommend using motor oils meeting certain viscosity grades and American Petroleum Institute service requirements. Whether the motor oil is a 5w20, 5w30, 10w30 or 0w30 or even a synthetic vs. a petroleum-based oil will not affect warranty coverage. A 5w30 motor oil is a perfectly acceptable alternative to the 5w20 oil that is recommended for your 2001 or 2002 vehicle because the same engine was in service in 2000 using the recommended 5w30 grade (at least with Ford vehicles).

Regardless of which viscosity grade you choose, the manufacturer is required to cover all equipment failures it would normally cover as long as the oil meets API service requirements and was not the cause of the failure. In order to legally deny a warranty claim, a dealership/manufacturer must prove that your maintenance practices caused the problem at hand, and they must be willing to put it in writing. In addition, they can only deny that particular claim. They cannot void your entire warranty, even if you did cause the problem.

Moreover, the federally mandated Magnuson - Moss Warranty Improvement Act states that a manufacturer may not require a specific brand of aftermarket product unless it is provided free of charge (a copy of the relevant portions of this Act is provided in the section below titled "New Car Warranties and Extended Drains".

If your dealership continues to tell you that you need to use 5w20 oil to maintain your warranty, then ask them to put it in writing. If they indicate you must use a particular brand of oil to maintain your warranty, tell them you expect it to be provided free of charge. You have the legal right to do that.

Their position is inaccurate and, in fact, violates existing U.S. legislation. Additionally, if there is ever a question of whether or not a particular oil was the cause of an engine failure, make sure to get a sample of the used oil in a bottle, typically 6 oz. minimum. That will provide enough fluid to send oil to 2 independent testing labs for analysis. Remember that being a knowledgeable and informed consumer

is your best defense against being taken advantage of by a car dealership service center.

NOTE: If you've purchased an extended warranty, the above may not apply. Extended warranties are not necessarily bound by the same regulations as factory warranties are. Companies can put significant restrictions on auto owners in order to maintain extended warranty coverage. Just be careful.

WHAT ABOUT SYNTHETICS?

If after reading this you still choose to use 5w20, there is an acceptable alternative that **will** actually provide a noticeable increase in fuel economy and will maintain superior engine protection. Go with a synthetic 5w20 motor oil.

A 5w20 synthetic oil will likely have less film and shear strength than a synthetic 5w30, 10w30 or 0w30. However, if you compare that same synthetic 5w20 motor oil to a petroleum 5w30, or 10w30, it will likely have better film and shear strength than the petroleum oils.

Obviously, this means it will certainly have better film and shear strength than a petroleum 5w20 oil. So, if you'd feel more comfortable sticking with the manufacturer recommended 5w20, go with a quality synthetic oil.

WHEN CAN I SWITCH TO SYNTHETIC?

Opinions vary greatly regarding how long you should allow your new vehicle to "break in" before switching to synthetic oil. In fact, there are those who don't think a break in is necessary at all. So who do you believe?

I recommended that a gas engine be operated up to the first regularly scheduled oil change at 3 to 5,000 miles before making the switch. Diesels should be operated to 10 or 20,000 miles before making the switch. However, some manufacturers recommend an oil change well before that. It's not uncommon for a manufacturer to recommend a first change at 500 to 1,000 miles.

That's not what I mean when I refer to the "first regularly scheduled oil change". You should change your oil at about 1,000 miles just to get out the metal shavings that show up in your oil as the engine breaks in. But, you should keep using petroleum oil until about 3,000 to 5,000 miles before switching to synthetic (or 10 to 20,000 on a diesel).

I recommend this for a couple of reasons. First, during the initial break-in, your rings are still in the process of seating properly. If the rings are not seated properly before making the switch to synthetic, you'll have oil blowing by the rings into the combustion chamber. This will cause significant oil consumption, which can be very costly when using a synthetic oil. In addition, it will decrease engine performance since your engine is not designed to burn oil for power.

Using petroleum oil during this break in period allows the rings to seat because a certain amount of "wear" is necessary for this process to complete. Because synthetic oils protect against wear so much better than petroleum oils, the "break-in" period can be extended indefinitely if the switch is made too early.

The second reason for waiting to make the switch would be that new engines and engine components generate high wear metals in the first few thousand miles. There is also debris left in the engine from machining and assembly. If you make the switch to synthetic to early, you risk allowing these wear metals to collect and circulate throughout the crankcase in an expensive synthetic motor oil. If you have decided to use extended drains, this could be a long time and could end up causing even more wear to

occur.

By operating the vehicle with petroleum oil until its first regularly scheduled change, these wear metals and manufacturing debris collect in the oil and then are removed from the crankcase when the oil is drained. The result is a much cleaner environment for the synthetic oil to operate in.

Of course, machining processes are improving all the time and new techniques are making it possible for synthetics to be run directly from the factory. In fact, GM has been running Mobil 1 synthetic in all of their new corvettes straight from the factory since the mid to late 90's.

In speaking with a very knowledgeable service tech from a GM dealership I was informed that GM intends on using Mobil 1 straight from the factory in all of their automobiles within only a year or two. Not only that, but on most new GM trucks, the company will be shipping with Mobil 1 in the crankcase and recommending 10,000 to 20,000 mile oil drain intervals - I am told.

They've even begun running vehicles with an oil life monitoring system to help drivers decide when it's really time to change their oil. This system has its merits, but I'll talk about it's potential drawbacks in a moment.

There is one other reason for not moving to synthetics right away (if not already done by the factory). If there are any major defects in the assembly or workmanship of the engine components, hopefully they will show up within the first few thousand miles. Then they may be corrected before installing the more expensive synthetic motor oil.

Occasionally, re-machined components in rebuilt engines can be mismatched. Issues such as this would be noticed in a relatively short period of time. These problems should be corrected before the introduction of an expensive synthetic to the system.

GM'S OIL LIFE MONITORING SYSTEM

This is an interesting system and should be helpful to many GM drivers. Basically, here's what GM has done. The company spent a great deal of time testing oils under differing heat and stress conditions to determine what factors cause the most deterioration in an oil's ability to protect your engine.

Once they established what these factors, they established how much each of these factors really affect oil drain intervals. Factors such as the temperature of your engine, whether your driving is stop and go or highway driving and so on are some of the factors that they decided were important.

So, they designed a system that will monitor those factors. Depending upon the results of the monitoring, the oil life system will then alert you to when it believes you'll need to change your oil.

This is a useful system, but there are a couple of things I take issue with. First of all, many consumers are under the mistaken impression that this system actually tests the oil to see whether it is still good or not. It doesn't. It does not monitor the oil. What it monitors are the factors within your engine that will affect the drain interval of the oil.

So, technically, it could tell you to change your oil when it wasn't yet time. It could also fail to alert you that your oil needs to be changed even though it is necessary because it doesn't actually test the oil itself. I don't believe that would happen, but it is possible. GM does recommend changing the oil at one year or 10,000 miles regardless of what the system says.

Another issue that is important to note is that the oil life monitoring system does not take into account the difference between the effective life of a petroleum oil as compared to a synthetic oil. In other

words, even if you're using a synthetic oil, the system makes its oil change recommendations based upon the assumption that you're using petroleum oil.

In addition, it does not in any way account for using advanced filtration to extend oil life. Even a petroleum oil can have its useful life greatly extended by using a high efficiency oil filter. The monitoring system doesn't factor this into its oil change algorithm.

That could be very costly for someone using a high quality premium oil that is designed for greatly extended drains. The monitoring system would likely indicate that a change was necessary LONG before that was really the case.

Just be aware that although the system is useful, it's not perfect. Don't rely on it alone to establish your oil drain intervals.

WON'T SYNTHETIC OILS CAUSE LEAKAGE?

This is a huge misconception about synthetic oils which was caused by some poor basestock and additive choices back in the 70's and 80's among some synthetic oil manufacturers. Back in these early days of synthetic oil use, some synthetic oil manufactures did not properly additize their oils to prevent seal shrinkage.

You see, some synthetic basestocks will naturally cause seal shrinkage. So, if the proper additives are not used to counteract this problem, oil leakage can become an issue. In addition, back then some synthetic oil manufacturers actually used components in their oils that reacted negatively with seals and caused deterioration. As a result, leaks developed.

This is not the case with present day synthetic oils. Synthetic oil manufacturers have revised their basestock and additive choices and have adjusted their blending techniques so that their oils are completely compatible with the seals in your engine. Leakage should not be an issue.

The only case in which leakage could be an issue is if you own an older vehicle (8 to 10 years old or older) with average mileage (say 100,000 miles or more). These are rough estimates, so don't take them as gospel. But, even though every vehicle is a little different, this at least gives you an estimated baseline.

If you've been using petroleum oil all along, it is possible that you have seals and gaskets, which are dried and cracked from long-term petroleum use. However, you may not notice any leaks at present because the petroleum oil you've been using has coated your seals and gaskets with sludge and deposits - thereby effectively sealing up any potential leak points.

The introduction of a synthetic to the system will clean out these deposits over time. If there were any leak points present, once these deposits are gone, leaks may develop.

I would point out that this scenario is fairly unlikely. Even in vehicles over 10 years old the occurrence of this type of problem is very low. Some of these leaks will even seal themselves up due to the seal conditioning additives found in most quality synthetic oils.

If you own an older vehicle, only you can weigh the potential benefits of using synthetic oil against the potential drawback of temporary or permanent leakage (which can only be corrected by replacement of the leaky seals and/or gaskets.

NEW CAR WARRANTIES & EXTENDED DRAINS

Many times when you make a change in your vehicle maintenance practices, dealers get a little ornery. In fact, in extreme cases, they may even tell you that your change in maintenance practices has now voided your warranty. This can be especially true in cases where you extend your oil drains. Don't be fooled. This practice is neither legal, nor ethical.

I can't stress this enough. Legally (by virtue of the Magnuson-Moss Warranty Act), no dealer or manufacturer can void your warranty simply because you have installed an add-on performance accessory or changed your vehicle maintenance practices. The only way that a warranty claim can be denied is if the dealership has proof that your maintenance practices caused the problem for which you are requesting warranty coverage.

Here's what the relevant portions of the M-M warranty Act state:

Sec. 700.10 Section 102(c).

(a) Section 102(c) prohibits tying arrangements that condition coverage under a written warranty on the consumer's use of an article or service identified by brand, trade, or corporate name unless that article or service is provided without charge to the consumer.

(c) No warrantor may condition the continued validity of a warranty on the use of only authorized repair service and/or authorized replacement parts for non-warranty service and maintenance. For example, provisions such as, 'This warranty is void if service is performed by anyone other than an authorized 'ABC' dealer and all replacement parts must be genuine 'ABC' parts,' and the like, are prohibited where the service or parts are not covered by the warranty. These provisions violate the Act in two ways. First, they violate the section 102 (c) ban against tying arrangements. Second, **such provisions are deceptive under section 110 of the Act, because a warrantor cannot, as a matter of law, avoid liability under a written warranty where a defect is unrelated to the use by a consumer of 'unauthorized' articles or service.**

For instance, a dealer denying warranty coverage on your engine because you used 10w30 oil instead of 5w30 motor oil is no different than denying warranty coverage on your door handle because you installed new hubcaps. No direct relationship has been shown between your actions and the problem at hand.

This is true whether you've chosen to use a different brand than they recommend, a different viscosity than they recommend or if you choose to extend your lube and/or filter change intervals longer than they recommend. If a connection can be shown, the dealer may have a leg to stand on.

However, you always have the right to take the dealer to court (they pay all your court costs and legal fees if you win) or contact the FTC if you believe their decision is unfair. Generally, if a dealership knows they should be accepting your claim and you indicate your knowledge of your warranty rights, they'll give in. Just stand your ground.

A word of caution. The above discussion of warranty issues does not apply to extended warranties. A company offering an extended warranty really can put whatever restrictions they want on you. They could technically require you to change your oil every 500 miles if they wanted to. So, just be careful and read the fine print. An extended warranty could end up costing you far more then the hefty fee they charge up front.

API SJ, SH, CG, CH-4 ... Huh?

You may have seen lettering such as that in the heading above on different bottles of motor oil, but you didn't have a clue what it meant. Or maybe you looked in your vehicle guide and saw similar notations

but were unsure of what to make of it. That's ok. Many people aren't really sure of what these letters mean, even though it's really very simple - you just have to have somebody explain it.

First of all, understand that there are different specifications depending upon whether you're referring to a motor oil designed for gasoline engines or one designed for diesel engines. Some oils can actually be used for both, but not all oils can be.

Any time you see a notation that says something like API SJ or API SH, you are seeing a specification that applies only to gasoline oils. The API stands for American Petroleum Institute, which is an organization that sets new specifications every few years for the motor oils that you buy. These specifications are meant to be minimum standards that an oil should meet in order to adequately protect your engine.

GASOLINE SPECIFICATIONS

You'll know if you're looking at a specification for a gasoline motor oil if it begins with an "S". Any spec that begins with an S and some second letter after it is a specification for a gasoline motor oil. So, SJ, SH, SG, SF and so on are all specifications which define standards that gasoline motor oils should meet in order for you to consider purchasing them for your vehicle.

But which specification is best? Which one should you be looking for? In simplest terms look for the one that has the "highest" second letter. In other words, the most current (and most stringent) specification is the API SL rating. If an oil meets that rating, it is up to date. If it doesn't, you should probably stay clear of it.

But what if your owner's manual calls for an SG rated oil? What if you can't find any oils that list the SG rating. Not to worry. All API ratings are backward compatible. Therefore, an SJ rated oil will be just fine for an SH, SG or SF rated vehicle. However, on a newer vehicle that calls for an SJ rated oil, it is not recommended that you use an oil that does not indicate that it meets the SJ standard.

DIESEL SPECIFICATIONS

You might have guessed this one, but any specification that begins with a C is an API motor oil rating for diesel powered engines. So, CD, CF, CG, CH, CH-4 and so on are all diesel oil ratings. Again, the higher the second letter, the better the oil (meets more stringent API requirements).

Also, when a number follows the letter specification, it is a reference to whether the engine is a 4 cycle or 2 cycle specification. 2-Cycle? Diesel? YES! There are 2 cycle diesel engines. Obviously, these require special consideration. So, if an engine calls for a CF-2 oil, it's a 2 cycle engine and should not use any oil that does not have the "-2" specification.

Just like with the gasoline motor oil specs, these also are backward compatible. So, a CH oil will be just fine if your manual calls for a CF rated oil. However, in the case of both gasoline and diesel rated oils, the specifications are not forward compatible. In other words, don't use an oil that only meets the CF spec in an engine that calls for a CH spec oil.

As I said before, an oil can potentially meet both the gasoline motor oil specs and the diesel motor oil specs, but they won't always. This means that in some instances you might be able to use the same oil for both your diesel and your gasoline powered engines, thereby eliminating the need to have more than one type or viscosity grade of oil on your premises. However, be sure to check the bottle carefully to be sure it meets both required specs before going this route.

NON-API SPECIFICATIONS

There is another spec that is applied to oils, and you may see it listed as a requirement for the oil used in your engine. The specification is set by ILSAC (International Lubricant Standardization and Approval Committee). The current specification is GF-3 for gasoline oils. That specification surpasses the previous GF-1 and GF-2 specs.

In addition, some engine/vehicle manufacturers have their own specifications for oil in addition to API and ILSAC specs. For instance, Ford, GM, Volvo, VW, Mack, Cummins, Caterpillar and others all have their own oil specs for specific applications. Make sure that your oil meets these standards as well if called for.

ONE LAST THING

One last point about API specifications. Understand that API specifications are minimum specifications for oils. They exist for your safety so that you have reasonable assurance that an oil will "adequately" protect your engine. However, these are not, by any means, a standard by which you could determine whether an oil was good or not. As an example, you'll find that even a cheapo off-brand oil which costs 50 cents per quart will most likely carry the API SJ rating. That should tell you something about how hard it is to attain that rating.

I say this only because there are some synthetic oils on the market that do not submit their oils to the API for testing and certification. In most cases these are top of the line oils which already have a reputation for superior protection and performance and don't need the API's stamp of approval which costs hundreds of thousands of dollars.

This doesn't mean that the oils don't meet the latest API standard. On the contrary, they generally exceed the latest standard by a wide margin and have done extensive testing to make sure of that. However, they are more interested in putting their money into research and development than in having the API tell them what they and their customers already know.

So, just be aware that some of the best oils out there, don't carry the little API "starburst". They will still note which API specifications they meet or exceed. They just won't have the API's stamp of approval. In these cases you must separate the good and the bad by studying individual technical specifications of the oils and by doing a little bit of research to see what others think.

Just a little FYI

SWITCHING BACK AND FORTH

A question asked of me repeatedly is "If I switch to synthetic, can I go back to petroleum later? I've heard that once you switch there's no going back."

This is nonsense. In the old days of synthetics, there were some incompatibilities between petroleum oils and certain synthetic oils but that is basically a thing of the past. Today's synthetics are designed to be completely compatible with petroleum oils.

You can switch back and forth as many times as you want. You can mix and match them if you want. Basically, this is a non-issue. Just don't worry about it.

MY OIL IS DIRTY

Many times when people make the switch to synthetic oil in order to take advantage of the extended drain benefits, one of the first issues that comes up is "dirty oil". About 5 or 10,000 miles down the road,

they check their oil only to find out that it's not that nice amber color it was out of the bottle. Then they start getting worried.

Relax. The old "if I can't see through it, it must be time to change it" rule doesn't hold water. It's just not an accurate way of determining whether an oil is still good or not. The truth of the matter is that there are tons of contaminants that will darken your oil but are not large enough to do any damage to your engine.

For instance, I know a gentleman who took his vehicle in to be serviced. He had put 30,000 miles on the same oil in one year. The oil was very dark and his dealer was concerned that it needed to be changed. However, oil analysis showed that the oil was still good for continued use.

As another example that color is not a good way to determine whether an oil is still good, consider a diesel engine. Many diesel engines will darken an oil after only a few hundred miles. After a thousand miles or so the oil can sometimes be almost pitch black. However, the oil is still good. Color alone is simply not a good rule of thumb.

The only way to truly know whether an oil is still good is via oil analysis. This is a very scientific and proven method for determining how much an oil has broken down and/or been contaminated. However, if you don't wish to use oil analysis, and aren't sure about simply following the oil manufacturer's recommendations, there is a decent rule to use.

First, rub the oil between your thumb and forefinger. Does it seem gritty? If not, there is probably not enough contamination in the oil to hurt anything. Smell the oil. Does it smell burnt? If not, there is probably very little breakdown occurring.

Keep in mind that this is not a foolproof test, but it is normally fairly accurate. I still recommend oil analysis, though, if you choose not to follow the oil manufacturer's recommendations.

HOW MUCH IS TOO MUCH?

Very often you'll read information that says not to overfill your crankcase with oil when you do your oil changes. However, nobody ever really says why. Will your engine explode? Will oil start pouring out your air conditioning vents? Will your oil pan simply blow off? What really would happen if you put in too much oil?

Well, as it turns out, not too much, really. In most cases it will simply end up blowing by the rings into the combustion chamber. Since your engine is not designed to burn oil as a means of producing power, if you had too much oil blowby you could notice a significant (although temporary) loss of performance.

In a more serious case where there is WAY too much oil (like 20% or more extra), you could end up with fouled plugs, and your rings could begin sticking, both of which would cause an even greater decrease in engine performance.

None of these issues are major and shouldn't cause any long-term effects, but too much oil will cause minor problems such as these. The assumption is that you probably want to avoid these issues.

FLUSHING AN ENGINE: IS IT NECESSARY?

You may have seen some products on the shelf of your local auto parts store that guarantee to clean out your engine and leave it sparkling like new. Do these products really work? Are they really necessary?

In most cases the products do work. They'll clean out much of the dirt, deposits and grime left behind when using petroleum oil in your engine. The longer your oil drain intervals with petroleum, the more sludge will be left behind, usually. Also, the more years that you use petroleum oil the worse the sludge problem becomes.

If you are using petroleum oil it is probably a good idea to do a flush once per year or every couple of years just to keep the engine somewhat clean inside. If you've been using petroleum oil for awhile and would like to switch to synthetic, then you'll want to do an engine flush to prep your engine for the introduction of synthetic oil. Otherwise, you may see pretty high oil consumption for the first 5 to 10,000 miles while the synthetic oil does the work of cleaning things out.

So, here comes "Super-Techno-Gumout" to save the day ... almost.

There is one problem with many off-the-shelf engine crankcase cleaners. Many of them use harsh chemicals such as kerosene to clean out the deposits from your engine. Unfortunately, in some cases, especially in the case of kerosene, the chemicals used for cleaning your engine may also react negatively with certain engine components. Therefore, it's a good idea to know what's in these products before putting them in your engine.

I know of at least two companies that produce an engine flush which doesn't appear to use these harsh chemicals to do its dirty work (there may be others). Gold Eagle Oil System Flush contains no kerosene, according to the manufacturer. I haven't tested it to know how well it works. Also, the Amsoil company manufactures an engine flush which contains the same detergents that their motor oils contain (in much higher quantity) - and nothing more, according to a company tech support representative.

Basically, where a motor oil will contain mostly basestocks and a small percentage of detergency additives, the AMSOIL engine flush product raises the percentage of detergency additives and lower the lubricant basestock percentage. The end result is a super high detergency, extremely low viscosity lubricant. In other words, you're putting an extremely light weight oil in your engine that just happens to contain a high concentration of mild detergents. This is much less abusive to your engine.

I'm not certain that this is the basis for the Gold Eagle product chemistry, but at least it doesn't contain kerosene. Whether it works or not is another story. If you've tried the product and have seen good results, drop me a line and maybe I'll revise this section based upon customer experience.

WHAT ABOUT THE TORQUE CONVERTER?

Changing the transmission fluid in your vehicle may not be such a difficult thing, but what you may find difficult is making sure that you change the whole system over. You see, simply draining the oil from the pan and refilling it is not enough, at least if you're switching fluid types.

If you're going to switch to synthetic, you want to make sure you're getting the most bang for your buck. Thus, you'll want to make sure that you get as much of the old fluid OUT as you can so that you can put as much of the new fluid IN as you can.

The problem is that your torque converter will be holding some fluid that won't be pushed through unless the vehicle is running. You need to somehow get that fluid out. You can take it to a shop that can do a complete transmission flush and refill, but they'll certainly charge you for it.

Keep this in mind, though. If you take it to the local Spiffy Lube, they may have a flushing machine available to do the job. However, be careful. Some of the machines out there use extra pressure to push the fluid through more quickly. This is good for them because they make more money in less time.

It may not be good for you and your vehicle, though. The extra pressure can blow a seal. You don't want that. Dealerships also have these machines, but they know better than to use a machine that uses added pressure. They won't blow your seals.

No matter who you have do it, if you bring your own ATF, watch the technician and make sure he/she uses most all the fluid you brought. And, if there is any left, make sure you get it back. Alternatively, at least ask to see the empty bottles.

But, if you'd like to save yourself a few bucks, here's a way that you can do it yourself without doing any damage to your transmission and without removing the torque converter. You'll need at least two and maybe three people to do the job, but not because it's that difficult. You just can't be in more than one place at one time. You can do it by yourself, but the job will be far more time consuming than with a "helper".

Here's the plan. Find out how much fluid your transmission holds. Then find out how much fluid your torque converter holds. You may have to contact your local dealer for that info. Add the two together and then add about two quarts to that total. You'll probably need the extra to do the job, but if you don't at least you'll have some extra for topping off if it ever becomes necessary.

Now, change the fluid in the transmission fluid pan and replace the seal (if needed) and the pan. Then, disconnect the fluid line which is running OUT of your radiator or transmission fluid cooler and back to your transmission system. If this line is flexible, then disconnect the end that attaches to your transmission (making sure to clean any dirt off the end of the hose and the area around the connection first). You'll use this disconnected end to drain fluid from. Don't disconnect the other end.

If it is not flexible, you'll probably need to have some extra temporary, flexible hose on hand to use. In this case you'll disconnect the same line, but disconnect it where it comes out of the cooling system, NOT where it attaches to the transmission (again making sure to clean the area around the connection first). Then connect one end of the flexible line (brake line should work - ask your local auto parts store) to the fluid cooler (where you removed the other line) and leave the other end unconnected and pointed into a drain pan.

If you're not sure why we're doing this, you'll understand in a minute.

At this point you should have one person begin pouring in transmission fluid at the same time that you start the engine (another person should be watching the fluid coming out of the oil line).

Keep pouring in fluid until the color of the fluid coming out of the hose changes color. At that point, all of the old fluid has been drained out and replaced with new tranny fluid. Shut off the car, stop pouring in fluid and reconnect the hose. Then, simply make sure that your fluid level is at full capacity, and you're all set. Pretty simple, eh?

If you've only got two people to do the job, it can still be done in nearly the same manner. Just have one person watching the hose and one person starting the vehicle. Allow a quart or two quarts of the old fluid to drain. Then shut off the vehicle and pour in an equal amount of new tranny fluid. Then restart the car and drain some more fluid. Shut off the car and refill.

Continue to do this until you see the color change. One way to be more sure of the color change is to do the following. Instead of draining directly into a drain pan, drain the old fluid into an empty bottle. Have two clear or white shallow dishes standing by.

Have a small amount of the new fluid in one of the dishes. In the other dish, pour a little bit of each drained bottle of old fluid. Compare the color of the fluid in the two dishes. When the fluid looks nearly

identical in each dish, you've basically got the system flushed.

ROTARY ENGINES AND SYNTHETIC OIL

Conventional wisdom about rotary engines (such as in the RX-7) and synthetic oil is that they are not compatible. In a rotary engine, oil is injected into the combustion chamber for lubrication purposes. This is not the case in non-rotary engines. Because oil is injected into the combustion chamber it must burn, and it must burn cleanly without leaving any residues behind.

Many internet sites say that some synthetic oils **may** not perform well under these circumstances and may begin to coat combustion chamber components. This, of course, would gum up the works and can cause problems. As a result, the conventional advice is to steer clear of all synthetics to avoid the issue altogether.

However, although the logic of the above statements may be somewhat reasonable, I have yet to see any conclusive evidence that the above scenario actually occurs or has occurred in any rotary engine. In fact, my readings and the opinions of reputable mechanics who know about and work on rotary engines on a regular basis indicate that at least a couple of synthetic oils do not cause these problems. There may also be others.

Catalogs from reputable engine tuners such as *Racing Beat* and *Mazda Trix* either recommend or avoid condemning synthetic oils, and more than a few other popular Mazda periodicals have recommended the use of AMSOIL synthetic oil. Some others have recommended Redline.

This question is really a difficult one to answer, but from what I've read on the issue (since I don't personally own a vehicle with a rotary engine) it seems that you could at least use AMSOIL or Redline. I suspect that you could probably also use others, but I don't know this for a fact.

YOU DIDN'T ANSWER MY QUESTION

Although I've tried to touch on the questions I am most often asked in regards to motor oil, I'm sure there are some questions that I've missed. So, in light of that, you are more than welcome to email me with any other questions you might have regarding motor oil, filtration or other lube related issues. If you don't mind, I might even use your question and my answer on this FAQs page in the future, although I won't use your name or anything.

You can email me here: **info@motor-oil-bible.com**

SPECIAL BONUS CHAPTERS

Motor Oil Comparisons

Well, we've now discussed just about all there is to discuss about oil. You should know a great deal more about automotive lubrication than you did before we started - I hope. However, you still must determine which brand oil you intend on using.

The information in our technical specification charts has been taken directly from each oil manufacturer's website or from literature that was sent from the company to me (unless otherwise indicated). There are a total of 26 brands and 19 viscosity grades for a total of well over 300 different oils listed.

A couple of oils have purposely been left out. Bel Ray declined to provide technical specifications, so they could not be included. Exxon Synthetic Blend spec sheets had virtually no pertinent information on them, so I chose not to bother including them. Lucas Oil 15w40 also did not provide enough pertinent information to make it worth publishing their specs.

If there are other oils that I've missed, please let me know. I will add them at the next revision if I can get my hands on the numbers.

The following specifications are included in the charts below: API Rating, VI (viscosity index), FP (flash point measured in Fahrenheit), PP (pour point measured in F), FRP (fire point measured in F), HT/HS (High Temperature/High Shear), NOACK (NOACK volatility score), TBN (Total Base Number), FB (Four Ball Wear Scar in millimeters), Phosphorous content, Zinc content, CCS (Cold Crank Simulator viscosity), Ash content and the revision date of the spec sheets I used.

If you are unsure what any of the above listed specifications means, go back and read the chapter titled "Motor Oil Technical Specifications" which begins on page 55. This will tell you anything you need to know about the specs listed.

If you are concerned about whether the information is up to date, take a look at the revision date listed. If one is not listed, it is because the manufacturer didn't list one. If the revision date says "2001?" it's because the oil lists an API rating of SL, but didn't list a revision date for the tech spec sheet. Since the SL rating came out in 2001, it's likely the revision date of the spec sheet is sometime in 2001.

THINGS TO KEEP IN MIND

If there is data "missing" from the technical specifications provided it is because the manufacturer didn't provide that information on their technical specs sheets or the information provided was unclear. Information that was not provided is indicated by a "0" in that field. However, in the Pour Point category, although one or two oils were missing this information, the rest have a "0" listing because the pour point really is 0 degrees. In some cases, a spec will be provided with a "?" after it. This indicates that I am fairly certain that I have interpreted their data sheet correctly.

I guarantee you that each manufacturer has information relating to all of the technical specifications I'm providing (with the exception of possibly the 4 Ball and the HT/HS for monograde oils). Basically, all of these tests (minus the 4 Ball) had to have been run in order to verify API classification and/or SAE viscosity grade of the oils. I decline to give any opinions as to why I believe these specifications may have been left out.

COLD CRANK SIMULATOR (CCS) NUMBERS

Remember that the lubricants industry is in a transition phase in regards to CCS testing and viscosity

classification based on this testing. The old testing and classification method required testing the oil at a temperature 5 degrees C warmer than the current method. Also, the cutoff requirements for the CCS value were lower with the old specification. Some manufacturers will already have the new numbers up. Some will have the old numbers up.

As a general rule try to compare the CCS ratings for like temperatures. When this is not possible, assume that the CCS value of an oil will nearly double with a 5 degree drop in temperature on the CCS test. This is only an estimate, though. Don't treat it as gospel. In fact, synthetic oil CCS scores will not generally double with the 5 degree drop. A closer approximation for synthetic oils would likely be about 1.5 times.

If you use this method and you see one petroleum oil scored a 3100 cP value at -25 degrees C and another scored a 5000 cP value at -30 degrees, the second oil probably has better cold temperature cranking ability.

I say this because if the testing of the first oil was done at –30 degrees, the cP value would likely have been nearly double what it was at –25 degrees. In other words, it would have scored about 6000 cP. Thus, the second oil actually has a better CCS rating.

Also, remember that the CCS test is only required if an oil is to be classified as a multi-grade oil. So, for oils classified as monogrades (such as SAE 30 or SAE 40 oils), you will see "n/a" listed for the CCS rating. This is because the manufacturer is not required to run this test, so they don't provide the information. There's nothing sneaky going on.

In some cases, a manufacturer will simply list the maximum limits set for the CCS numbers for that viscosity grade. In other words, for a 5w30 motor oil of a particular brand, instead of listing the actual CCS score for their oil, the company lists the maximum cP value their oil needed on the CCS in order to be classified as a 5w30.

The assumption is that the oil scored under that maximum limit, but there is no way to know how far under the limit. So, obviously, this makes it very difficult to compare the CCS value of this oil to any of the others. As a result, since this information is basically useless, I have put a "0" in place of this max value for any manufacturer that provided it. The information they provided was no more useful for comparison than if they had left it out entirely.

ZINC, PHOSPHOROUS AND SULFATED ASH

Many companies do not list any of the above specs. Some list only some of them. I'd like to take a moment to explain why this is and elaborate on the importance (or unimportance) of this omission.

First, the API only sets limits on phosphorous (and possibly sulfated ash). So, although it's likely that they have zinc content information as well, you can only be certain that the company has done testing to establish phosphorous (and maybe sulfated ash) levels. Thus, if zinc content levels are not listed, it's not necessarily because the company is trying to keep you in the dark.

Also, you may want to go back and read what I had to say about these three specifications in an earlier chapter that discusses the technical specifications of oils. However, if you choose not to, here's a brief synopsis.

The API sets limits on the amount of phosphorous some oils can contain in order to be API certified. These limits are set because of concern over "damage" to the catalytic converter by phosphorous which passes into exhaust gases when your oil burns. However, they make no distinction between petroleum and synthetic oils when setting this limit.

Since the catalytic converter is only affected by high phosphorous levels when the oil burns, the volatility of an oil is crucial in establishing how the phosphorous content in that oil will affect the catalytic converter. Higher volatility oils will allow more phosphorous to pass into the exhaust gases and "poison" the catalytic converter. Low volatility oils will allow less.

So, low volatility synthetic oils should logically be able to contain higher levels of phosphorous without increasing the likelihood of damage to the catalytic converter. Unfortunately, the API won't make any allowances for NOACK volatility when considering the phosphorous limits.

What About Sulfated Ash Content?

There is a similar issue going on here. Many people will tell you that you want an oil with very low sulfated ash content. This is only half true. You see, the irony is, the very thing that people are trying to avoid by keeping sulfated ash content to a minimum is the very thing they may see caused by sulfated ash levels that are too low.

As discussed in an earlier chapter, sulfated ash is the residue that is left behind when an oil burns. The higher the metallic detergent additive levels within the oil, the greater the level of sulfated ash that is left behind when the oil burns. When sulfated ash is left behind from the burning of an oil, it forms deposit build-up within your engine, which is, obviously, a bad thing.

So, most people recommend sticking with an oil that has low sulfated ash content. As a general rule, especially among petroleum oils, this is a good idea. However, since the level of sulfated ash is directly proportional to the level of detergent additives in your oil, low sulfated ash content generally means limited detergency properties. Too little detergent means too much deposit build-up, the very thing you wanted to avoid.

The key, as with the phosphorous issue, is with the volatility of the oil. An oil that has low volatility will not have much burn off. Therefore, the sulfated ash residue that is left behind from the burning of metallic detergent additives will be less. It is my belief that oils with lower NOACK volatility scores can have higher levels of detergency additives (which raise sulfated ash levels) without causing increases in ending deposit build-up. In fact, I would contend that build-up would be less because they can include higher levels of detergent additives.

Why Is This Important?

I believe that some companies manufacturing low volatility oils may leave their Zinc, Phosphorous and Sulfated Ash levels off their technical specification sheets because consumers might misinterpret the numbers (not being aware of the importance of the NOACK for understanding these numbers). As a result, to avoid any confusion, they leave them off.

If the company is manufacturing oils with zinc and phosphorous content (zinc content is very closely related to phosphorous content) higher than what the API allows, they may be afraid consumers may choose not to purchase their oil as a result. The same could be true of Sulfated Ash content. This would be unfortunate since higher zinc and phosphorous levels are a good thing as long as they are tempered by a low NOACK score. It is possible that higher sulfated ash content may also signify the positive aspect of better detergency properties.

Just keep in mind that although some manufacturers may leave out these specs because they are low, others may leave them out because they are high. This is only my personal opinion, though. For what it's worth. I would say, if the information is provided, great. If not, don't penalize the oil manufacturer for it. If it is provided, look to see if the NOACK is also provided. If so, at least you'll be able to see if higher levels of zinc, phosphorous and sulfated ash will be a problem as a result of oil burning.

VISCOSITY INDEX

I've hopefully made it clear that I believe the viscosity index of an oil can be an important factor in determining its quality. A high VI is a good indicator that an oil will maintain its viscosity over a wide temperature range – a very good thing. Also, this is a spec that just about every oil manufacturer will list, so it can nearly always be used to compare two oils. However, there is a drawback to focusing too much on the viscosity index of an oil.

Petroleum oils tend to use a fair amount of viscosity improver additives (which was discussed in an earlier chapter). Because of this, although a petroleum oil may have a good viscosity index when it comes out of the bottle, as those additives are broken down, the oil's viscosity index begins to drop steadily.

So, if you're comparing a petroleum oil to a synthetic oil, it's possible that the two might have similar VI numbers. The viscosity index of the petroleum oil will likely begin to drop off fairly quickly once in use. The synthetic oil will not. So, in this case, I'd give some bonus points to the synthetic in this regard.

In some cases, you may notice that not only is the viscosity index of a petroleum oil close to the synthetic oils, it may also have flashpoint and pour point values which are very close. Typically, this means the petroleum oil has gone through some sort of hydrofinishing or hydrocracking process to create a more advanced petroleum oil which performs more closely to that of a synthetic oil.

Since it's difficult to be certain sometimes whether a petroleum oil is hydrofinished/hydrocracked, I haven't made that distinction. Just know that some petroleum oils listed in the chart are not synthetic but have characteristics much more closely related to synthetics than petroleum basestock oils. Also, know that at least one manufacturer is calling a hydrocracked petroleum oil a synthetic oil. There may be others.

NOACK VOLATILITY SCORE

Many oils do not list their Noack volatility percentage even though this test is required in order to indicate that the oil meets a certain API rating. For those oils that don't list a NOACK here's a general rule of thumb. All API rated oils must have a NOACK rating of less than 15% volatility. So, any oil on the list that has an indicated API rating has a NOACK under that 15% level.

If the oil that you're looking at is a typical petroleum oil (not hydrofinished or hydrocracked), it will likely have a NOACK between 12 and 15%. If the oil you're looking at is a synthetic oil, normally the NOACK will fall between 5 and 10%. The lower the viscosity grade, the higher the NOACK score typically is. The higher the viscosity grade, the lower the NOACK score typically is, within the indicated range.

So, for instance, a petroleum 5w30 oil might have a NOACK of 15%, whereas a 10w30 of the same brand would probably NOACK score of 13 or 14%. A synthetic 5w30 would probably be even lower than that, maybe 8 or 9% or lower, and a synthetic 10w30 based upon a similar formulation would have a NOACK or 6 or 7%. Just something to keep in mind for those oils that don't list a NOACK.

FLASH POINT AND POUR POINT

Nearly all of the oils list these specs. That makes them nice tools for comparison. Obviously, depending upon where you live and drive, one may be more important for the other. For instance, if you live in Alaska, you'll be far more concerned with the pour point than with the flash point, even though both are useful. If you live in Texas, the pour point of an oil may not be all that important to you.

No matter what, even if you live in a cold climate, I wouldn't recommend going with an oil that has a flash point less than 400 to 420 degrees F. Likewise, even if you live in a typically warm climate, try and maintain a pour point of at least –10 to –15 degrees F. That way, if you happen to have a colder than average day, you won't likely have to worry about the oil thickening up too much.

On the average, you know you've gotten your hands on a decent oil if you can get a flash point above 440 and a pour point under –30 or so. Tempered with a good viscosity index, even if you didn't look at any other specifications, you could be at least fairly certain that you've purchased a good quality lubricant. Anything more than that is icing on the cake.

FOUR BALL TESTING

Don't forget about the Four Ball Testing, though. Even though this information is sparse, notice that in the cases where a Four Ball Wear Scar comparison is possible, oils which have higher flashpoints and possibly even higher viscosity indexes sometimes show more wear on the Four Ball.

In other words the quality of an oil is not necessarily represented **completely** by those three main tech specs. Those just happen to be the ones that everybody lists. They are useful and should not be ignored, but if more information is available, pay attention to it.

CHOOSING THE BEST

You might get somewhat discouraged by the above statements because they seem to indicate that there is no way to be sure that you've found the best oil, even if you think the oil has the best numbers. To some extent you are right.

However, keep in mind that the numbers below make it clear that synthetic oils are, by and large, far superior to petroleum oils. So, by choosing any of the synthetics listed below, you'll be purchasing enhanced protection for your vehicle.

In addition, to help out a little, in the electronic version of The Motor Oil Bible, I have put together two different listings of motor oil comparisons. The same oils are listed, the order is simply different. One lists the oils alphabetically, the same way as you will find in this printed version. However, there is a second listing, which ranks the oils based upon a quality algorithm that I've set up.

Basically, I've used the viscosity index, pour point, flash point, high temperature/high shear and TBN values for oils as the variables within the ranking algorithm. If these numbers are all provided and are all good, the oil will rank high. The more of these values that are not provided or are poor, the lower the ranking the oil will receive.

Even in the alphabetically listed chart you'll still see the ranking scores printed at the very right of the chart. So, you can still find the better oils. The chart ordered by ranking simply makes it easy to pick out all of the top contenders. However, there are a few things to keep in mind.

First, the specs being used for comparison are not the be all and end all. They just happen to be the most commonly provided specs that are relevant to the quality of an oil. Other factors should be considered, though. Most importantly, understand that, although the ranking algorithm is a good rule of thumb, it's not by any means perfect.

The top ranked oil in any one category may not necessarily be the best oil available. But, you can assume that it most likely is within the top 15 to 20% of all of the listed oils in terms of its engine protection qualities. In fact, if there is a listing of 30 different oils, you can probably assume that the top 5 or 6 are the best of the bunch, although #5 might actually be better than #3 and # 1 might actually be worse than #2. It's just not exact.

So, if you're looking for the best oil for you, do the following. First, select the top 15 to 20% of the pack to compare more closely. Start looking at the specifications directly. See what specs put the "top" oils on top. Then look at those specs that the algorithm doesn't take into account (either because the math was impossible or because too many oil manufacturers don't provide that particular specification).

For instance, take a look at the CCS score. The lower the better for cold temperature characteristics. Believe it or not, oils with exactly the same pour point can have radically different CCS scores. Cold temperature flow does not necessarily correlate directly with cold temperature cranking ability.

Take a look at the Noack and Four Ball, if available. Phosphorous, Zinc and ash content are also good numbers to take a look at, but remember what I've previously indicated about these specs.

COST CONSIDERATIONS

Once you've compared all of this, then take a look at price and the possibility of extended drains. A high TBN is necessary to provide proper protection of your engine for extended drains, so pay careful attention to this number if you plan on attempting long drains.

As we've already mentioned in a number of chapters, there are a few companies, which actually recommend using their oils for extended drains. For gas engines, AMSOIL and NEO offer 25,000 miles. For diesel engines AMSOIL recommends doubling the manufacturer recommended interval, but I've seen oil analysis after 20,000 miles that showed the oil was still good.

Red Line recommends between 10 and 18,000-mile intervals for gas engines depending upon your driving habits. Diesel engines should change Red Line oil every 10,000 to 12,000 miles.

Synergyn recommends 10,000 miles (at least for some of it's oils).

Some or all of these manufacturers may place time limits on their oil drains as well. Most will be a one year limit for gas engines and possibly a six month limit for diesels, even if you haven't made it to the mileage limit yet. In my experience, you can sometimes extend intervals beyond these limits if you have oil analysis done. It may very well indicate the oil is still good.

Of the extended drain oils I've listed, Red Line will likely run you approximately $8 per quart. Expect to pay $9 or $10 for NEO full synthetic. AMSOIL will run you between about $6 and $8 per quart retail, but they offer a preferred customer buying program that gets you approximately a 25% discount on products.

Synergyn, will run you about $5 per quart for their full synthetic oils.

Non-extended drain oils such as those typically found on department store shelves will typically run you between $3.50 and $4.50 per quart, although you can occasionally find them for less and will occasionally end up paying more. Although not guaranteed by the manufacturer, these oils, such as Mobil 1, Valvoline Synpower, etc., could probably be used for drains of 7500 to 10,000 miles without too much trouble.

NOTE: ** All prices above in US dollars **

SYNTHETIC BLENDS

Many times people will look to synthetic blends as the best of both worlds. You get some of the protection benefits of a synthetic while not paying the hefty price tag. Or so they think. My research indicates that this is likely not the case. You'll see why when you examine the technical specifications below.

For those companies that provide a synthetic blend, I've included those technical specifications. In nearly every case, the synthetic blend has technical specs which are only slightly better than its petroleum oil counterpart. In fact, in a couple of instances, the blend actually has worse numbers, believe it or not.

In my opinion, if you're interested in padding the pockets of the lubricants industry, purchase all the synthetic blends you want. However, if you're looking for a cheap way to provide extra protection for your engine, park it in the garage. No engine wear, no fuel expenses and **no transportation**.

On the other hand, if you'd actually like to drive your vehicle, good engine protection is going to cost you. Just bite the bullet and do it. At least if you purchase an extended drain synthetic oil, at year's end you won't have spent any more than you used to on petroleum. It just hurts more the first time around.

VERIFYING THE NUMBERS

The numbers in these charts may change over time as companies reformulate their oils. Although I try to maintain current numbers, I won't always have the updated numbers as soon as they are available. As a result, you may wish to visit these companies' websites or give them a call to verify data.

You'll find all the comparison data in the Appendix "Motor Oil Technical Specification Comparison Chart" near the end of this book. It begins on page 148.

Choosing the Right Oil

Choosing the right oil for your vehicle is crucial to making certain that you have the best balance of protection, performance, fuel efficiency and cost. Therefore, it would be a good idea to know just "how" to choose the right oil.

You might think this would be simple, and to some extent you would be right. However, there are a few things that you should consider when looking for the right oil that might not come to mind right off the bat.

That's what this chapter is all about, getting down to specifics regarding your engine's condition and age, your driving habits, your auto buying habits, etc. All of these should figure into your choice of which oil will best serve your needs.

However, I must say one thing before I continue. I am certain that you've already discovered that I'm partial to synthetics. This chapter is not here to necessarily convince you to use synthetics. Although I believe that in most cases, synthetics are a far better choice than petroleum oils, this is not always true. I'll try to be as impartial as possible as I make recommendations in this chapter.

ENGINE CONDITION

Let's first consider condition. Does your vehicle leak oil? If so, you probably have bad seals and/or gaskets. Putting an expensive oil in your vehicle is not likely to correct the problem (whether synthetic or high grade petroleum). Your leaks will continue until you decide to replace your seals and gaskets. As a result, in this situation, you'll want to stick with a standard buck a quart brand oil.

If you need to stick with petroleum oil, I would stick with major oil brands as opposed to off-brand or store brand oils. I can't say that I can guarantee they are better, but many times you get what you pay for. If you pay 50 cents per quart as opposed to 1.25 per quart, it's likely that you're getting an inferior oil. To compare brand name oils, check my technical specs page within this book.

One other thing to consider if your vehicle is leaking oil is to move to a higher viscosity grade. If you've been using a 5w30 or 10w30, consider going with a 10w40. You might find that you have less leakage simply because the oil remains "thicker" and can't pass as easily by the seal leak points.

Please note that it's not recommended that you move more than one grade away from the manufacturer's specifications. For example, don't go to a 20w50 weight oil if the manufacturer of your vehicle calls for a 5w30. You may find that you'll have a significant loss in performance and fuel mileage.

In addition, it is possible that engine temperatures could increase significantly with such an increase in viscosity. This can cause long term engine damage, so I recommend against it.

ENGINE AGE

The age of your engine should also be a consideration. A vehicle that has over 8 or 9 years on it might not be a good candidate for moving to synthetic oil. If you've been using synthetic oil with success then stick with it, but if you've been using petroleum oil, now might not be the time to switch to synthetics.

Here's the deal. Although it is highly unlikely that the issue will come up, the following scenario is a possibility and has happened in a small percentage of older vehicles. A vehicle with significant age which has been maintained with petroleum oil may have seals and gaskets which are dried and

cracked. However, in some cases, petroleum oil burn-off has left behind enough deposits around these seals and gaskets that leaks have been plugged.

When such an engine is switched over to a premium synthetic oil with a high quality detergency package, these deposits are cleaned out, thereby exposing those weak seals and gaskets. At that point leaks could occur. Of course, when using a synthetic oil, leaks can be very costly. In some cases, the seal swell properties of the synthetic oil will seal up the leaks, but in other cases it will not.

You have to decide whether you are willing to take the chance. If you're engine runs fairly well and has been adequately maintained, a good synthetic oil could do wonders for performance and fuel mileage in such a vehicle, but the potential leaks must not be overlooked. Just something to think about.

YOUR DRIVING HABITS

Driving habits should also be considered when deciding on a motor oil for your vehicle. For instance, if you are a low mileage driver (under 15,000 miles per year), there are a couple of things to think about.

First of all, low mileage drivers (under 10,000 to 15,000 miles per year) tend to have more condensation build-up within their engine (the engine never has enough time to warm up and burn off the condensation). This can cause acid build-up within the oil, which will lead to engine corrosion.

However, an oil with good TBN characteristics will be able to effectively neutralize these acids to protect your engine. Generally, the cheaper the oil, the less acid neutralizing capability an oil will provide. Synthetics are almost always better at neutralizing acids than petroleum oils, but this is not always the case.

Petroleum oils rated for diesel use may have higher TBN levels than synthetics rated for gasoline use. Sometimes oils rated for diesel use are designed for mixed fleets and can be used in gas engines as well. So, if you need good TBN levels, but don't want to go with synthetic, try to find a dual use petroleum diesel oil with good specs.

As a rule of thumb, expect a petroleum oil to be in need of a change at least every 3 to 4 months, even if you haven't reached 3,000 miles yet. A dual use diesel oil with good TBN numbers might go a little further, but condensation will still take its toll on your oil, and it must be replaced fairly often. An off-the-shelf synthetic can likely go 5 or 6 months. Obviously, extended drain synthetics can go much longer.

Now, a synthetic oil change at a local quick lube would probably cost $50.00. If you're willing to trust the oil, most synthetics are probably good for 5 or 6 months under these driving conditions. Thus, you'd need to have about two oil changes over the course of the year - amounting to $100 for oil changes.

Petroleum oil changes at 3 or 4 month intervals over the same year would amount to about $60 to $80. Three or four oil changes at about $20 per change. Thus, even though the synthetic is a great deal more expensive in the short run, over the course of a year it comes out only slightly more expensive than the petroleum oil while still providing better acid neutralization. Moreover, you'd probably more than make up the extra $20 to $40 in fuel mileage increases.

An extended drain synthetic like AMSOIL, NEO or Redline would require one oil change and probably an extra filter change in between. Thus, over the course of the year, you'd spend about $60 to $100 if you had someone do the oil and filter change labor for you.

In essence you pay about the same price with maybe a little more convenience. However, for a short mileage driver, the benefits of using such an oil would be found more in their superior protection abilities than in their time and/or pocketbook savings. These oils are generally formulated better than

non-extended drain synthetics, so they will provide better engine protection against corrosion.

Nevertheless, I know some of my readers will still not be comfortable with extended drains, no matter how much proof I've provided for their usage. That being the case, if you won't be using extended drains, the fuel mileage benefits of synthetic oils will be of little benefit if you're a low mileage driver. So, cost wise, in the short run you're best served with a good quality petroleum oil changed every few months or a dual use diesel petroleum oil changed at slightly longer intervals. If you want to keep the vehicle for a very long time, you might still be well served with a quality petroleum oil.

HIGH MILEAGE DRIVERS

What if you're a high mileage driver? Well, high mileage drivers won't have as much problem with water in the oil, which reduces the necessity for neutralizing acids, but they are the ones who deal with the inconvenience and cost of frequent oil changes. In addition, high mileage drivers pay a great deal for fuel each year.

Let's assume you drive 25,000 miles per year. Then you'd need about eight 3,000 mile petroleum oil changes which would cost about $160 at a quick lube shop. With an off-the-shelf synthetic you'll incur three 7500 mile oil changes over this period (although you'll be awfully close to a fourth). At about $50 each, that amounts to at least $150 over the course of a year. Still roughly the same as petroleum oil.

Alternatively, if you're using an extended drain synthetic with a long life filter you'll need only about one oil change and an extra filter change along the way. At $6 to $9 per quart and $10 for a good long-life high efficiency filter you're looking at about $50 to $80 per change depending upon how many quarts your vehicle holds and whether you do the work yourself or have it done at a shop.

However, even at $80 for an oil change and then another $20 for a filter change ($10 for filter and $10 for labor if you have someone else do it), you still only incur a $100 bill over the course of the entire year. That's about a 30% savings on oil changes. In addition, you only have to go to the shop twice. Not a bad deal.

You'll also save on fuel by using a synthetic oil. In fact, unless you are very heavy on the pedal, just about any synthetic will probably raise your fuel mileage by 2 to 5%. Premium synthetics may raise your fuel mileage even further.

For instance, after making the switch to 0w30 synthetic motor oil, two of my vehicles saw a 15 to 20% increase in fuel mileage. An increase that large might not be so common with other brand synthetics nor with different vehicles, but you should be able to expect a 2 to 10% increase depending upon your situation. Imagine how much money you would save on fuel over the course of a year.

Even if you're still not too keen on significantly extended oil drains, an off-the-shelf synthetic at 7500 mile change intervals should still net you plenty of fuel mileage gains and greatly enhanced engine protection over petroleum oils, makeing them a superior choice in this regard.

YOUR AUTOMOTIVE PURCHASING HABITS

There is one more thing that you probably should consider when determining what oil to use in your vehicle. How long do you intend on owning it? Most vehicles sold these days will maintain good performance for at least a few years even when using petroleum oil.

Over the first few years that you own your vehicle you're unlikely to have any significant problems, and maintenance costs should be limited to oil changes and little else. So, it's not altogether necessary to make certain that you have the best protection available for your engine. A petroleum oil will protect adequately for the first few years.

However, if you intend on keeping the vehicle for much longer than this, you should consider that the performance of your engine can begin to decline steadily after those first few years if you use petroleum oil to protect it (unless you use high efficiency oil filtration and change the oil often).

Oil burn-off will leave deposits behind making your engine run less efficiently. The inferior protection qualities of a petroleum oil will allow engine wear and component deterioration due to corrosion. Fuel mileage will decline, acceleration will be slowed and reliability will be hampered. The longer you own your vehicle the worse its performance will be and the lower its resale value will be.

On the other hand, if you are using a high quality synthetic oil, there will little or no engine deposits left behind. Acid neutralization will be better which will reduce corrosion and deterioration of engine components. Engine wear will be minimized.

Overall, the performance of your vehicle will remain nearly the same as when you purchased the vehicle. Not only will that allow you to drive the vehicle for far longer without the necessity of purchasing another vehicle, it will maintain a higher resale for the vehicle once you decide to sell it. Both scenarios will save you a great deal of money in the long run. Of course, the better the synthetic that you use, the more you will realize these benefits.

PULLING IT ALL TOGETHER

To wrap this all up nice and neat and tidy, I would say that there are really only two scenarios that I believe make it logical to stick with petroleum oil. If you have an older vehicle that has leaks or one that might produce leaks after the switch, I would think twice about making the switch to synthetic.

That doesn't mean you shouldn't do it, it just means that you need to remember what the potential drawbacks are and decide whether you're willing to take the risk to gain the potential benefits. Only you can make that decision.

Also, if you are one who leases your vehicles or who generally purchases a new vehicle every few years, using a synthetic oil probably won't be of much help to you. Petroleum oil will be adequate for that length of time, and resale value really shouldn't be hampered much.

For just about any other situation, it seems to me that synthetics definitely provide a benefit over petroleum oils. There are some cases when it might seem to be a wash, but if that's the case, why not just go with synthetic?

In the end it will probably come down to your willingness to delay the gratification of saving time and money beyond the first one or two oil changes. In the short run, petroleum oil will always be cheaper.

There's no way to make a synthetic oil that won't cost considerably more than a petroleum oil. However, if you can see the big picture, it's likely that you'll save a significant amount of time, money and headache if you make the switch to synthetics as soon as possible.

Motor Oil Isn't "All That"

Motor oil is the lifeblood of your vehicle's engine. Without it there would be little hope of your vehicle making it out of the driveway each morning. However, your engine doesn't do all the work.

It may provide the power, but there are still other parts of the equation which should be considered. Those moving parts need proper lubrication and protection as well.

This chapter discusses, even if only briefly, some of these other systems that require your attention every once in awhile.

GETTING YOUR VEHICLE IN MOTION

All the power generated by the engine isn't worth much if you don't have a system in place to turn that power into motion. That system is your transmission. Of course, there are both manual and automatic transmissions.

Basically, all automatic transmissions (and some manual transmissions) take automatic transmission fluid as the lubricant of choice. However, just any ATF will not do in some instances. Some auto manufacturers are very specific about the type of fluid they want used in their transmissions. As a result, they may have specific specifications that the lubricant has to meet.

Not all automatic transmission fluids will meet those specifications. In fact, sometimes, the only way to meet the specs is to purchase the fluid from the dealer or manufacturer directly. There's no way to know for certain whether a manufacturer does this to make more money selling their own fluid or if there really is a reason that they want a different type of fluid than other manufacturers. So, you just have to make sure you've got the right stuff.

Your manual will tell you what you can use and/or what specifications your atf must meet. If you have a US built vehicle, Ford (Lincoln, Mercury) will call for a Mercon or Mercon V specification (the V is the newest spec). GM (GMC, Chevy, Pontiac, Oldsmobile) vehicles will generally call for a Dexron II or III specification, although it sounds like their coming out with a new spec soon. Chrysler (Dodge, Jeep, Eagle) has issued a number of different specifications over the past few years. There is ATF+, ATF+2, ATF+3 and ATF+4. Make sure you know which one your vehicle calls for and use the right one.

ATF: THE MOST COMPLEX LUBRICANT ON THE PLANET

Automatic transmission fluid (ATF) is used in passenger car and commercial vehicle automatic transmissions as well as some industrial applications that require hydraulic fluids with extreme high or low temperature performance capabilities. Almost half of ATF goes to the automotive transmission market.

A vehicle's transmission is the first link in transmitting the engine's power to the wheels. An automatic transmission uses a hydraulic coupling between the engine and the gears. The hydraulic coupling, rather than the driver, does the work of selecting gears.

Automatic transmission fluid serves as a hydraulic fluid, transmitting power from the engine to the gears, and serves as a lubricant, cooling the torque converter assembly and lubricating the transmission gears. ATF is perhaps the most complex lubricant in existence.

Due to the extremely narrow passageways in their electronic shift selectors, automatic transmissions are extremely sensitive to fluid viscosity and do not function properly when cold thickens ATF

excessively. This is why the superior low temperature fluidity characteristics of synthetics are necessary.

Also, due to their extremely high operating temperatures, automatic transmissions tend to thermally and oxidatively degrade ATF rapidly. Synthetic ATF is much more thermally and oxidatively stable than petroleum ATF. Therefore, it maintains its superior lubricating qualities and resists the formation of sludge, varnish, deposits and acids which can harm your vehicle's transmission.

GEAR LUBES & DIFFERENTIALS: WHAT ARE THEY?

You may have heard someone at one time or another refer to a vehicle's differential. You may or may not know what they were referring to. If not, here's a simple explanation of what a differential does and why the lubricant used to protect your differentials is so important.

Your transmission is designed to translate the power from your engine to and through the driveshaft of your vehicle and puts your vehicle in motion by selecting the appropriate gears to move from slow speeds to high speeds or switch from forward to reverse. However, something else is needed to transfer this power from the driveshaft to the wheels.

You see, the driveshaft and your wheels are rotating perpendicularly to each other (at a 90 degree angle). Because of this, there needs to be an intermediate mechanism, which changes the direction of rotation from the driveshaft to the wheels. This mechanism is the differential.

In order for the differential to translate this power from the driveshaft to the wheels, the gears within the differential must operate at a severe angle to each other. As you can well imagine, this results in high loads on small areas of the gears. In many cases there will not be a full lubricating film separating the gears.

Obviously, maintaining proper protection within this type of environment requires a lubricant that can stand up to the extreme temperature and pressure generated within your differential without breaking down too quickly. It must be able to properly lubricate, protect and cool the system while also carrying wear debris away from the gears.

The lubricant I'm speaking of is, interestingly enough, called a gear lube. Fitting name, don't you think? Gear lubes are designed with special extreme pressure additives which shield geared systems from the excessive wear of metal to metal contact.

Over the years, as engines have been designed with increased output, differentials have been subjected to higher loads and temperatures. It is difficult for petroleum lubes to stand up to this kind of abuse for very long. As a result, most commercial equipment and over-the-road trucks now use synthetic gear lubes exclusively.

Synthetic gear lubes not only protect better and provide for much improved fuel mileage, they also last far longer than petroleum gear lubes do. In many passenger car and light duty truck applications, synthetic gear lubes are a fill for life fluid.

THE WHOLE ENCHILADA

By making sure to always use a quality lubricant in all three of the critical powered systems within your vehicle (engine, transmission and differential), you can keep your vehicle running well for many years to come. Couple that with excellent filtration through high efficiency oil and air filters and you've got a vehicle that's nearly bulletproof.

Think of it as your own personal light duty tank. Good luck.

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Specification Chart Introduction

RANKING SCORES

The oils are all assigned a "ranking score" based upon my own ranking algorithm which is explained below. Within each viscosity grade, the oils are listed in order from highest ranking score to lowest ranking score. This ranking algorithm isn't perfect. Please take it for what it is: an honest attempt to give readers some idea of which oils fall at the "head of the pack".

In other words, the top 5 oils in a particular viscosity grade are probably the top 5, but it's possible that the "number 1" oil is not necessarily better than "number 2" and "number 5" might be better then "number 4". Find the best oils in your viscosity and carefully evaluate them.

UNAVAILABLE SPECIFICATIONS

Not all manufacturers provide all of the specs we would like for evaluating their oil. Those specs that were unavailable are listed as "-" and count as "0" in the ranking algorithm.

DEFAULT MINIMUM VALUES AND WEIGHTED SCORES

Additional weight is placed on the HT/HS and TBN scores. Also, the NOACK score is used in the algorithm AND given additional weight. In order not to skew the results in the case of oils that don't list HT/HS, TBN and/or NOACK scores, I've put default minimum values in for oils which don't list the information.

Based upon the SAE J300 specification chart for establishing oil viscosities, a minimum HT/HS score can be established for any viscosity of oil because this score is used to classify the oil. For instance, a 0w20 or 5w20 oil each must have a minimum HT/HS score of 2.6 in order to be given that viscosity classification. Thus, even if the company doesn't list this spec for a 0w20 or 5w20 motor oil, I know the HT/HS must be at least 2.6.

IF a company doesn't list this specification, I'm going to assume it's close to the bare minimum, and the company doesn't want customers to know it. I could be wrong, but I can't think of any other legitimate reason to leave off this specification. So, that's the number I'm going to use by default - the absolute minimum HT/HS score the oil could have and still be classified as that particular viscosity.

Any company that is upset by this can feel free to provide me with the actual HT/HS values for the chart.

NOACK:

As I mentioned above, additional weight is being given to this spec, but to be sure the results are not abnormally skewed for oils which don't list their NOACK scores, I am inserting a default maximum value in those instances to lessen the negative affect on an oil's ranking score.

In order to meet recent API standards, gas and diesel engine oils have to have a maximum NOACK volatility score - the lower the score, the better. Those maximum values are different for gas and diesel engines, but I've tried to be generous in this department. I'm using a NOACK score of 13 as the base which is the current diesel spec max. The recent API specs for gas engine oils allow for NOACK scores as high as 15 and will still grant API gas engine oil certification.

In other words, gas engine oils which don't have the NOACK listed might be getting a break if their actual NOACK is 15, but I'm using the default of 13, which is better. I'm such a nice guy.

TBN:

I'm using a default value of 5 for TBN, if a manufacturer doesn't list the TBN of it's oil. Most oils that actually list a TBN are at least 6+, but some are actually lower than that. If a manufacturer chooses not to list this very basic oil characteristic, then I think giving them a "5" is being more than generous, since they're being somewhat less than forthcoming with very basic, but important information.

This value is also given additional weight in the ranking algorithm.

SO WHAT'S THE ACTUAL RANKING ALGORITHM?

The ranking scores are calculated using the following equation:

VI + Flash + (20 x HT/HS) + (2 x TBN) - (Pour Point) - (3 x NOACK)= Ranking Score

NOACK scores and TBN scores tend to be in the same range (5 - 13), but I consider the NOACK score to be slightly more important because TBN has less significance if you choose not to extend your oil drain intervals. Since many people don't, the TBN becomes less significant.

The NOACK, on the other hand, I believe to hold just as much significance for short drain intervals as for long drain intervals. So, it is more applicable to more people. Thus, it is weighted at 3x instead of 2x for the TBN.

Of course, since you want LOW NOACK scores and HIGH TBN scores, the TBN is added while the NOACK score is subtracted in the ranking score equation.

The HT/HS score is typically between 2.6 and 5, so the numbers are typically lower than the TBN and NOACK. This would mean the HT/HS scores need additional weighting in order that they would have equal effect on the ranking score as compared to the effect of the TBN and NOACK scores.

In addition, because HT/HS is far more often actually listed by an oil manufacturer than is the NOACK, I give it even more weight because I less often have to use a "default" value. In many cases it is an actual value, so I think it deserves additional weighting since I'm not "guessing" at what the value might be.

This specification, as with the NOACK, will be important to any driver, regardless of their drain intervals. So, that gives reason to weight it slightly more heavily as well.

As such, you'll notice the multiplier is 20x which is about 7 times "heavier" than the NOACK. I think this is justified considering the above explanation. However, if you feel it is not, simply take a look at the top oils in your category and then take a look at the HT/HS scores of those oils. If one has a super high HT/HS score which you believe has pushed it unfairly to the top of the ranks, adjust it's ranking accordingly when making your decision regarding oil choice.

UPDATES TO THE SPECS FROM LAST MONTH

On the chart, you'll notice that some listings are shown in black and some are shown in orange. Listings in black are unchanged from the previous listing.

If an oil's spec sheet DID change, you will see two listings for that oil. One will be listed in black (the old specs), the other listing will be shown in orange which will reflect the new specs. This way you can see whether a company has upgraded or downgraded it's formulation since the last update went out.

Sometimes, you'll notice that the specs for the old and new listings are the same. In these instances, the manufacturer updated the spec sheet itself (maybe some wording changed slightly or something), but the specs themselves were not changed (meaning the formulation likely didn't change).

I have still listed these in orange to indicate a change in the spec sheet, but it will be obvious that the formulation didn't change because the specs will be the same and the ranking score won't change.

Jesus Died for You

Jesus gave his life so that we might live and live abundantly. He blesses my business endeavors every day, and I believe that it would be a tremendous oversight not to acknowledge that publicly and openly to everyone I meet.

Many might say that putting a statement like this on my Website will hurt business. Quite to the contrary, I believe that my faith cannot be separated from my business. Everything I have, the Lord has graciously given to me. My family, my business, my health and my eternal salvation: I owe it all to Him.

I pray that if you are not sure of your eternal resting place, you will read on and see the great love that Jesus has for you. If you've been trying for years to make your life "whole" but always feel like there is something missing, there is: God. He created that hole in your life in such a way that only He can fill it.

Open your heart to Him today and let him take your burdens upon His shoulders. He wants to help. He wants to provide peace and comfort, but you have to ask for it. The gift of eternal salvation is waiting for you.

It's already been gift-wrapped and your name is on the box. But, you have to receive the gift.

EMPTINESS

Is there an emptiness in your life? Is there a void that you just can't seem to fill? Money doesn't do it. Power doesn't do it. Sex doesn't do it. Drugs don't do it. What could possibly fill that void and make your life whole?

Jesus...Because He Loves You Enough to Die for You

For God so loved the world, that he gave his only begotten son, that whosoever believeth in him should not perish, but have everlasting life.

-- John 3:16

Maybe you believe in evolution, so you don't believe there is a personal God.
The following might change your mind.

Christian Answers

Here's a letter that Jesus addressed to you:

I had to write to tell you how much I love you and care for you. Yesterday, I saw you walking

and laughing with your friends; I hoped that soon you'd want me to walk along with you, too. So, I painted you a sunset to close your day and whispered a cool breeze to refresh you. I waited--you never called--I just kept on loving you.

As I watched you fall asleep last night, I wanted to hold you. I spilled moonlight onto your face--trickling down your cheeks as so many tears have. You didn't even think of Me; I wanted so much to comfort you.

The next day I exploded a brilliant sunrise into glorious morning for you. But you woke up late and rushed off to class--you didn't even notice. My sky became cloudy and My tears were the rain.

I love you, oh, if you'd only listen. I really love you. I try to say it in the quiet of the green meadow and in the blue sky. The wind whispers My love throughout the treetops and spills it into the vibrant colors of all the flowers. I shout it to you in the thunder of the great waterfalls and compose love songs for birds to sing to you. I warm you with the clothing of My sunshine and perfume the air with nature's sweet scent. My love for you is deeper than any ocean and greater than any need in your heart. If you'd only realize how I care.

My Dad sends His love. I want you to meet Him--He cares too. Fathers are just that way. So, please; call on Me soon. No matter how long it takes, I'll wait--because I love you.

Your friend,

Jesus

I hope that you don't think that I'm some "Holier than thou" Christian who's trying to reshape the human race in my "perfect" image, because this is far from the truth. According to Romans 3:23, "...all have sinned and come short of the Glory of God..." I am definitely included in this category, as are all of us.

In fact, I'm going to tell you something that I've never told anyone outside of my wife and my church small men's group before. **I have an addiction to pornography**. I say "HAVE" because unless the Lord chooses to completely "heal" me of this addiction, it will always be with me (maybe to remind me of just how **IM**perfect I am – so I don't judge others too harshly for their struggles with sin).

Luckily, the Lord Jesus Christ has left me His Holy Spirit to guide, direct, support and assist me in overcoming this addiction that was so severely hurting me, my marriage and my walk with God.

Why do I tell you this? Because I KNOW that many of the readers of this book are viewing pornography, even Christians, and I know that it is eating them up inside and tearing their families apart (even though many may not even know it).

Pornography is EVERYWHERE these days, especially if you have an internet connection (which makes it nearly anonymous). As men, we can't help that we are visually stimulated. That is how God made us, and that tendency, in and of itself, is NOT a sin.

However, our willingness to allow that tendency to draw us into viewing images of naked women who are NOT our wives IS most definitely a sin. But I'll get back to that in just a moment.

Right now I simply want to ask you a question? If you are a viewer of pornography (either "soft" or "hard"), do you truly believe that IF you wanted to, you could quit viewing pornography for a month? I'm not asking if you want to, but only whether you truly believe you COULD stop viewing porn if you wanted to.

You might superficially say, "Yeah, I can stop whenever I want. I'm in control." But, I want you to stop and really think about that question and see if there is any hesitation in you at all. If there is, I'm going to guarantee you couldn't (at least not on your own).

In fact, I'm going to challenge you. Commit to going an entire month without viewing porn. First, for those days that you manage to stay "porn free" I guarantee that you'll get more accomplished, because you won't be wasting your time on a useless and highly destructive "pastime".

Second, I know that many of you will fail. I know this because I was one who would have failed that test. That's how I knew it was an addiction and not just "entertainment". I started viewing pornography as a kid and didn't know any better (magazines that my Dad and my grandfather thought were hidden – do YOU have any pornography that YOU think is hidden from YOUR kids – it's not – your kids will find it).

As I grew older and became a Christian, I then knew I was doing something I shouldn't but felt powerless to stop. I believe the Lord chose NOT to empower me to overcome that addiction because I hadn't fully exposed the problem to those people that mattered. There is power in truth and openness. Satan thrives on secret sins.

Maybe the above is a good description of you. Maybe not. Either way, if you can't stop viewing pornography, then you're addicted and the only true way to overcome an addiction is to take hold of the Power of God to free you from it.

Often you have to take hold of that power on a daily basis – I still have temptations, but, by the Power of the Holy Spirit working in me, I am a conqueror of those temptations most every time.

Yes, I still falter, but not in the same way I used to. I don't view pornography any more – not for quite some time. These days, it is simply an issue of taking control of my thoughts so that NO other woman ever has a place in my sexual fantasies besides my wife (a true gift of God).

No other women should ever hold that place in my mind (or in front of my eyes), and I won't deny that I can still struggle with that a bit, but now, I recognize it immediately and CHOOSE to think of something else.

Anyway, my point is only that many of you are addicted to pornography, whether you consciously realize it or not. Those of you who aren't addicted, quit now or you will be.

Men are too easily stimulated visually. Continued viewing of pornography creates a fantasy world in our mind that no other woman (including our wives) will ever be able to live up to. As a result, we will never feel fulfilled in the "real world" and, consequently, we will continue to be drawn back into that fantasy world.

Don’t let it happen to you. If it has, do something about it. Allow the Lord Jesus Christ to free you from that sin in your life.

What IS Sin, Really?

I define sin as “Anything that breaks the heart of God”. Sin is actually anything that falls outside of the will of God for your life. Anytime we choose to act in such a way that is not in accordance with God’s perfect plan for our life, we choose to accept the consequences of that action, which are generally harmful in one way or another (physically, mentally, emotionally and/or spiritually).

At the very least, those consequences keep us from experiencing the abundant blessings our Lord and Savior Jesus Christ has planned for us. Anytime that we miss out on the blessings God has set aside for us, the Lord’s heart is grieved. His heart breaks over our pain and our loss.

But, He is a just God, and there are consequences for acting in a way that is contrary to His plan. One of those consequences, a supernatural one, is eternal separation from God (IF we choose to ignore His pleading for a relationship with us).

Are You Entirely Sure of Where You’ll Spend Eternity When You Die?

Even if you haven't committed adultery or murder or some other "terrible sin", I'm sure that you've lusted after money or power, or someone of the opposite sex (or pornography). If not, have you ever said something inconsiderate or mean or done something that hurt another person? I know I have - plenty of times, both intentionally and unintentionally. Do you really think that any of us is perfect enough to WORK our way into heaven? Heaven is perfect, and everything and everyone who is or will be allowed to enter must be perfect.

Please do not misunderstand me. In no way am I trying to say that you, or I or anyone else on this earth is worthless, to man **or** to God. Far from it. First of all, nobody sacrifices anything for something or someone worthless. And yet, God gave His precious Son to be beaten and tortured and to die for our sins.

Doesn't this tell you something about how important we are to God? Would you allow your son or daughter or another family member to be beaten, tortured and hung on a cross to die so that the rest of us wouldn't have to? Think about just how hard that would be.

We were each created in God's image, and as such we have inherent worth to God and to man (this is why abortion and euthanasia are wrong--all living beings have inherent worth, regardless of what they can or cannot do).

Our worth does not depend on what we do or what we say or even how we act. If it did, we'd all be completely doomed. We do too many hurtful and selfish things to ever "work" our way into God's heart. Luckily, we are already there. God loves us in spite of our faults and shortcomings.

I have written this message as a way to introduce you to Jesus, the only person who can make you perfect in the eyes of God. Because of his death on the cross and His resurrection three

days later -- His sacrifice -- my sins have been washed away and some day I am going to meet God face to face in heaven so that I can thank him for all that he has done for me.

Will you have the opportunity to thank Him for your eternal salvation? We will all meet God someday. The question is whether He will allow us to remain with Him in heaven.

Jesus said, "I am the way, the truth and the life: no man (or woman) comes to the Father, but by Me." -John 14:6. If you don't know Him there's no hope. "For the wages of sin is death, but the gift of God is eternal life through Jesus Christ our Lord." -Romans 6:23.

Jesus IS our road to eternal life. Let's face it, He gave us life, He can take it away. OR HE CAN LET US KEEP IT FOR ETERNITY!!!!

YOU can have eternal life and peace right now. Jesus can cleanse you and make you whole again in the eyes of God. Do you want peace, freedom from your addictions, the power to love and be loved again? Jesus can give you all of that and so much more. All you have to do is ask.

Right now. Not tomorrow, not next week or next year. That may be too late. There's no second chance after death. Besides, why would you want to wait? Jesus is offering you a gift with no strings attached -- a gift so precious He had to die to give it to you.

Just ask Jesus into your heart. He's listening. Tell Him that you believe He is the Son of God, that you believe He died on a cross to pay for your sins, that you believe He rose from the dead on the third day.

Tell Him that you know you're a sinner, and you need his cleansing power. Tell Him that you want to put your sin aside and be cleansed. He will help you. Only He can do that.

Anyone who just asked Jesus to take control of their life may be feeling a little different. That's good! That feeling is clean, spiritual freedom. Satan doesn't have a hold on you anymore. You are free from the bondage of sin.

But, don't let it end here. You need to find someone who can support you in your new life in Christ. Old habits are hard to break and Satan is always going to be there to tempt you back.

Expose the “dirty little secrets” of your life so that Satan can’t hold them over your head. If there are people who have been or are being hurt by those secret sins, you need to ask Jesus to help give you the courage to expose those secrets to them and apologize for the hurt you’ve caused.

You also need to understand that, just because you put your faith in Jesus Christ, that doesn’t mean there won’t be consequences from the sins of your past and those that you will still commit in the future.

God will grant you mercy and will give you the strength to deal with those consequences, but there may still be hurts that will come your way as a result of your past decisions to disobey God’s Holy Word. Just knowing that will help you to more effectively deal with those consequences when they come your way.

Find a church or pastor or family member who is a Christian and tell them about your new found salvation. They will be elated. Then ask them if they will help you stay on track and keep you

accountable. If you can't think of anyone, e-mail me. I'll be glad to talk with you. I'm no great religious teacher, and I'm not perfect. But, I love Jesus and He loves me. I want you to love him too. I'm here to help in any way I can.

For those of you out there who think there is no intellectual basis for believing in God or Creation, etc., think about it this way. There are only two theories right now which are used to describe where the universe and we as individuals came from. One says that God created it all. The other, "Big Bang-Evolutionism" says that it all started about 20 billion years ago with a spinning ball of matter and a big bang. So, my question is, if God didn't create it, where did the stuff come from for there to be a big bang?

Christian Answers

Motor Oil Technical Specifications (Ranked Order)

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Legend:

P/S/B =	Petroleum or Synthetic or Synthetic Blend	**Noack =**	Noack Volatility (DIN 51581) 250°C for 1 hour, % weight loss
API =	Most Current American Petroleum Institute Specification(s)	**TBN =**	Total Base Number (ASTM D-2896)
VI =	Viscosity Index (ASTM D-2270)	**4 Ball =**	Four-Ball Wear Test (ASTM D 4172) Scar diameter, mm
PP =	Pour Point (ASTM D-97)	**Phos =**	Phosphorus ppm
FP =	Flash Point (ASTM D-92)	**Zinc =**	Zinc ppm
FRP =	Fire Point (ASTM D-92)	**CCS =**	Cold Crank Simulator Apparent Visc. @ x°C, cP (ASTM D 5293)
HT/HS =	High Temperature High Shear Viscosity (ASTM D-4683)	**Ash % =**	Sulfated ash percentage of motor oil volume (ASTM D-874)
		Rev. =	Last revision of the manufacturer's technical specification sheet

0w20																	RANKING
Brand	**Product**	**P/S/B**	**API**	**VI**	**PP**	**FP**	**FRP**	**HT/HS**	**Noack**	**TBN**	**4 Ball**	**Phos**	**Zinc**	**CCS**	**Ash**	**Rev.**	**SCORE**
Mobil 1	SuperSyn	S	SL/CF	165	-70	453	-	2.61	13.00	5.0	-	-	-	6200 @ -35	1.28	Mar-03	711
Mobil 1	**SuperSyn**	**S**	**SL/CF**	**165**	**-71**	**450**	**-**	**2.61**	**13.00**	**5.0**	**-**	**-**	**-**	**6200 @ -35**	**1.28**	**Jun-03**	**709**
Synergyn	Racing Oil	S	SJ/CG-4	165	-65	410	-	2.60	13.00	5.0	-	-	-	-	-	Feb-01	663
Valvoline	VR-1 Racing Syn	S	-	162	-58	420	-	2.60	13.00	5.0	-	-	-	3200 @ -30	-	Jul-98	663
Valvoline	SynPower Racing	S	-	162	-49	420	-	2.60	13.00	5.0	-	-	-	3200 @ -30	-	Oct-99	654
Torco	MPZ Racing	S	SL/SJ	-	-40	392	419	2.60	13.00	5.2	-	-	-	2150 @ -30	-	2001	455

5w20																	RANKING
Brand	Product	P/S/B	API	VI	PP	FP	FRP	HT/HS	Noack	TBN	4 Ball	Phos	Zinc	CCS	Ash	Rev.	SCORE
AMSOIL	XL7500	S	SL/SJ	183	-51	444	468	2.90	8.20	10.2	0.38'	-	-	3670 @ -30	-	Apr-03	732
AMSOIL	XL7500	S	SL/SJ	183	-30	444	468	2.90	8.20	10.2	0.38'	-	-	3670 @ -30	~1.0	Jul-02	711
Red Line	20 Wt RACE ONLY	S	-	142	-58	455	-	2.60	6.00	5.0	-	-	-	3000 @ -25	-	Apr-99	699
Pennzoil	Multigrade	P	SL/SJ	158	-49	445	-	2.65	13.00	5.0	-	-	-	6600 @ -30	-	May-02	676
Pennzoil	Multigrade	P	SL/SJ	158	-49	445	-	2.65	13.00	5.0	-	-	-	6600 @ -30	-	Nov-02	676
CAM2	Synavex	S	SL/SJ	156	-54	437	-	2.60	13.00	5.0	-	-	-	6600 @ -30	-	?	670
Havoline	Petroleum	P	SL/SJ	148	-27	460	-	2.60	13.00	8.5	-	940	1120	5200 @ -30	0.90	Mar-03	665
Chevron	Supreme	P	SL/SJ	148	-27	460	-	2.60	13.00	8.3	-	940	1120	5200 @ -30	0.90	Mar-03	665
Chevron	Supreme	P	SL/SJ	148	-27	460	-	2.60	13.00	8.3	-	940	1120	5200 @ -30	0.90	Mar-03	665
Havoline	Petroleum	P	SL/SJ	148	-27	460	-	2.60	13.00	8.3	-	940	1120	5200 @ -30	0.90	Jun-03	665
TropArtic	Conventional	P	SL	156	-31	448	-	2.60	13.00	5.0	-	-	-	5800 @ -30	-	?	658
Conoco	Hydroclear	P	SL/SJ	147	-49	435	-	2.60	13.00	5.0	-	-	-	5900 @ -30	-	Nov-01	654
Valvoline	DuraBlend	B	SL/CF	154	-33	428	-	2.60	10.00	8.1	-	960	-	6600 @ -30	1.00	Apr-02	653
76 Lubricants	Super	P	SL	157	-33	430	-	2.70	13.00	8.0	-	-	1080	6000 @ -30	0.92	Jul-01	651
Kendall	GT-1	P	SL/SJ	150	-38	432	-	2.60	13.00	7.4	-	-	1100	6200 @ -30	0.90	Mar-02	648
Valvoline	All Climate	P	SL/SJ	157	-38	428	-	2.60	14.60	8.0	-	970	1080	6600 @ -30	0.92	Apr-02	647
Q. State	Multigrade	P	SL/SJ	151	-27	445	-	2.60	13.00	5.0	-	-	-	-	-	Oct-01	646
Q. State	Peak Performance	P	SL/SJ	151	-27	445	-	2.60	13.00	5.0	-	-	-	6600 @ -30	-	Jan-02	646
Petro Canada	Supreme MultiGrade	P	SL	157	-38	424	-	2.60	13.00	6.8	-	-	-	3270 @ -30	0.90	Mar-02	646
Shell	FormulaShell	P	SL/SJ	152	-44	421	-	2.60	13.00	7.8	-	-	1090	6070 @ -30	0.90	2001?	646
Shell	FormulaShell	P	SL/SJ	151	-44	421	-	2.60	13.00	7.8	-	-	1090	6070 @ -30	0.90	2001?	645
Royal Purple	Multi-Grade	S	SL	156	-	455	480	2.60	13.00	5.0	-	-	-	-	-	?	634
Exxon	Superflo	P	SL/SJ	153	-22	435	-	2.60	13.00	5.0	-	-	-	6600 @ -30	0.87	Mar-03	633
Castrol	GTX	P	SL/SJ	158	-22	400	430	2.80	13.00	5.0	-	1000	1100	6600 @ -30	-	Jun-02	607
Motorcraft	Prem. Syn. Blend	B	SJ	161	-49	365	-	2.65	13.00	7.5	-	-	-	-	0.94	?	604
Exxon	Superflo	P	SL/SJ	153	-33	392	-	2.60	13.00	5.0	-	-	-	4470 @ -30	-	Oct-01	601
Mobil	Drive Clean	P	SL/SJ	153	-33	392	-	2.60	13.00	5.0	-	-	-	2200 @ -25	-	May-02	601
Citgo	SuperGard	P	SL/SJ	154	-	421	-	2.60	13.00	5.0	-	-	-	4080 @ -30	-	Jul-01	598
Citgo	SuperGard	P	SL/SJ	154	-	421	-	2.60	13.00	5.0	-	-	-	4080 @ -30	-	Dec-02	598
Mobil	Drive Clean	P	SL	153	-26	392	-	2.60	13.00	5.0	-	-	-	5130 @ -30	-	Apr-03	594
Mobil	Drive Clean	P	SL	153	-26	392	-	2.60	13.00	5.0	-	-	-	5130 @ -30	-	Jun-03	594
CAM2	SuperPro	P	SL/SJ	156	-49	-	-	2.60	13.00	5.0	-	-	-	6600 @ -30	-	Oct-02	228

SAE 30																	RANKING
Brand	Product	P/S/B	API	VI	PP	FP	FRP	HT/HS	Noack	TBN	4 Ball	Phos	Zinc	CCS	Ash	Rev.	SCORE
Neo	Neo	S	CE/SG	180	-50	470	520	2.90	13.00	8.0	-	-	-	n/a	1.03	?	735
Schaeffer	Moly Pure	S	SG/CE	132	-45	465	500	5.00	13.00	10.0	-	-	-	n/a	1.00	Oct-91	723
Precision	102P	P	SJ/CF-4	127	-25	514	-	2.90	13.00	12.0	-	-	-	n/a	-	Jan-03	709
76 Lubricants	ED Guardol 1500	P	CF	117	-40	455	-	3.60	13.00	15.2	-	-	1310	n/a	2.00	Jul-01	675
AMSOIL	SAE 30	S	CF/SH	124	-36	450	486	2.90	7.40	12.0	0.38"	-	-	n/a	~1.5	?	670
AMSOIL	SAE 30	S	CH-4/SJ	124	-36	450	486	2.90	7.40	12.0	0.38"	-	-	n/a	~1.5	Dec-01	670
Exxon	**XD3**	**P**	**CF/SF**	**98**	**-22**	**496**	**-**	**3.70**	**13.00**	**7.3**	**-**	**-**	**-**	**n/a**	**0.80**	**Mar-03**	**666**
76 Lubricants	T5X HD Mono.	P	CF/SJ	116	-29	470	-	3.60	13.00	8.1	-	-	1300	n/a	0.90	Jul-01	664
Mobil	Delvac 1330	P	CF/SF	117	-22	482	-	2.90	13.00	12.0	-	-	-	n/a	1.40	Mar-03	664
Mobil	**Delvac 1330**	**P**	**CF/SF**	**117**	**-22**	**482**	**-**	**2.90**	**13.00**	**12.0**	**-**	**-**	**-**	**n/a**	**1.40**	**Jun-03**	**664**
Pennzoil	LongLife HD	P	CF-2/CF	105	-27	482	-	3.60	13.00	7.5	-	-	-	n/a	<1.0	May-01	662
Pennzoil	LongLife HD	P	CF/SL	107	-22	482	-	3.80	13.00	7.0	-	-	-	n/a	<1.0	Jul-02	662
Royal Purple	RP	S	SJ/CF	119	-33	460	515	2.90	13.00	13.5	-	-	-	n/a	-	?	658
Chevron	RPM Heavy Duty	P	SL/CF	101	-38	482	-	2.90	13.00	8.0	-	1000	1110	n/a	1.03	Sep-02	656
Texaco	Ursa Super Plus	P	SL/CF	101	-38	482	-	2.90	13.00	8.0	-	1000	1110	n/a	1.03	Jul-02	656
76 Lubricants	Super	P	SL	104	-33	470	-	3.70	13.00	6.2	-	-	990	n/a	0.80	Jul-01	654
76 Lubricants	Guardol QLT	P	SL/CF	114	-27	460	-	3.60	13.00	10.2	-	-	1270	n/a	1.35	Sep-02	654

Chevron	RPM Heavy Duty	P	SL/CF	101	-38	482	-	2.90	13.00	7.2	-	1000	1090	n/a	0.95	Jun-03	654
76 Lubricants	T5X HD Mono.	P	CF	116	-27	465	-	3.50	13.00	7.2	-	-	980	n/a	0.88	Sep-02	653
Kendall	Dual Action	P	SJ	112	-11	489	-	3.50	13.00	5.0	-	-	1000	n/a	0.60	Jun-00	653
Havoline	Petroleum	P	SL/SJ	108	-27	482	-	2.90	13.00	7.6	-	940	1030	n/a	0.90	Mar-03	651
Havoline	**Petroleum**	**P**	**SL/SJ**	**108**	**-27**	**482**	**-**	**2.90**	**13.00**	**7.6**	**-**	**940**	**1030**	**n/a**	**0.90**	**Jun-03**	**651**
Chevron	Supreme	P	SL/SJ	108	-27	482	-	2.90	13.00	7.4	-	940	1030	n/a	0.90	Mar-03	651
Chevron	**Supreme**	**P**	**SL/SJ**	**108**	**-27**	**482**	**-**	**2.90**	**13.00**	**7.4**	**-**	**940**	**1030**	**n/a**	**0.90**	**Jun-03**	**651**
76 Lubricants	Guardol	P	CF-4/SJ	108	-29	460	-	3.60	13.00	9.2	-	-	1190	n/a	1.20	Jul-01	648
Citgo	Citgard 600	P	CF/SL	102	-6	482	-	3.70	13.00	11.0	-	-	1400	n/a	1.50	Sep-02	647
Citgo	Citgard 600	P	CF/SL	102	-6	482	-	3.70	13.00	11.0	-	-	-	n/a	1.50	Dec-02	647
Mystik	JT-8 Super HD	P	SL/CF	103	-11	489	-	2.90	13.00	12.0	-	-	-	n/a	1.60	Dec-02	646
Mystik	**JT-8 Super HD**	**P**	**SL/CF**	**103**	**-11**	**489**	**-**	**2.90**	**13.00**	**12.0**	**-**	**-**	**-**	**n/a**	**1.60**	**Aug-03**	**646**
TropArtic	Single Grade	P	SL/CD	103	-22	489	-	2.90	13.00	5.0	-	-	-	n/a	0.80	?	643
Shell	FormulaShell	P	SL/SJ	116	-33	455	-	2.90	13.00	6.8	-	-	1110	n/a	0.91	2001 ?	637
Chevron	Delo 400	P	CF/SJ	104	-24	468	-	2.90	13.00	10.2	-	1160	1270	n/a	1.35	Jan-03	635
Shell	FormulaShell	P	SL/SJ	114	-33	455	-	2.90	13.00	6.8	-	-	1110	n/a	0.91	Dec-02	635
Texaco	Ursa Premium TDX	P	SL/CF	104	-24	468	-	2.90	13.00	9.2	-	1140	1270	n/a	1.18	Aug-02	633
Conoco	HD Fleet	P	CF/CF-2	103	-27	470	-	2.90	13.00	7.1	-	-	-	n/a	1.00	Oct-02	633
Conoco	Hydroclear Power D	P	CF/SH	103	-27	470	-	2.90	13.00	7.1	-	-	-	n/a	1.00	Aug-02	633
Chevron	Delo 300	P	CF/SJ	100	-27	459	-	2.90	13.00	14.0	-	1190	1320	n/a	1.61	Sep-00	633
Citgo	Citgard 500	P	CF/SL	100	-11	471	-	3.70	13.00	8.0	-	-	1040	n/a	1.00	Sep-02	633
Citgo	Citgard 500	P	CF/SL	100	-11	471	-	3.70	13.00	8.0	-	-	-	n/a	1.00	Dec-02	633
Kendall	GT-1	P	SL/SJ	101	-29	471	-	2.90	13.00	6.2	-	-	1000	n/a	0.80	Mar-02	632
76 Lubricants	Firebird HD	P	CF-4/SJ	111	-24	445	-	3.60	13.00	9.2	-	-	1270	n/a	1.20	Jul-01	631
Chevron	Delo 400	P	CF/SJ	104	-22	468	-	2.90	13.00	8.7	-	1190	1320	n/a	0.96	Aug-00	630
Chevron	Delo 100	P	CF	99	-22	475	-	2.90	13.00	7.0	-	980	1080	n/a	0.76	Sep-00	629
Texaco	Ursa	P	CF/CD	99	-22	475	-	2.90	13.00	7.0	-	980	1080	n/a	0.76	Feb-02	629
Mobil	Delvac 1630	P	CF/SF	117	-22	446	-	2.90	13.00	12.0	-	-	-	n/a	1.40	May-03	628
Mobil	**Delvac 1630**	**P**	**CF/SF**	**117**	**-22**	**446**	**-**	**2.90**	**13.00**	**12.0**	**-**	**-**	**-**	**n/a**	**1.40**	**Jun-03**	**628**
Kendall	Super-D 3	P	SJ/CF	115	-17	453	-	2.90	13.00	11.0	-	-	-	n/a	1.30	Mar-00	626
Royal Purple	MonoGrade	S	SJ/CF	119	-	460	515	3.70	13.00	5.0	-	-	-	n/a	-	?	624
Phillips 66	Super HD II	P	SJ/CF	108	-22	457	-	2.90	13.00	8.0	-	-	-	n/a	0.85	?	622
Wolf's Head	Heavy Duty	P	SL/SJ	107	-6	465	-	3.65	13.00	5.0	-	-	-	n/a	<.9	Oct-01	622
Schaeffer	Supreme 7000	B	CF/SJ	105	-10	455	475	3.50	13.00	10.0	-	-	-	n/a	1.20	?	621
Mystik	Power Lubricants	P	SL/CF	100	-11	471	-	2.90	12.00	8.0	-	-	-	n/a	1.00	Sep-02	620
76 Lubricants	Triton QLT	P	CF/SJ	118	0.4	445	-	3.50	13.00	13.0	-	-	1300	n/a	1.65	Jul-01	620
Kendall	Super-D 3	P	SL/CF	101	-11	453	-	3.60	13.00	10.5	-	-	1400	n/a	1.40	Sep-02	619
Mobil	Delvac 1230	P	CF-2/SH	112	-17	442	-	3.50	13.00	7.8	-	-	-	n/a	0.83	Jan-97	618
Mystik	Power Lubricants	P	SL/CF	100	-11	471	-	2.90	13.00	8.0	-	-	-	n/a	1.00	Dec-02	617
Exxon	Superflo	P	SL/SJ	107	-6	453	-	3.70	13.00	5.0	-	-	-	n/a	-	Oct-01	611
Lubriplate	Super GPO	-	SJ/CF	100	-30	435	465	2.90	13.00	13.0	-	-	-	n/a	-	Mar-02	610
Citgo	SuperGard	P	SL	100	-	478	-	2.90	13.00	5.0	-	-	-	n/a	-	Jul-00	607

Citgo	SuperGard	P	SL	100	-	478	-	2.90	13.00	5.0	-	-	-	n/a	-	Dec-02	607
Pennzoil	HD	P	SL/SJ	105	-22	450	-	2.90	13.00	5.0	-	-	-	n/a	-	Jul-01	606
Phillips 66	HDS	P	SJ/CF	110	-22	435	-	2.90	13.00	10.0	-	-	-	n/a	1.00	?	606
Chevron	ECO	P	SJ/CF	104	-	450	-	3.70	13.00	8.0	-	1000	1100	n/a	1.20	Aug-00	605
Schaeffer	Moly Bond X-200	P	SJ/CF	106	-	460	500	2.90	13.00	10.0	-	-	-	n/a	1.20	Oct-00	605
Shell	Rimula	P	CF/CD	97	-10	455	-	2.90	13.00	12.0	-	-	-	n/a	1.65	Dec-02	605
Schaeffer	Micron Moly Racing	P	SJ	102	-	455	490	3.50	13.00	8.3	-	-	-	n/a	1.00	?	605
LE	Monolec Plus	P	CD	95	-22	460	-	2.90	13.00	4.2	-	-	-	n/a	0.35	?	604
Exxon	Superflo	P	SJ	110	-	453	-	3.25	13.00	5.0	-	-	-	n/a	-	Mar-00	599
Q. State	Universal HDX	P	CF/SL	105	-22	435	-	2.90	13.00	7.0	-	-	-	n/a	0.95	Aug-02	595
Mobil	Drive Clean	P	SL/SJ	105	-6	453	-	2.90	13.00	5.0	-	-	-	n/a	-	Apr-03	593
Mobil	**Drive Clean**	**P**	**SL/SJ**	**105**	**-6**	**453**	**-**	**2.90**	**13.00**	**5.0**	**-**	**-**	**-**	**n/a**	**-**	**Jun-03**	**593**
Q. State	FCI HDX	P	CF/SJ	106	-5	425	450	3.70	13.00	9.2	-	-	-	n/a	-	Sep-02	589
Wolf's Head	Special Duty	P	CH-4/SJ	109	-5	435	-	2.90	13.00	9.2	-	-	-	n/a	<1.0	Sep-01	586
Castrol	Heavy Duty	P	SH/SJ	107	-	450	470	2.90	13.00	5.0	-	1300	1400	n/a	1.00	2001 ?	586
Lubriplate	Super HDS	-	SJ/CF	106	-25	420	455	2.90	13.00	5.0	-	-	-	n/a	-	May-97	580
Conoco	Hydroclear Super	P	SL/SJ	110	-27	410	-	2.90	13.00	5.0	-	-	-	n/a	-	Nov-01	576
LE	Monolec GFS	P	CF/SJ	95	-17	425	-	2.90	13.00	10.0	-	-	-	n/a	1.00	?	576
CAM2	**Magnum Special**	**P**	**SC**	**112**	**-**	**430**	**-**	**2.90**	**13.00**	**5.0**	**-**	**-**	**-**	**n/a**	**-**	**?**	**571**
Valvoline	VR-1 Racing	P	SJ/CD	111	-	415	-	2.90	13.00	12.0	-	1140	1200	n/a	1.50	Sep-99	569
Q. State	Single-Grade HD	P	SJ/SH	113	-	425	460	2.90	13.00	5.0	-	-	-	n/a	-	May-01	567
Walmart	**SuperTech**	**P**	**SL/SJ**	**113**	**0**	**425**	**460**	**2.90**	**13.00**	**5.0**	**-**	**-**	**-**	**n/a**	**-**	**Sep-01**	**567**
Lyondell	Fleet S3 Plus	P	CF/SJ	101	-	430	-	2.90	13.00	8.0	-	-	-	n/a	0.90	Dec-00	566
Q. State	HD 4-Cycle	P	SJ/SH	95	+14	455	-	2.90	13.00	5.0	-	-	-	n/a	-	Jun-00	565
Mobil	Drive Clean HD30	P	SJ	107	-	428	-	2.90	13.00	5.0	-	-	-	n/a	-	May-02	564
Castrol	Heavy Duty	P	SL/SJ	106	21	446	470	2.90	13.00	5.0	-	800	850	n/a	-	Jun-02	560
Q. State	Single-Grade	P	SL/SJ	101	-	425	460	2.90	13.00	5.0	-	-	-	n/a	-	Sep-01	555
Pennzoil	4-Cycle	P	SJ	105	-10	410	-	2.90	13.00	5.0	-	-	-	n/a	1.00	Apr-99	554
Superior Lub.	HD	P	SH/CF	95	0	420	-	2.90	13.00	8.0	-	-	-	n/a	0.95	?	550
Shell	Rotella T Mono	P	CF-4/SJ	-	-	450	-	2.90	13.00	7.3	-	-	-	n/a	1.00	Dec-02	484
Valvoline	Maxlife	P	SL/SJ	-	-6	430	-	2.90	13.00	8.0	-	950	1080	n/a	-	Oct-02	471
Lyondell	Supreme	P	SJ	-	-	428	-	2.90	13.00	5.0	-	-	-	n/a	-	Dec-00	457
Valvoline	All Fleet Extra	P	CI-4/SL	109	-17	-	-	3.70	13.00	11.0	-	-	1600	n/a	1.50	Jul-02	183
Valvoline	All Fleet Extra	P	SL/CF	109	-17	-	-	3.70	13.00	11.0	-	-	1600	n/a	1.50	Feb-03	183
Valvoline	All Fleet Plus	P	CF-4/SL	113	-11	-	-	3.71	13.00	8.0	-	-	1100	n/a	<1.0	Jul-02	175
Valvoline	All Fleet Plus	P	CF-4/SL	113	-11	-	-	3.71	13.00	8.0	-	-	1100	n/a	<1.0	Feb-03	175
Valvoline	All Fleet Super	P	CD	104	-11	-	-	2.90	13.00	14.0	-	-	1200	n/a	1.80	Sep-01	162
CAM2	**Magnum HD**	**P**	**SL/SJ**	**112**	**-17**	**-**	**-**	**2.90**	**13.00**	**5.0**	**-**	**-**	**-**	**n/a**	**0.60**	**Aug-02**	**158**
CAM2	**Magnum Plus**	**P**	**SL/SJ**	**112**	**-17**	**-**	**-**	**2.90**	**13.00**	**5.0**	**-**	**-**	**-**	**n/a**	**0.60**	**Apr-97**	**158**
CAM2	**Magnum XHD**	**P**	**SL/SJ**	**112**	**-17**	**-**	**-**	**2.90**	**13.00**	**5.0**	**-**	**-**	**-**	**n/a**	**0.60**	**Aug-02**	**158**
Exxon	XD3	P	CF	100	-6	-	-	3.70	13.00	7.3	-	-	-	n/a	0.80	Nov-02	156
CAM2	**SuperPro**	**P**	**SL/SJ**	**105**	**-17**	**-**	**-**	**2.90**	**13.00**	**5.0**	**-**	**-**	**-**	**n/a**	**-**	**Oct-02**	**151**

0w30																	RANKING
Brand	**Product**	**P/S/B**	**API**	**VI**	**PP**	**FP**	**FRP**	**HT/HS**	**Noack**	**TBN**	**4 Ball**	**Phos**	**Zinc**	**CCS**	**Ash**	**Rev.**	**SCORE**
AMSOIL	S2000	S	SL/CF	195	-65	439	477	3.40	8.60	11.0	0.39'	-	-	5520 @ -35	-	Mar-03	763
AMSOIL	S2000	S	SL/CF	196	-60	439	464	3.50	9.20	11.0	0.37'	-	-	2993 @ -30	~1.0	Sep-01	759
Petro Canada	Duron XL Blend	B	CH-4/SJ	176	-54	448	-	3.50	13.00	9.0	-	-	-	5249 @ -35	1.20	Aug-02	727
Chevron	Delo 400 Synth.	S	SJ/CG-4	190	-76	419	-	2.90	13.00	10.0	-	1140	1300	2780 @ -30	1.10	Sep-02	724
Mobil 1	SuperSyn	S	SL/CF	175	-65	453	-	2.99	13.00	5.0	-	-	-	6200 @ -35	1.20	Mar-03	724
Mobil 1	**SuperSyn**	**S**	**SL/CF**	**175**	**-65**	**453**	**-**	**2.99**	**13.00**	**5.0**	**-**	**-**	**-**	**6200 @ -35**	**1.20**	**Jun-03**	**724**
Petro Canada	Blend PCMO	B	SL	173	-54	459	-	2.90	13.00	7.1	-	800	-	5190 @ -35	0.90	Mar-02	719
Pennzoil	Long Life HD	B	CG-4/SJ	182	-60	428	-	3.45	13.00	9.0	-	-	-	6200 @ -35	1.20	Oct-98	718
Castrol	Syntec	S	SL/CF	175	-44	437	450	2.95	13.00	5.0	-	900	1100	6200 @ -35	-	Jun-02	686
BG	Hi-L0W30	S	-	162	-65	420	-	2.90	13.53	8.3	-	-	-	2775 @ -30	0.99	Dec-99	681
BG	Hi-Performance ATV	S	-	168	-65	413	-	2.90	13.00	7.7	-	-	-	3808 @ -35	0.91	Jun-03	680
Castrol	Syntec	S	SL/CF	181	-44	410	430	3.10	13.00	5.0	-	900	1000	2750 @ -30	0.90	2001 ?	668
76 Lubricants	Synthetic HD Arctic	S	CH-4/SJ	176	-49	370	-	3.30	13.00	9.7	-	-	1270	5500 @ -35	1.20	Aug-02	641
Shell	Rotella T Blend	B	CG-4/SJ	-	-45	410	-	2.90	13.00	9.0	-	-	-	6200 @ -35	1.20	Dec-02	492

5w30																	RANKING
Brand	**Product**	**P/S/B**	**API**	**VI**	**PP**	**FP**	**FRP**	**HT/HS**	**Noack**	**TBN**	**4 Ball**	**Phos**	**Zinc**	**CCS**	**Ash**	**Rev.**	**SCORE**
AMSOIL	XL7500	S	SL/SJ	196	-60	453	482	3.10	8.80	10.1	0.38'	-	-	2320 @ -25	-	Apr-03	765
Schaeffer	Moly Pure	S	SJ	185	-60	465	500	3.80	13.00	8.0	-	-	-	2100 @ -25	0.90	?	763
AMSOIL	5w30	S	SL/CF	182	-60	446	-	3.50	6.90	11.0	0.35"	-	-	2555 @ -25	~1.0	Oct-01	759
AMSOIL	XL7500	S	SL/SJ	196	-60	444	468	3.10	8.80	10.1	0.38'	-	-	2320 @ -25	-	Jul-02	756
AMSOIL	S3000	S	CH-4/SL	175	-60	446	482	3.50	8.60	12.0	0.39'	-	-	6131 @ -30	~1.5	Jan-02	749
AMSOIL	S3000	S	CI-4/SJ	175	-60	446	482	3.50	8.60	12.0	0.39'	-	-	6131 @ -30	~1.5	Jan-02	749
Havoline	Synthetic	S	SL/CF	172	-44	471	-	2.90	10.00	8.6	-	980	1070	3700 @ -30	0.93	Sep-02	732
Exxon	Superflo Syn.	S	SJ	159	-62	471	-	3.10	13.00	5.0	-	-	-	2200 @ -25	-	Oct-99	725
Valvoline	SynPower	S	SL/CF	173	-44	468	-	2.90	12.00	9.0	-	1000	-	4200 @ -30	1.10	Apr-02	725
Valvoline	SynPower	S	SL/CF	173	-44	468	-	2.90	12.00	9.0	-	1000	-	4200 @ -30	1.10	Mar-03	725
Chevron	Supreme Syn.	S	SL/CF	161	-62	464	-	2.90	13.00	9.0	-	920	1280	2400 @ -25	1.12	Oct-02	724
CAM2	**Synavex**	**S**	**SL/SJ**	**175**	**-54**	**464**	**-**	**2.90**	**13.00**	**5.0**	**-**	**-**	**-**	**6600 @ -30**	**-**	**?**	**722**
Havoline	Energy	P	SJ	188	-54	450	-	2.95	14.50	5.0	-	-	-	6600 @ -30	-	?	718
Kendall	Elite	S	SJ/CF	160	-54	468	-	3.10	13.00	5.0	-	-	-	3910 @ -30	-	Sep-98	715
Kendall	SHP	S	SJ/CF	160	-54	468	-	2.90	13.00	5.0	-	-	-	3820 @ -30	-	Jul-00	711
Valvoline	SynPower Racing	S	-	164	-49	468	-	2.90	13.00	5.0	-	-	-	2400 @ -25	-	Oct-99	710
Red Line	Passenger	S	SJ/CF	153	-49	455	-	2.90	6.00	5.0	-	-	-	3300 @ -25	-	May-00	707
Valvoline	HP Syn	S	SH/CD	164	-40	460	-	3.50	13.00	5.0	-	1200	1200	3300 @ -25	-	Jul-98	705
Valvoline	VR-1 Racing Syn	S	SH/CD	164	-40	460	-	3.50	13.00	5.0	-	1200	1200	3300 @ -25	-	Jul-98	705

CAM2	Full Synthetic	S	SJ/SH	160	-49	464	-	2.90	13.00	5.0	-	-	-	3000 @ -20	-	?	702
Petro Canada	Synthetic PCMO	S	SL	169	-44	455	-	2.90	13.00	6.5	-	800	-	3920 @ -30	0.90	May-02	700
Castrol	Syntec	S	SL/CF	172	-38	455	475	3.00	13.00	5.0	-	900	1000	2400 @ -25	0.90	2001 ?	696
Q. State	Synthetic	S	SL/CF	177	-49	440	482	2.90	13.00	5.0	-	-	-	6600 @ -30	-	Oct-02	695
Valvoline	Durablend	B	SL/CD	161	-38	460	-	2.90	13.00	8.1	-	960	-	5800 @ -30	1.00	Apr-02	694
Neo	Neo	S	SJ	170	-60	430	-	2.90	13.00	6.2	-	-	-	3000 @ -25	0.64	?	691
Kendall	GT-1 Synthetic	S	SL/CF	166	-38	446	-	3.10	13.00	7.9	-	-	1000	4150 @ -30	1.00	Mar-02	689
Kendall	SHP Syn	S	SL/CF	166	-38	446	-	3.10	13.00	7.9	-	-	1000	4150 @ -30	1.00	Mar-02	689
Valvoline	Special Syn. Racing	S	-	157	-40	460	-	2.90	13.00	5.0	-	1200	1200	5700 @ -30	-	Mar-03	686
Petro Canada	Blend PCMO	B	SL	162	-49	441	-	2.90	13.00	6.8	-	900	-	4130 @ -30	0.80	Mar-02	685
Conoco	Syncon	S	SL/SJ	170	-45	440	-	2.90	13.00	5.0	-	-	-	6600 @ -30	-	May-02	684
Mobil 1	SuperSyn	S	SL/CF	167	-49	435	-	3.08	13.00	5.0	-	-	-	6600 @ -30	1.20	Mar-03	684
Mobil 1	SuperSyn	S	SL/CF	167	-49	435	-	3.08	13.00	5.0	-	-	-	6600 @ -30	1.20	Jun-03	684
Havoline	Petroleum	P	SL/SJ	159	-33	450	-	2.90	13.00	7.6	-	940	1030	5700 @ -30	0.90	Mar-03	676
Havoline	Petroleum	P	SL/SJ	159	-33	450	-	2.90	13.00	7.6	-	940	1030	5700 @ -30	0.90	Jun-03	676
Chevron	Supreme	P	SL/SJ	159	-33	450	-	2.90	13.00	7.4	-	940	1030	5700 @ -30	0.90	Mar-03	676
Chevron	Supreme	P	SL/SJ	159	-33	450	-	2.90	13.00	7.4	-	940	1030	5700 @ -30	0.90	Jun-03	676
Castrol	Syntec	S	SL/CF	171	-38	437	450	2.92	13.00	5.0	-	900	1100	6600 @ -30	-	Jun-02	675
Chevron	Supreme Syn. Blend	B	SL	159	-31	450	-	2.90	13.00	7.5	-	940	1030	5700 @ -30	0.90	Jun-03	674
Havoline	Synthetic Blend	B	SL/SJ	159	-31	450	-	2.90	13.00	7.5	-	940	1030	5700 @ -30	0.90	Jun-03	674
Schaeffer	Supreme 7000	B	SL	180	-	448	485	3.50	13.00	7.1	-	-	-	5073 @ -30	0.86	Jul-02	673
TropArtic	Synthetic	S	SL	158	-60	425	-	2.90	13.00	5.0	-	-	-	3100 @ -25	0.93	?	672
Citgo	SuperGard Blend	B	-	154	-27	455	-	3.20	13.00	5.0	-	-	-	5360 @ -30	-	Dec-02	671
Q. State	Synthetic	S	SJ/CF	151	-49	440	482	2.90	13.00	5.0	-	-	-	6600 @ -30	-	May-01	669
Petro Canada	Max MultiGrade	P	SL	160	-44	430	-	2.90	13.00	6.6	-	-	-	5000 @ -30	0.80	Feb-02	666
Petro Canada	Supreme MultiGrade	P	SL	159	-44	430	-	2.90	13.00	6.8	-	-	-	4310 @ -30	0.80	Mar-02	666
Citgo	SuperGard Blend	B	-	144	-33	446	-	3.30	13.00	5.0	-	-	-	2760 @ -25	-	May-02	660
Q. State	Higher Mileage	P	SJ	176	-43	410	-	2.90	13.00	5.0	-	-	-	7000 @ -25	-	Sep-00	658
Pennzoil	Multigrade	P	SL/SJ	160	-44	420	-	3.10	13.00	5.0	0.54'	-	-	6600 @ -30	-	May-02	657
Pennzoil	Multigrade	P	SL/SJ	160	-44	420	-	3.10	13.00	5.0	0.54'	-	-	6600 @ -30	-	Nov-02	657
Exxon	Superflo	P	SL/SJ	158	-22	442	-	3.10	13.00	5.0	-	-	-	6600 @ -30	0.74	Mar-03	655
Shell	FormulaShell	P	SL/SJ	159	-42	421	-	2.90	13.00	6.9	-	-	1110	6040 @ -30	0.91	Dec-02	655
Shell	FormulaShell	P	SL/SJ	156	-42	421	-	2.90	13.00	6.9	-	-	1110	6040 @ -30	0.91	2001 ?	652
Conoco	Hydroclear Super	P	SL/SJ	158	-40	424	-	2.90	13.00	5.0	-	-	-	6150 @ -30	-	Nov-01	651
76 Lubricants	Super	P	SL	154	-38	420	-	3.10	13.00	6.2	-	-	990	5450 @ -30	0.80	Jul-01	647
Motorcraft	Super Premium	P	SJ	159	-40	410	-	3.20	13.00	6.7	-	-	-	6600 @ -30	0.86	?	647
Kendall	GT-1	P	SL/SJ	152	-40	421	-	3.00	13.00	6.2	-	-	1000	6500 @ -30	0.80	Mar-02	646
Kendall	GT-1 Synthetic Blend	B	SL/SJ	157	-44	410	-	3.10	13.00	6.2	-	-	1000	5500 @ -30	0.80	Mar-02	646
Castrol	HIGH MILEAGE	P	SL/SJ	167	-27	415	415	3.30	13.00	5.0	-	1000	1100	6600 @ -30	-	Jun-02	646
Royal Purple	Multi-Grade	S	SL	161	-	455	480	2.90	13.00	5.0	-	-	-	6600 @ -30	-	?	645
Wolf's Head	Super Duty	P	SL/SJ	162	-33	420	-	2.90	13.00	5.0	-	-	-	6600 @ -30	<.9	Jul-02	644
Torco	MPZ Racing	S	SL/SJ	176	-40	397	430	2.90	13.00	5.2	-	-	-	2300 @ -25	-	2001	642

Mystik	JT-8 Premium	P	SL	162	-27	424	-	2.90	13.00	5.0	-	-	-	6480 @ -30	-	Dec-02	642
Q. State	HP Blend	B	SL/CF	165	-35	410	446	2.90	13.00	5.0	-	-	-	6600 @ -30	-	Jun-00	639
Q. State	Synthetic Blend	B	SL/CF	165	-35	410	446	2.90	13.00	5.0	-	-	-	6600 @ -30	-	May-02	639
Royal Purple	RP	S	SJ/CH-4	160	-44	395	435	2.90	13.00	10.5	-	-	-	6600 @ -30	-	?	639
Wolf's Head	Super Duty	P	SL/SJ	157	-33	420	-	2.90	13.00	5.0	-	-	-	3330 @ -30	<.9	Oct-01	639
Q. State	4x4 Blend	B	SL	164	-44	400	460	2.90	13.00	5.0	-	-	-	6600 @ -30	-	May-02	637
LE	8530 Monolec SPB	B	SJ	145	-40	420	-	2.90	13.00	6.2	-	-	-	6600 @ -30	0.64	?	636
Valvoline	All Climate	P	SL/SJ	162	-38	403	-	2.90	13.00	7.0	-	900	1050	6000 @ -30	0.80	Apr-02	636
Castrol	Syntec Blend	B	SL/SJ	160	-27	415	415	3.10	13.00	5.0	-	1000	1100	6600 @ -30	-	Jun-02	635
Exxon	Superflo	P	SL/SJ	157	-33	410	-	3.20	13.00	5.0	-	-	-	6029 @ -30	-	Oct-01	635
Kendall	Victory	B	SJ	157	-38	410	-	2.90	13.00	5.0	-	-	-	5510 @ -30	0.60	Aug-00	634
Mystik	JT-8 Premium	P	SJ/CF	162	-33	410	-	2.90	13.00	5.0	-	-	-	3400 @ -25	-	Oct-00	634
Castrol	Syntec Blend	B	SL/SJ	156	-36	410	430	3.00	13.00	5.0	-	900	900	3200 @ -25	1.00	2001 ?	633
Citgo	SuperGard	P	SL	154	-	442	-	3.20	13.00	5.0	-	-	-	5810 @ -30	-	Jul-00	631
Citgo	SuperGard	P	SL	154	-	442	-	3.20	13.00	5.0	-	-	-	5810 @ -30	-	Dec-02	631
Q. State	4x4 Blend	B	SJ/SH	158	-44	400	460	2.90	13.00	5.0	-	-	-	6600 @ -30	-	Feb-01	631
Castrol	GTX	P	SL/SJ	160	-27	410	430	3.00	13.00	5.0	-	900	1000	3100 @ -25	0.90	2001 ?	628
Q. State	HP Blend	B	SJ/CF	152	-35	410	446	2.90	13.00	5.0	-	-	-	6600 @ -30	-	Jun-00	626
Walmart	**SuperTech Blend**	**B**	**SJ/CF**	**152**	**-35**	**410**	**446**	**2.90**	**13.00**	**5.0**	**-**	**-**	**-**	**3500 @ -25**	**-**	**Sep-01**	**626**
Mobil	Drive Clean Plus	B	SL/CF	159	-44	392	-	2.90	13.00	5.0	-	-	-	5896 @ -30	-	Apr-03	624
Mobil	**Drive Clean Plus**	**B**	**SL/CF**	**159**	**-44**	**392**	**-**	**2.90**	**13.00**	**5.0**	**-**	**-**	**-**	**5896 @ -30**	**-**	**Jun-03**	**624**
TropArtic	Conventional	P	SL	155	-30	410	-	2.90	13.00	5.0	-	-	-	4688 @ -30	-	?	624
TropArtic	**Conventional**	**P**	**SL**	**155**	**-30**	**410**	**-**	**2.90**	**13.00**	**5.0**	**-**	**-**	**-**	**4688 @ -30**	**0.80**	**?**	**624**
Walmart	**SuperTech**	**P**	**SL/SJ**	**155**	**-35**	**405**	**430**	**2.90**	**13.00**	**5.0**	**-**	**-**	**-**	**3500 @ -25**	**-**	**Sep-01**	**624**
Superior Lub.	PCMO	P	SJ	154	-35	405	-	2.90	13.00	5.0	-	-	-	3300 @ -20	1.00	?	623
Schaeffer	Micron Moly	P	SL	159	-	424	455	3.20	13.00	7.1	-	-	-	6000 @ -30	0.86	Jun-02	622
Synergyn	Racing Oil	S	-	156	-30	406	-	2.90	13.00	5.0	-	-	-	6600 @ -30	-	?	621
Castrol	GTX	P	SL/SJ	160	-27	400	430	3.10	13.00	5.0	-	1000	1100	6600 @ -30	-	Jun-02	620
Q. State	Multigrade	P	SL/SJ	159	-27	405	430	2.90	13.00	5.0	-	-	-	6600 @ -30	-	Oct-01	620
Q. State	Peak Performance	P	SL/SJ	159	-27	405	430	2.90	13.00	5.0	-	-	-	6600 @ -30	-	Jan-02	620
Spectro	Spectro4	P	SH	151	-29	410	-	2.90	13.00	5.0	-	-	-	6600 @ -30	-	?	619
Kendall	Superb 100	P	SJ	155	-38	396	-	2.90	13.00	5.0	-	-	-	5900 @ -30	-	Jun-00	618
Mobil	Drive Clean	P	SL/SJ	159	-38	392	-	2.90	13.00	5.0	-	-	-	5500 @ -30	-	Apr-03	618
Mobil	**Drive Clean**	**P**	**SL/SJ**	**159**	**-38**	**392**	**-**	**2.90**	**13.00**	**5.0**	**-**	**-**	**-**	**5500 @ -30**	**-**	**Jun-03**	**618**
Kendall	GT-1	P	SJ	154	-38	396	-	2.90	13.00	5.0	-	-	-	5900 @ -30	-	Jul-00	617
Mobil	Drive Clean Blend	B	SL/CF	156	-39	392	-	2.90	13.00	5.0	-	-	-	5000 @ -30	-	May-02	616
Shell	FormulaShell Syn	S	SL/CF	-	-35	440	-	2.90	13.00	5.0	-	-	-	4300 @ -30	-	Jul-03	504
Valvoline	Maxlife	P	SL/SJ	-	-38	430	-	2.90	13.00	8.0	-	950	1080	6600 @ -30	-	Apr-02	503
Lyondell	Supreme	P	SJ	-	-40	396	-	2.90	13.00	5.0	-	-	-	3100 @ -25	-	Dec-00	465
Pennzoil	Synthetic	S	SJ	159	-54	-	-	3.05	6.90	5.0	-	-	-	2000 @ -25	-	May-00	263
Pennzoil	Synthetic	S	SL	176	-54	-	-	3.07	13.00	5.0	-	-	-	6600 @ -30	-	Jan-03	262
Pennzoil	Synthetic Blend	B	SJ	155	-49	-	-	3.00	13.00	5.0	-	-	-	3300 @ -25	-	Aug-00	235

Pennzoil	High Mileage	P	SL/SJ	165	-27	-	-	3.30	13.00	5.0	-	-	-	7000 @ -30	-	Dec-02	229
CAM2	Earth Friendly	P	SJ/SH	155	-44	-	-	2.90	13.00	5.0	-	-	-	6600 @ -30	0.60	Apr-97	228
CAM2	Magnum HD	P	SJ/SH	155	-44	-	-	2.90	13.00	5.0	-	-	-	6600 @ -30	0.60	Aug-02	228
CAM2	Magnum Plus	P	SJ/SH	155	-44	-	-	2.90	13.00	5.0	-	-	-	6600 @ -30	0.60	Apr-97	228
CAM2	Magnum XHD	P	SL/SJ	155	-44	-	-	2.90	13.00	5.0	-	-	-	6600 @ -30	0.60	Aug-02	228
CAM2	SuperPro	P	SL/SJ	155	-44	-	-	2.90	13.00	5.0	-	-	-	6600 @ -30	-	Oct-02	228
Pennzoil	Synthetic Blend	B	SL	158	-33	-	-	3.00	13.00	5.0	-	-	-	6600 @ -30	-	Jan-02	222
10w30																	**RANKING**
Brand	**Product**	**P/S/B**	**API**	**VI**	**PP**	**FP**	**FRP**	**HT/HS**	**Noack**	**TBN**	**4 Ball**	**Phos**	**Zinc**	**CCS**	**Ash**	**Rev.**	**SCORE**
Red Line	30 Wt Race ONLY	S	-	136	-58	518	-	2.90	6.00	5.0	-	-	-	3400 @ -20	-	Apr-99	762
AMSOIL	10w30	S	SL/CF	176	-54	446	-	3.50	5.50	12.2	0.35"	-	-	3097 @ -25	~1.0	Jun-03	754
AMSOIL	10w30	S	SL/CF	167	-54	446	-	3.50	6.60	12.2	0.35"	-	-	3444 @ -25	~1.0	Jun-01	742
Neo	Neo	S	SH	185	-49	470	-	2.90	13.00	8.0	-	-	-	3150 @ -20	1.03	?	739
AMSOIL	XL7500	S	SL/SJ	163	-45	453	482	3.20	4.70	10.2	0.38'	-	-	2300 @ -20	~1.0	Jul-02	731
Valvoline	SynPower	S	SL/CF	149	-44	482	-	2.90	8.00	9.0	-	1000	-	4400 @ -25	1.10	Apr-02	727
Valvoline	SynPower	S	SL/CF	149	-44	482	-	2.90	8.00	9.0	-	1000	-	4400 @ -25	1.10	Mar-03	727
Havoline	Synthetic	S	SJ/CF	148	-60	482	-	3.23	13.00	5.0	-	-	-	2300 @ -20	1.10	May-00	726
Chevron	Supreme Syn.	S	SJ	146	-60	480	-	2.90	13.00	9.2	-	920	1280	2100 @ -20	1.11	Aug-01	723
Chevron	Supreme Syn.	S	SL/CF	146	-60	480	-	2.90	13.00	9.2	-	920	1280	2100 @ -20	1.11	Oct-02	723
AMSOIL	XL7500	S	SL/SJ	163	-45	444	468	3.20	4.70	10.2	0.38'	-	-	2300 @ -20	-	Apr-03	722
Valvoline	HP Syn	S	SH/CD	155	-40	480	-	3.70	13.00	5.0	-	1200	1200	2700 @ -20	-	Jul-98	720
Valvoline	VR-1 Racing Syn	S	SH/CD	155	-40	480	-	3.70	13.00	5.0	-	1200	1200	2700 @ -20	-	Jul-98	720
Kendall	Elite	S	SJ/CF	146	-54	482	-	3.30	13.00	5.0	-	-	-	3910 @ -25	-	Oct-00	719
Exxon	Superflo Syn.	S	SJ	148	-54	482	-	3.10	13.00	5.0	-	-	-	2300 @ -20	-	Oct-99	717
CAM2	Synavex	S	SL/SJ	155	-49	482	-	2.90	13.00	5.0	-	-	-	7000 @ -25	-	?	715
Valvoline	SynPower Racing	S	-	155	-49	480	-	2.90	13.00	5.0	-	-	-	2720 @ -20	-	Oct-99	713
CAM2	Full Synthetic	S	SJ/SH	146	-54	482	-	2.90	13.00	5.0	-	-	-	2530 @ -25	-	?	711
Red Line	Passenger	S	SJ/CH-4	137	-45	475	-	2.90	5.00	5.0	-	-	-	3300 @ -20	-	May-00	710
Citgo	Citgard 600	P	CI-4/SL	140	-27	486	-	3.60	14.00	11.0	-	-	-	6500 @ -25	1.30	Dec-02	705
Citgo	Citgard 600	P	CI-4/SL	140	-27	486	-	3.60	14.00	11.0	-	-	-	6500 @ -25	1.30	Aug-03	705
Valvoline	Special Syn. Racing	S	-	156	-40	480	-	2.90	13.00	5.0	-	1200	1200	6200 @ -25	-	Mar-03	705
Precision	102P	P	CI-4/SL	130	-25	504	-	2.90	13.00	12.0	-	-	-	7000 @ -25	-	Jan-03	702
Mobil 1	SuperSyn	S	SL/CF	147	-49	471	-	3.17	13.00	5.0	-	-	-	7000 @ -25	1.20	Mar-03	701
Mobil 1	SuperSyn	S	SL/CF	147	-49	471	-	3.17	13.00	5.0	-	-	-	7000 @ -25	1.20	Jun-03	701
Petro Canada	Synthetic PCMO	S	SL	154	-33	473	-	2.90	13.00	6.7	-	800	-	3625 @ -25	0.90	May-02	692
Castrol	Syntec	S	SL/CF	159	-27	455	475	3.50	13.00	5.0	-	900	1100	2500 @ -20	1.04	2001 ?	682
Kendall	GT-1 Synthetic	S	SL/CF	148	-38	455	-	3.20	13.00	7.9	-	-	1000	4050 @ -25	1.00	Mar-02	682
76 Lubricants	Nascar Synthetic	S	SL	148	-38	455	-	3.20	13.00	7.8	-	930	1020	4050 @ -25	0.97	Sep-02	682
Mobil	Delvac 1300 Super	P	CG-4/SH	147	-38	439	-	3.60	13.00	11.0	-	-	-	6000 @ -25	1.20	Feb-03	679
Petro Canada	Duron HD	B	CI-4/SL	143	-44	441	-	3.50	13.00	9.1	-	-	-	5648 @ -25	1.20	Aug-02	677

76 Lubricants	Nascar HP	P	SJ	144	-45	450	-	3.30	13.00	5.5	-	-	1020	4700 @ -25	0.67	Jul-01	677
Castrol	Syntec	S	SL/CF	159	-33	450	450	3.10	13.00	5.0	-	900	1100	7000 @ -25	-	Jun-02	675
Exxon	**XD3**	**P**	**CI-4/SL**	**145**	**-27**	**464**	**-**	**2.90**	**13.00**	**10.0**	**-**	**-**	**-**	**7000 @ -25**	**1.10**	**Mar-03**	**675**
BG	Shear Power	B	-	145	-35	460	-	2.90	13.00	6.8	-	-	-	4993 @ -25	-	Jun-03	673
Chevron	Delo 400	P	CH-4	150	-44	439	-	2.90	13.00	10.1	-	1260	1400	3150 @ -20	1.34	Oct-01	672
Chevron	Delo 400	P	CI-4/SL	150	-44	439	-	2.90	13.00	10.1	-	1260	1400	3150 @ -20	1.34	Jan-03	672
Texaco	URSA Premium TDX	P	CI-4/SL	150	-44	439	-	2.90	13.00	10.1	-	1260	1400	6400 @ -25	1.30	Jan-03	672
Conoco	Syncon	S	SL/SJ	150	-33	460	-	2.90	13.00	5.0	-	-	-	7000 @ -25	-	May-02	672
Q. State	Synthetic	S	SL/CF	160	-40	440	482	2.90	13.00	5.0	-	-	-	7000 @ -25	-	Oct-02	669
Havoline	Synthetic Blend	B	SL/SJ	134	-38	453	-	2.90	10.50	8.2	-	980	1090	6400 @ -25	0.90	Jul-02	668
Valvoline	Durablend	B	SL/CD	138	-38	448	-	2.90	10.32	8.1	-	960	-	5700 @ -25	1.00	Apr-02	667
Mobil	Delvac 1300 Super	P	CI-4/SL	145	-22	444	-	3.50	13.00	12.0	-	-	-	6500 @ -25	1.30	Mar-03	666
Mobil	**Delvac 1300 Super**	**P**	**CI-4/SL**	**145**	**-22**	**444**	**-**	**3.50**	**13.00**	**12.0**	**-**	**-**	**-**	**6500 @ -25**	**1.30**	**Jun-03**	**666**
Pennzoil	LongLife HD	P	CI-4/SL	144	-38	425	-	3.50	13.00	12.0	-	-	-	6500 @ -25	1.50	Jul-02	662
Valvoline	Durablend	B	SL/CD	138	-38	448	-	2.90	13.00	8.1	-	960	-	5700 @ -25	1.00	Oct-01	659
Petro Canada	Blend PCMO	B	SL	145	-44	437	-	2.90	13.00	6.6	-	900	-	4360 @ -25	0.80	Mar-02	658
76 Lubricants	Guardol QLT	P	CH-4/SH	146	-45	415	-	3.50	13.00	10.1	-	-	1300	5600 @ -25	1.30	Jul-01	657
Q. State	Synthetic	S	SJ/CF	148	-40	440	482	2.90	13.00	5.0	-	-	-	7000 @ -25	-	May-01	657
Walmart	**SuperTech Full Syn**	**S**	**SJ/CF**	**148**	**-40**	**440**	**482**	**2.90**	**13.00**	**5.0**	**-**	**-**	**-**	**3500 @ -20**	**-**	**Sep-01**	**657**
Chevron	RPM Heavy Duty	P	CI-4/SH	129	-44	446	-	2.90	13.00	9.2	-	1140	1270	5800 @ -25	1.18	Sep-02	656
Chevron	RPM Heavy Duty	P	CI-4/SH	129	-44	446	-	2.90	13.00	9.2	-	1140	1270	5800 @ -25	1.18	Jun-03	656
Texaco	URSA Super Plus	P	CI-4/SL	129	-44	446	-	2.90	13.00	9.2	-	1140	1270	6000 @ -25	1.18	Jan-03	656
Pure Power	Pure Power	P	CH-4/SJ	145	-33	430	-	2.90	13.00	13.4	0.44""	-	-	7000 @ -25	0.92	Nov-98	654
Havoline	Petroleum	P	SL/SJ	135	-31	453	-	2.90	13.00	7.6	-	940	1030	5800 @ -25	0.90	Mar-03	653
Pennzoil	LongLife HD	P	CH-4/SH	140	-27	445	-	2.90	13.00	11.0	-	-	-	7000 @ -25	1.35	May-01	653
Chevron	Supreme Blend	B	SL	139	-29	450	-	2.90	13.00	7.5	-	940	1030	5800 @ -25	0.90	Jun-03	652
Havoline	**Synthetic Blend**	**B**	**SL/SJ**	**139**	**-29**	**450**	**-**	**2.90**	**13.00**	**7.5**	**-**	**940**	**1030**	**5800 @ -25**	**0.90**	**Jun-03**	**652**
TropArtic	**Synthetic Blend**	**B**	**SL**	**148**	**-36**	**439**	**-**	**2.90**	**13.00**	**5.0**	**-**	**-**	**-**	**6086 @ -25**	**0.80**	**?**	**652**
Havoline	**Petroleum**	**P**	**SL/SJ**	**135**	**-31**	**450**	**-**	**2.90**	**13.00**	**7.6**	**-**	**940**	**1030**	**5800 @ -25**	**0.90**	**Jun-03**	**650**
Petro Canada	Max MultiGrade	P	SL	141	-33	444	-	2.90	13.00	6.6	-	-	-	4930 @ -25	0.80	Feb-02	650
Chevron	Supreme	P	SL/SJ	135	-31	450	-	2.90	13.00	7.4	-	940	1030	5800 @ -25	0.90	Mar-03	650
Chevron	**Supreme**	**P**	**SL/SJ**	**135**	**-31**	**450**	**-**	**2.90**	**13.00**	**7.4**	**-**	**940**	**1030**	**5800 @ -25**	**0.90**	**Jun-03**	**650**
Chevron	ECO	P	SJ	156	-27	432	-	2.90	13.00	7.7	-	960	1010	2900 @ -20	0.67	Jul-00	649
Citgo	SuperGard Blend	B	-	133	-22	453	-	3.50	13.00	5.0	-	-	-	2720 @ -20	-	May-02	649
Kendall	Super-D 3	P	CI-4/SL	126	-33	430	-	3.70	13.00	12.0	-	-	1300	6900 @ -25	1.50	Sep-02	648
Kendall	GT-1 Synthetic Blend	B	SL/SJ	146	-38	428	-	3.10	13.00	6.2	-	-	1000	5350 @ -25	0.80	Mar-02	647
Motorcraft	Super Premium	P	SJ	139	-31	439	-	3.20	13.00	6.7	-	-	-	7000 @ -25	0.86	?	647
Shell	FormulaS Blend	B	SL/SJ	140	-44	428	-	2.90	13.00	7.0	-	-	1090	4750 @ -25	0.87	2001 ?	645
Petro Canada	Supreme MultiGrade	P	SL	144	-33	433	-	2.90	13.00	6.8	-	-	-	4320 @ -25	0.80	Mar-02	643
Schaeffer	Supreme 7000	B	SL	150	-	444	465	3.50	12.00	7.1	-	-	-	4500 @ -25	0.86	Jul-02	642
Citgo	SuperGard Blend	B	-	138	-22	441	-	3.50	13.00	5.0	-	-	-	5500 @ -25	-	Dec-02	642
LE	Monolec UltraBlend	B	CG-4/SH	145	-33	425	-	2.90	13.00	10.0	-	-	-	3500 @ -20	1.00	?	642

Kendall	Super-D 3	P	CH-4/SJ	144	-33	421	-	2.90	13.00	11.0	-	-	-	3100 @ -20	1.30	Mar-00	639
76 Lubricants	Guardol QLT	P	CI-4/SL	135	-33	415	-	3.50	13.00	12.0	-	-	1270	6650 @ -25	1.50	Sep-02	638
Pennzoil	Multigrade	P	SL/SJ	140	-33	430	-	3.20	13.00	5.0	-	-	-	7000 @ -25	-	May-02	638
Pennzoil	Multigrade	P	SL/SJ	140	-33	430	-	3.20	13.00	5.0	-	-	-	7000 @ -25	-	Nov-02	638
Shell	FormulaShell	P	SL/SJ	140	-36	430	-	2.90	13.00	6.2	-	-	1080	5620 @ -25	0.87	Dec-02	637
Exxon	Superflo	P	SL/SJ	135	-27	442	-	3.10	13.00	5.0	-	-	-	7000 @ -25	0.74	Mar-03	637
Royal Purple	RP	S	SJ/CH-4	148	-49	400	435	2.90	13.00	10.5	-	-	-	7000 @ -25	-	?	637
Chevron	Supreme Blend	B	SJ	130	-38	432	-	2.90	13.00	8.8	-	920	1120	3350 @ -20	1.12	Feb-01	637
Valvoline	VR-1 Racing	P	SH/CD	150	-27	415	-	2.90	13.00	12.0	-	1200	1140	7000 @ -25	1.50	Sep-99	635
Shell	FormulaShell	P	SL/SJ	137	-36	430	-	2.90	13.00	6.2	-	-	1080	5620 @ -25	0.87	2001 ?	634
Schaeffer	**Micron Moly**	**P**	**SL**	**148**	**-**	**446**	**465**	**3.20**	**12.80**	**7.1**	**-**	**-**	**-**	**5800 @ -25**	**0.86**	**Jul-03**	**634**
BG	Shear Power	B	-	148	-40	415	-	2.90	13.00	5.9	-	-	-	5253 @ -25	-	Dec-02	634
Phillips 66	Super HD II	P	CG-4	139	-49	410	-	2.90	13.00	8.0	-	-	-	2750 @ -20	0.85	?	633
TropArtic	Conventional	P	SL	139	-33	432	-	2.90	13.00	5.0	-	-	-	4936 @ -25	-	?	633
TropArtic	**Conventional**	**P**	**SL**	**139**	**-33**	**432**	**-**	**2.90**	**13.00**	**5.0**	**-**	**-**	**-**	**4936 @ -25**	**0.80**	**?**	**633**
Torco	MPZ Racing	P	SL/SJ	160	-15	428	450	2.90	13.00	5.2	-	-	-	2400 @ -20	-	2001	632
Kendall	Victory	B	SJ	146	-29	428	-	2.90	13.00	5.0	-	-	-	4000 @ -25	0.60	Aug-00	632
Spectro	Golden Motor-Guard	B	SH	162	-31	410	-	2.90	13.00	5.0	-	-	-	7000 @ -25	-	?	632
Q. State	4x4 Blend	B	SL	140	-25	437	464	2.90	13.00	5.0	-	-	-	7000 @ -25	-	May-02	631
Q. State	HP Blend	B	SL/CF	143	-30	428	453	2.90	13.00	5.0	-	-	-	7000 @ -25	-	May-02	630
Q. State	Synthetic Blend	B	SL/CF	143	-30	428	453	2.90	13.00	5.0	-	-	-	7000 @ -25	-	May-02	630
Kendall	Superb 100	P	SJ	139	-29	432	-	2.90	13.00	5.0	-	-	-	5600 @ -25	-	Jun-00	629
Mystik	JT-8 Premium	P	SJ/CF	141	-28	430	-	2.90	13.00	5.0	-	-	-	3400 @ -20	-	Oct-00	628
Shell	FormulaS Blend	B	SL/SJ	140	-30	425	-	2.90	13.00	7.0	-	-	1090	4750 @ -25	0.87	Dec-02	628
Shell	**FormulaShell SB**	**B**	**SL/SJ**	**140**	**-30**	**425**	**-**	**2.90**	**13.00**	**7.0**	**-**	**-**	**870**	**4750 @ -25**	**0.87**	**Jul-03**	**628**
Kendall	GT-1	P	SJ	137	-29	432	-	2.90	13.00	5.0	-	-	-	5600 @ -25	-	Jul-00	627
Shell	Rotella T MG	P	CI-4/SL	155	-20	410	-	2.90	13.00	11.5	-	-	-	7000 @ -25	1.47	Dec-02	627
Q. State	High Mileage	P	SJ/SH	150	-22	425	-	2.90	13.00	5.0	-	-	-	7000 @ -25	-	Sep-01	626
Q. State	Higher Mileage	P	SJ	150	-22	425	-	2.90	13.00	5.0	-	-	-	7000 @ -25	-	Sep-00	626
Q. State	Special Blend	B	SJ/CF	152	-35	410	446	2.90	13.00	5.0	-	-	-	3500 @ -25	-	Aug-01	626
Shell	Rotella T MG	P	CH-4/SL	155	-20	410	-	2.90	13.00	10.7	-	-	-	7000 @ -25	1.40	2001 ?	625
Lubriplate	Super GPO	-	CG-4/SH	140	-40	400	430	2.90	13.00	13.0	-	-	-	7000 @ -25	-	Mar-02	625
Q. State	4x4 Blend	B	SJ/SH	134	-25	437	464	2.90	13.00	5.0	0.60'	-	-	7000 @ -25	-	Feb-01	625
Q. State	HP Blend	B	SJ/CF	138	-30	428	453	2.90	13.00	5.0	-	-	-	7000 @ -25	-	Jun-00	625
Royal Purple	Multi-Grade	S	SL	141	-	455	480	2.90	13.00	5.0	-	-	-	7000 @ -25	-	?	625
Walmart	**SuperTech Blend**	**B**	**SJ/CF**	**138**	**-30**	**428**	**453**	**2.90**	**13.00**	**5.0**	**-**	**-**	**-**	**3500 @ -20**	**-**	**Sep-01**	**625**
76 Lubricants	Super	P	SL	136	-33	420	-	3.10	13.00	6.2	-	-	990	5900 @ -25	0.80	Jul-01	624
76 Lubricants	Nascar HP	P	SL	135	-33	420	-	3.10	13.00	6.5	-	-	1060	5900 @ -25	0.84	Jul-02	624
Conoco	Hydroclear Super	P	SL/SJ	134	-40	421	-	2.90	13.00	5.0	-	-	-	6200 @ -25	-	Nov-01	624
Royal Purple	RP	S	CH-4/SJ	144	-40	400	445	2.90	13.00	10.5	-	-	-	7000 @ -25	-	?	624
Castrol	HIGH MILEAGE	P	SL/SJ	149	-22	415	415	3.30	13.00	5.0	-	1000	1100	7000 @ -25	-	Jun-02	623
Superior Lub.	PCMO	P	SJ	155	-33	406	-	2.90	13.00	5.0	-	-	-	3200 @ -20	0.80	?	623

TropArtic	Turbo	P	SL	135	-33	426	-	2.90	13.00	5.0	-	-	-	6156 @ -25	0.85	?	623
Mystik	JT-8 Premium	P	SL	136	-27	430	-	2.90	13.00	5.0	-	-	-	6570 @ -25	-	Dec-02	622
Kendall	GT-1	P	SL/SJ	135	-29	421	-	3.10	13.00	6.2	-	-	1000	6800 @ -25	0.80	Mar-02	620
Citgo	UltraLife	P	SL/SJ	144	-	435	-	3.50	13.00	5.0	-	-	-	6440 @ -25	-	Dec-02	620
Citgo	SuperGard	P	SL	137	-	451	-	3.00	13.00	5.0	-	-	-	6300 @ -25	-	Jul-00	619
Citgo	SuperGard	P	SL	137	-	451	-	3.00	13.00	5.0	-	-	-	6300 @ -25	-	Dec-02	619
Castrol	Syntec Blend	B	SL/SJ	138	-27	415	435	3.30	13.00	5.0	-	900	1000	3100 @ -20	0.90	2001 ?	617
Valvoline	All Climate	P	SL/SJ	135	-27	421	-	2.90	13.00	7.0	-	900	1050	6000 @ -25	0.80	Apr-02	616
76 Lubricants	Firebird LD	P	SJ	141	-35	405	-	3.10	13.00	5.5	-	-	1010	3060 @ -20	0.67	Jul-01	615
Wolf's Head	Super Duty	P	SL/SJ	139	-17	430	-	2.90	13.00	5.0	-	-	-	7000 @ -25	<.9	Jul-02	615
Lubriplate	Super Lo-Hi-Vis	-	SJ/CF	135	-40	410	435	2.90	13.00	5.0	-	-	-	2450 @ -20	-	May-97	614
Mystik	JT-8 Super HD	P	CI-4/SL	143	-27	406	-	2.90	14.00	11.0	-	-	-	6500 @ -25	1.30	Dec-02	614
Mystik	JT-8 Super HD	P	CI-4/SL	143	-27	406	-	2.90	14.00	11.0	-	-	-	6500 @ -25	1.30	Aug-03	614
Wolf's Head	Super Duty	P	SL/SJ	138	-17	430	-	2.90	13.00	5.0	-	-	-	3330 @ -25	<.9	Oct-01	614
Castrol	GTX	P	SL/SJ	143	-22	415	445	3.10	13.00	5.0	-	900	1000	3200 @ -20	0.80	2001 ?	613
Castrol	Syntec Blend	B	SL/SJ	138	-27	415	415	3.10	13.00	5.0	-	1000	1100	7000 @ -25	-	Jun-02	613
Castrol	GTX	P	SL/SJ	142	-22	415	445	3.10	13.00	5.0	-	1000	1100	7000 @ -25	-	Jun-02	612
Q. State	Universal HDX	P	CI-4/SL	138	-22	410	-	2.90	13.00	10.0	-	-	-	7000 @ -25	1.20	Aug-02	609
Exxon	Superflo	P	SL/SJ	132	-33	408	-	3.20	13.00	5.0	-	-	-	6100 @ -25	-	Oct-01	608
Walmart	SuperTech	P	SL/SJ	140	-29	410	441	2.90	13.00	5.0	-	-	-	3500 @ -20	-	Sep-01	608
Q. State	FCI HDX	P	CH-4/SH	139	-25	405	430	2.90	13.00	9.2	-	-	-	3500 @ -20	-	Sep-02	606
Valvoline	Special Racing	P	-	133	-27	415	-	2.90	13.00	5.0	-	1200	1200	6800 @ -25	-	Dec-02	604
Q. State	Multigrade	P	SL/SJ	139	-22	410	441	2.90	13.00	5.0	-	-	-	7000 @ -25	-	Oct-01	600
Q. State	Peak Performance	P	SL/SJ	139	-22	410	430	2.90	13.00	5.0	-	-	-	7000 @ -25	-	Jan-02	600
Shell	Rimula Premium	P	CI-4/SL	131	-30	400	-	2.90	13.00	10.0	-	-	-	7000 @ -25	1.20	Dec-02	600
Mobil	Drive Clean Plus	B	SL/CF	145	-33	392	-	2.90	13.00	5.0	-	-	-	6290 @ -25	-	Apr-03	599
Mobil	Drive Clean Plus	B	SL/CF	145	-33	392	-	2.90	13.00	5.0	-	-	-	6290 @ -25	-	Jun-03	599
Mobil	Drive Clean Blend	B	SL/CF	140	-33	392	-	2.90	13.00	5.0	-	-	-	5500 @ -25	-	May-02	594
Mobil	Drive Clean	P	SL/SJ	134	-33	392	-	2.90	13.00	5.0	-	-	-	6200 @ -25	-	Apr-03	588
Mobil	Drive Clean	P	SL/SJ	134	-33	392	-	2.90	13.00	5.0	-	-	-	6200 @ -25	-	Jun-03	588
CAM2	Magnum Special	P	SC	141	-	410	-	2.90	13.00	5.0	-	-	-	7000 @ -25	-	?	580
Conoco	Hydroclear Power D	P	CI-4/SL	133	-27	371	-	2.90	13.00	12.0	-	-	-	7000 @ -25	1.60	Aug-02	574
Conoco	HD Fleet Supreme	P	CI-4/SL	130	-27	371	-	2.90	13.00	11.0	-	-	-	7000 @ -25	1.60	Aug-02	569
Valvoline	Maxlife	P	SL/SJ	-	-33	446	-	2.90	13.00	8.0	-	950	1080	7000 @ -25	-	Apr-02	514
Shell	FormulaShell Syn	S	SL/CF	-	-30	445	-	2.90	13.00	5.0	-	-	-	4090 @ -25	-	Jul-03	504
Shell	Rotella T Blend	B	CH-4/SJ	-	-35	415	-	2.90	13.00	9.6	-	-	-	7000 @ -25	1.20	Dec-02	488
Klotz	MC Techniplate	S	SG	-	-30	425	-	2.90	13.00	5.0	-	-	-	7000 @ -25	-	Dec-00	484
Klotz	MX4 Techniplate	S	SG	-	-30	425	-	2.90	13.00	5.0	-	-	-	7000 @ -25	-	May-02	484
Neo	Street	?	SH/CG-4	-	-35	410	-	2.90	13.00	8.5	-	-	1200	3500 @ -20	1.00	?	481
Shell	Rotella SB	B	CH-4/SJ	-	-35	405	-	2.90	13.00	10.7	-	-	-	7000 @ -25	1.40	?	480
Klotz	Race Techniplate	S	SH/CD	-	-30	415	-	2.90	13.00	5.0	-	-	-	7000 @ -25	-	Dec-00	474
Lyondell	Supreme	P	SJ	-	-22	401	-	2.90	13.00	5.0	-	-	-	3300 @ -20	-	Dec-00	452

Pennzoil	Synthetic	S	SJ	150	-52	-	-	3.15	4.40	5.0	-	-	-	2230 @ -20	-	May-00	262
Pennzoil	Synthetic	S	SL	158	-49	-	-	3.20	13.00	5.0	-	-	-	7000 @ -25	-	Jan-03	242
Exxon	XD3	P	CI-4/SL	145	-27	-	-	3.50	13.00	10.0	-	-	-	7000 @ -25	1.20	Nov-02	223
Pennzoil	Synthetic Blend	B	SJ	136	-49	-	-	3.10	13.00	5.0	-	-	-	3300 @ -20	-	Aug-00	218
Valvoline	All Fleet Plus	P	CI-4/SL	141	-27	-	-	3.27	13.00	10.3	-	-	1600	6600 @ -25	1.40	Jul-02	215
Valvoline	All Fleet Plus	P	CI-4/SL	141	-27	-	-	3.27	13.00	10.3	-	-	1600	6600 @ -25	1.40	Jul-02	215
CAM2	Earth Friendly	P	SJ/SH	141	-33	-	-	2.90	13.00	5.0	-	-	-	7000 @ -25	0.60	Apr-97	203
CAM2	Magnum HD	P	SJ/SH	141	-33	-	-	2.90	13.00	5.0	-	-	-	7000 @ -25	0.60	Aug-02	203
CAM2	Magnum Plus	P	SJ/SH	141	-33	-	-	2.90	13.00	5.0	-	-	-	7000 @ -25	0.60	Apr-97	203
CAM2	Magnum XHD	P	SL/SJ	141	-33	-	-	2.90	13.00	5.0	-	-	-	7000 @ -25	0.60	Aug-02	203
CAM2	SuperPro	P	SL/SJ	141	-33	-	-	2.90	13.00	5.0	-	-	-	7000 @ -25	-	Oct-02	203
Pennzoil	High Mileage	P	SL/SJ	137	-22	-	-	3.40	13.00	5.0	-	-	-	7000 @ -25	-	Dec-02	198
Pennzoil	Synthetic Blend	B	SL	136	-27	-	-	3.10	13.00	5.0	-	-	-	7000 @ -25	-	Jan-02	196

SAE 40																	RANKING
Brand	Product	P/S/B	API	VI	PP	FP	FRP	HT/HS	Noack	TBN	4 Ball	Phos	Zinc	CCS	Ash	Rev.	SCORE
Schaeffer	Moly Pure	S	SG/CE	142	-40	495	530	5.50	13.00	10.0	-	-	-	n/a	1.00	Oct-91	768
76 Lubricants	Triton QLT	P	CF/SJ	115	-35	485	-	4.40	13.00	13.0	-	-	1300	n/a	1.65	Jul-01	710
Conoco	HD Fleet	P	CF/CF-2	101	-26	531	-	3.70	13.00	7.1	-	-	-	n/a	1.00	Oct-02	707
Conoco	Hydroclear Power D	P	CF/SH	101	-26	531	-	3.70	13.00	7.1	-	-	-	n/a	1.00	Aug-02	707
Precision	102P	P	SJ/CF-4	113	-10	518	-	3.70	13.00	12.0	-	-	-	n/a	-	Jan-03	700
76 Lubricants	Guardol QLT	P	SL/CF	107	-27	485	-	4.50	13.00	10.2	-	-	1270	n/a	1.35	Sep-02	690
Pennzoil	LongLife HD	P	CF/SL	103	-11	509	-	4.60	13.00	7.0	-	-	-	n/a	<1.0	Jul-02	690
76 Lubricants	Guardol	P	CF/SJ	111	-26	485	-	4.40	13.00	9.2	-	-	1190	n/a	1.20	Jul-01	689
Havoline	Petroleum	P	SL/SJ	107	-22	509	-	3.70	13.00	7.6	-	940	1030	n/a	0.90	Mar-03	688
Havoline	Petroleum	P	SL/SJ	107	-22	509	-	3.70	13.00	7.6	-	940	1030	n/a	0.90	Jun-03	688
Chevron	Supreme	P	SL/SJ	107	-22	509	-	3.70	13.00	7.4	-	940	1030	n/a	0.90	Mar-03	688
Chevron	Supreme	P	SL/SJ	107	-22	509	-	3.70	13.00	7.4	-	940	1030	n/a	0.90	Jun-03	688
Pennzoil	LongLife HD	P	CF-2/CF	99	-13	509	-	4.40	13.00	7.5	-	-	-	n/a	<1.0	May-01	685
76 Lubricants	T5X HD Mono.	P	CF/SJ	115	-29	475	-	4.40	13.00	8.1	-	-	1300	n/a	0.90	Jul-01	684
Chevron	RPM Heavy Duty	P	SL/CF	100	-27	498	-	3.70	13.00	7.6	-	1080	1200	n/a	0.85	Sep-02	675
Texaco	Ursa Super Plus	P	SL/CF	100	-27	498	-	3.70	13.00	7.6	-	1080	1200	n/a	0.85	Jul-02	675
Chevron	RPM Heavy Duty	P	SL/CF	100	-27	498	-	3.70	13.00	7.2	-	1000	1090	n/a	0.95	Jun-03	674
Mobil	Delvac 1340	P	CG-4	112	-6	493	-	3.70	13.00	12.0	-	-	-	n/a	1.40	Aug-02	670
Mobil	Delvac 1340	P	CF/SF	112	-6	493	-	3.70	13.00	12.0	-	-	-	n/a	1.40	Mar-03	670
Mobil	Delvac 1340	P	CF/SF	112	-6	493	-	3.70	13.00	12.0	-	-	-	n/a	1.40	Jun-03	670
Schaeffer	Supreme 7000	B	CF/SJ	105	-5	500	530	3.80	13.00	10.0	-	-	-	n/a	1.20	?	667
Chevron	Delo 400	P	CF/SJ	102	-27	482	-	3.70	13.00	10.2	-	1160	1270	n/a	1.35	Aug-00	666
Chevron	Delo 400	P	CF/SJ	102	-22	489	-	3.70	13.00	8.7	-	1190	1320	n/a	0.96	Aug-00	665
Texaco	Ursa Premium TDX	P	SL/CF	102	-27	482	-	3.70	13.00	9.2	-	1140	1270	n/a	1.18	Aug-02	664
Kendall	Dual Action	P	SJ	108	+1	498	-	4.40	13.00	5.0	-	-	1000	n/a	0.60	Jun-00	664

76 Lubricants	Super	P	SL	96	-22	490	-	4.10	13.00	6.2	-	-	990	n/a	0.80	Jul-01	663
76 Lubricants	T5X HD Mono.	P	CF	112	-27	465	-	4.20	13.00	7.2	-	-	980	n/a	0.88	Sep-02	663
Chevron	**Delo 100**	**P**	**CF**	**99**	**-17**	**498**	**-**	**3.70**	**13.00**	**7.0**	**-**	**980**	**1080**	**n/a**	**0.76**	**Sep-00**	**663**
Texaco	Ursa	P	CF/CD	99	-17	498	-	3.70	13.00	7.0	-	980	1080	n/a	0.76	Feb-02	663
Exxon	**XD3**	**P**	**CF/SF**	**98**	**-22**	**493**	**-**	**3.70**	**13.00**	**7.3**	**-**	**-**	**-**	**n/a**	**0.80**	**Mar-03**	**663**
Royal Purple	RP	S	SJ/CF	113	-33	460	515	3.70	13.00	10.5	-	-	-	n/a	-	?	662
Chevron	Delo 300	P	CF/SJ	99	-22	475	-	3.70	13.00	14.0	-	1190	1320	n/a	1.61	Sep-00	659
TropArtic	Single Grade	P	SL/CD	101	-15	498	-	3.70	13.00	5.0	-	-	-	n/a	0.80	?	659
76 Lubricants	Firebird HD	P	CF/SJ	109	-15	465	-	4.40	13.00	9.2	-	-	1270	n/a	1.20	Jul-01	656
Kendall	GT-1	P	SL/SJ	96	-22	489	-	3.70	13.00	6.2	-	-	1000	n/a	0.80	Mar-02	654
Shell	FormulaShell	P	SL/SJ	113	-27	464	-	3.70	13.00	6.3	-	-	1110	n/a	0.90	2001 ?	652
Shell	FormulaShell	P	SL/SJ	112	-27	464	-	3.70	13.00	6.3	-	-	1110	n/a	0.90	Dec-02	651
LE	Monolec Plus	P	CD	95	-6	505	-	3.70	13.00	4.4	-	-	-	n/a	0.42	?	650
Citgo	SuperGard	P	SL	98	-	504	-	3.70	13.00	5.0	-	-	-	n/a	-	Jul-00	647
Citgo	SuperGard	P	SL	98	-	504	-	3.70	13.00	5.0	-	-	-	n/a	-	Dec-02	647
Citgo	Citgard 600	P	CF/SL	100	+10	482	-	4.50	13.00	11.0	-	-	1400	n/a	1.50	Sep-02	645
Citgo	Citgard 600	P	CF/SL	100	+10	482	-	4.50	13.00	11.0	-	-	-	n/a	1.50	Dec-02	645
Chevron	GEO 940	P	CF	100	+5	498	-	3.70	13.00	7.6	-	1080	1200	n/a	0.90	Sep-01	643
Kendall	Super-D 3	P	SJ/CF	108	-11	468	-	3.70	13.00	10.3	-	-	-	n/a	1.20	Mar-00	643
Kendall	Super-D 3	P	SL/CF	98	-6	468	-	4.40	13.00	10.5	-	-	1400	n/a	1.40	Sep-02	642
Wolf's Head	Heavy Duty	P	SL/SJ	102	-	475	-	4.60	13.00	5.0	-	-	-	n/a	<.9	Oct-01	640
Mobil	Delvac 1640	P	CF/SF	112	-6	462	-	3.70	13.00	12.0	-	-	-	n/a	1.40	May-03	639
Mobil	**Delvac 1640**	**P**	**CF/SF**	**112**	**-6**	**462**	**-**	**3.70**	**13.00**	**12.0**	**-**	**-**	**-**	**n/a**	**1.40**	**Jun-03**	**639**
Valvoline	VR-1 Racing	P	SJ/CD	105	+5	480	-	3.70	13.00	12.0	-	1140	1200	n/a	1.50	Sep-99	639
Exxon	Superflo	P	SL/SJ	105	-	473	-	4.40	13.00	5.0	-	-	-	n/a	-	Oct-01	637
Mystik	JT-8 Super HD	P	SL/CF	101	-6	471	-	3.70	13.00	12.0	-	-	-	n/a	1.60	Dec-02	637
Mystik	**JT-8 Super HD**	**P**	**SL/CF**	**101**	**-6**	**471**	**-**	**3.70**	**13.00**	**12.0**	**-**	**-**	**-**	**n/a**	**1.60**	**Aug-03**	**637**
Phillips 66	Super HD II	P	SJ/CF	105	-6	468	-	3.70	13.00	8.0	-	-	-	n/a	0.85	?	630
Citgo	Citgard 500	P	CF/SL	100	+10	471	-	4.40	13.00	8.0	-	-	1040	n/a	1.00	Sep-02	626
Citgo	Citgard 500	P	CF/SL	100	+10	471	-	4.40	13.00	8.0	-	-	-	n/a	1.00	Dec-02	626
Exxon	Superflo	P	SJ	103	+5	473	-	4.20	13.00	5.0	-	-	-	n/a	-	Mar-00	626
Lubriplate	Super GPO	-	SJ/CF	103	-15	445	480	3.70	13.00	13.0	-	-	-	n/a	-	Mar-02	624
Royal Purple	MonoGrade	S	SJ/CF	113	-	460	515	3.70	13.00	5.0	-	-	-	n/a	-	?	618
Pennzoil	HD	P	SL/SJ	100	-17	455	-	3.70	13.00	5.0	-	-	-	n/a	-	Jul-01	617
Mystik	Power Lubricants	P	SL/CF	100	+10	471	-	3.70	12.00	8.0	-	-	-	n/a	1.00	Sep-02	615
Phillips 66	HDS	P	SJ/CF	109	-22	428	-	3.70	13.00	10.0	-	-	-	n/a	1.00	?	614
Schaeffer	Micron Moly Racing	P	SJ	100	+10	465	500	4.00	13.00	8.3	-	-	-	n/a	1.00	?	613
Mystik	Power Lubricants	P	SL/CF	100	+10	471	-	3.70	13.00	8.0	-	-	-	n/a	1.00	Dec-02	612
Castrol	Heavy Duty	P	SH/SJ	106	+5	465	480	3.70	13.00	5.0	-	1300	1400	n/a	1.00	2001 ?	611
Chevron	ECO	P	SJ/CF	105	+5	460	-	3.70	13.00	8.0	-	1000	1100	n/a	1.20	Aug-00	611
Q. State	Universal HDX	P	CF/SL	103	-11	446	-	3.70	13.00	7.0	-	-	-	n/a	0.95	Aug-02	609
Shell	Rimula	P	CF/CD	95	-5	445	-	3.70	13.00	12.0	-	-	-	n/a	1.65	Dec-02	604

Torco	MPZ Super Diesel	P	CH-4/SJ	95	+5	459	514	3.70	13.00	9.0	-	-	-	n/a	-	2001	602
LE	Monolec GFS	P	CF/SJ	95	-	450	-	3.70	13.00	10.0	-	-	-	n/a	1.00	?	600
Wolf's Head	Special Duty	P	CH-4/SJ	104	+5	446	-	3.70	13.00	9.2	-	-	-	n/a	<1.0	Sep-01	598
Lubriplate	Super HDS	-	SJ/CF	108	-15	430	475	3.70	13.00	5.0	-	-	-	n/a	-	May-97	598
CAM2	**Magnum Special**	**P**	**SC**	**108**	**-**	**440**	**-**	**3.70**	**13.00**	**5.0**	**-**	**-**	**-**	**n/a**	**-**	**?**	**593**
Conoco	Hydroclear Super	P	SL/SJ	102	-27	410	-	3.70	13.00	5.0	-	-	-	n/a	-	Nov-01	584
Q. State	FCI HDX	P	CF/SJ	104	+5	430	470	3.70	13.00	9.2	-	-	-	n/a	-	Sep-02	582
Lyondell	Fleet S3 Plus	P	CF/SJ	98	+10	440	-	3.70	13.00	8.0	-	-	-	n/a	0.90	Dec-00	579
Castrol	Heavy Duty	P	SL/SJ	106	21	446	470	3.70	13.00	5.0	-	800	850	n/a	-	Jun-02	576
Walmart	**SuperTech**	**P**	**SL/SJ**	**106**	**+10**	**435**	**470**	**3.70**	**13.00**	**5.0**	**-**	**-**	**-**	**n/a**	**-**	**Sep-01**	**576**
Q. State	Single-Grade	P	SL/SJ	102	+10	435	470	3.70	13.00	5.0	-	-	-	n/a	-	Sep-01	572
Shell	Rotella T Mono	P	CF-4/SJ	-	+5	460	-	3.70	13.00	7.3	-	-	-	n/a	1.00	Dec-02	505
Mobil	Delvac 1240	P	CF-2/SH	-	+5	439	-	4.30	13.00	7.8	-	-	-	n/a	0.83	Jan-97	497
Lyondell	Supreme	P	SJ	-	+5	437	-	3.70	13.00	5.0	-	-	-	n/a	-	Dec-00	477
Exxon	XD3	P	CF	96	-6	-	-	4.40	13.00	7.3	-	-	-	n/a	0.80	Nov-02	166
Valvoline	All Fleet Plus	P	CF-4/SL	105	-6	-	-	3.70	13.00	8.0	-	-	1100	n/a	<1.0	Jul-02	162
Valvoline	All Fleet Plus	P	CF-4/SL	105	-6	-	-	3.70	13.00	8.0	-	-	1100	n/a	<1.0	Feb-03	162
CAM2	**Magnum HD**	**P**	**SL/SJ**	**108**	**+5**	**-**	**-**	**3.70**	**13.00**	**5.0**	**-**	**-**	**-**	**n/a**	**0.60**	**Aug-02**	**148**
CAM2	**Magnum Plus**	**P**	**SL/SJ**	**108**	**+5**	**-**	**-**	**3.70**	**13.00**	**5.0**	**-**	**-**	**-**	**n/a**	**0.60**	**Apr-97**	**148**
CAM2	**Magnum XHD**	**P**	**SL/SJ**	**108**	**+5**	**-**	**-**	**3.70**	**13.00**	**5.0**	**-**	**-**	**-**	**n/a**	**0.60**	**Aug-02**	**148**
Valvoline	All Fleet Plus DD	P	CF-2/CF	100	-	-	-	3.70	13.00	6.5	-	-	-	n/a	0.79	Jul-01	148
CAM2	**SuperPro**	**P**	**SL/SJ**	**100**	**+5**	**-**	**-**	**3.70**	**13.00**	**5.0**	**-**	**-**	**-**	**n/a**	**-**	**Oct-02**	**140**
0w40																	**RANKING**
Brand	**Product**	**P/S/B**	**API**	**VI**	**PP**	**FP**	**FRP**	**HT/HS**	**Noack**	**TBN**	**4 Ball**	**Phos**	**Zinc**	**CCS**	**Ash**	**Rev.**	**SCORE**
Mobil 1	SuperSyn	S	SL/CF	187	-65	457	-	3.60	13.00	5.0	-	-	-	6200 @ -35	1.20	Mar-03	752
Mobil 1	**SuperSyn**	**S**	**SL/CF**	**187**	**-65**	**457**	**-**	**3.60**	**13.00**	**5.0**	**-**	**-**	**-**	**6200 @ -35**	**1.20**	**Jun-03**	**752**
Spectro	**Supreme Syn.**	**S**	**SH**	**165**	**-54**	**500**	**-**	**2.90**	**13.00**	**5.0**	**-**	**-**	**-**	**6200 @ -35**	**-**	**?**	**748**
AMSOIL	4-Stroke	S	SJ/CF	201	-60	442	-	2.90	11.63	8.9	0.40'	-	-	-	-	Sep-01	744
AMSOIL	4-Stroke	S	SJ/CF	201	-60	442	-	2.90	11.63	8.9	0.40'	-	-	5691 @ -35	-	Jan-02	744
Exxon	XD3 Elite	B	CH-4	210	-60	-	-	2.90	13.00	10.0	-	-	-	-	1.25	Oct-99	309

5w40																	RANKING
Brand	Product	P/S/B	API	VI	PP	FP	FRP	HT/HS	Noack	TBN	4 Ball	Phos	Zinc	CCS	Ash	Rev.	SCORE
Petro Canada	Duron Synthetic HD	S	CH-4/SL	172	-49	451	-	4.20	13.00	10.0	-	-	-	5598 @ -30	1.40	Aug-02	737
76 Lubricants	Pure Synthetic	S	SL/CF	175	-51	450	-	3.80	13.00	10.1	-	930	1050	6060 @ -30	1.10	Mar-02	733
Kendall	GT-1 Synthetic	S	SL/CF	175	-51	450	-	3.80	13.00	10.1	-	-	1100	6060 @ -30	1.10	Mar-02	733
Shell	Rotella T Syn	S	CH-4/SL	176	-40	475	-	2.90	13.00	10.0	-	-	-	6400 @ -30	1.30	Dec-02	730
76 Lubricants	Pure Synthetic	S	SJ/CF	164	-58	445	-	4.00	13.00	8.8	-	990	1090	5090 @ -30	1.10	Jul-01	726
Havoline	Synthetic	S	SJ/CF	161	-50	453	-	4.00	13.00	5.0	-	-	-	3260 @ -25	1.10	May-00	715
Chevron	Delo 400 Synth.	S	CI-4/SJ	175	-45	449	-	2.90	13.00	12.5	-	1360	1510	3150 @ -25	1.50	Sep-02	713
Chevron	Delo 400 Synth.	S	CH-4/SJ	175	-45	449	-	2.90	13.00	11.3	-	1360	1510	3150 @ -25	1.34	Sep-00	711
Citgo	Syndurance	B	CI-4/SL	151	-31	460	-	4.20	13.00	11.0	-	-	-	5500 @ -30	1.60	Sep-02	709
Havoline	Synthetic	S	SL/CF	158	-60	432	-	2.90	8.00	8.8	-	980	1030	5000 @ -30	1.20	Sep-02	702
Valvoline	SynPower	S	SJ/CF	159	-44	460	-	2.90	13.00	9.0	-	1100	-	3300 @ -25	1.10	Apr-02	700
Valvoline	SynPower	S	SJ/CF	159	-44	460	-	2.90	13.00	9.0	-	1100	-	3300 @ -25	1.10	Mar-03	700
Citgo	Syndurance	B	CI-4/SL	158	-33	435	-	4.20	13.00	11.5	-	-	-	6250 @ -30	-	Dec-02	694
Quaker State	European Synthetic	S	SL/CF	163	-38	440	-	3.90	13.00	5.0	-	-	-	6600 @ -30	-	Aug-02	690
Chevron	Supreme Syn.	S	SL/CF	158	-60	432	-	2.90	13.00	8.8	-	980	1030	5000 @ -30	1.20	Oct-02	687
Pennzoil	European Synthetic	S	SL/CF	163	-38	435	-	3.90	13.00	5.0	-	-	-	6600 @ -30	-	Apr-02	685
Mobil	Delvac 1	S	CI-4/SL	151	-49	439	-	2.90	13.00	12.0	-	-	-	6600 @ -30	1.35	Mar-03	682
Mobil	**Delvac 1**	**S**	**CI-4/SL**	**151**	**-49**	**439**	**-**	**2.90**	**13.00**	**12.0**	**-**	**-**	**-**	**6600 @ -30**	**1.35**	**Jun-03**	**682**
Spectro	SPL Race	S	SH/CD	155	-40	457	-	2.90	13.00	5.0	0.65'	-	-	-	-	?	681
Spectro	Supreme Syn.	S	SH	155	-40	457	-	2.90	13.00	5.0	-	-	-	-	-	?	681
Castrol	Syntec	S	SL/CF	175	-27	405	430	4.50	13.00	5.0	-	900	1000	3300 @ -25	-	Jun-02	668
Spectro	Golden Motor-Guard	B	SH	188	-40	410	-	2.90	13.00	5.0	-	-	-	-	-	?	667
Shell	Helix Ultra	S	SL/CF	187	-44	403	-	2.90	13.00	5.0	-	-	-	-	-	Dec-02	663
Torco	MPZ Racing	S	SL/SJ	177	-40	412	435	2.90	13.00	5.2	-	-	-	3000 @ -25	-	2001	658
Spectro	Golden Spectro4	B	SH	155	-40	419	-	2.90	13.00	5.0	-	-	-	-	-	?	643
Mobil	Delvac 1	S	CI-4/SL	-	-49	439	-	2.90	13.00	12.0	-	-	-	6100 @ -30	1.35	Nov-02	531
Valvoline	Prem. Blue Extreme	S	CI-4/SL	169	-38	-	-	4.07	13.00	12.0	-	-	-	6300 @ -30	1.60	May-02	273

10w40																	RANKING
Brand	Product	P/S/B	API	VI	PP	FP	FRP	HT/HS	Noack	TBN	4 Ball	Phos	Zinc	CCS	Ash	Rev.	SCORE
AMSOIL	High Performance	S	SJ/CI-4	183	-54	450	-	3.93	7.00	12.0	0.40'	-	-	2614 @ -20	~1.0	Jan-02	769
AMSOIL	High Performance	S	SH/CF	173	-54	450	-	4.20	6.60	12.0	0.40'	1150	1270	4500 @ -25	~1.0	Aug-01	765
AMSOIL	Motorcycle	S	SH/CF	173	-54	450	-	4.20	6.60	12.0	0.40'	1150	1270	4500 @ -25	~1.0	Aug-01	765
AMSOIL	Motorcycle	S	SJ/CI-4	173	-54	450	-	4.20	6.60	12.0	0.40'	1150	1270	4500 @ -25	~1.0	Sep-02	765
AMSOIL	XL7500	S	SL	178	-44	450	478	3.80	5.60	10.2	0.38'	-	-	4951 @ -25	-	Apr-03	752
Red Line	Passenger	S	SJ/CF	159	-45	495	-	2.90	6.00	5.0	-	-	-	3300 @ -20	-	May-00	749
Mobil 1	MX4T Motorcycle	S	SH/CF	164	-65	487	-	2.90	13.00	5.0	-	-	-	2900 @ -20	-	Apr-03	745
Mobil 1	**MX4T Motorcycle**	**S**	**SH/CF**	**164**	**-65**	**487**	**-**	**2.90**	**13.00**	**5.0**	**-**	**-**	**-**	**2900 @ -20**	**-**	**Jun-03**	**745**
Neo	Neo	S	SJ	185	-49	470	-	2.90	13.00	8.0	-	-	-	2900 @ -20	0.64	?	739
76 Lubricants	Nascar Synthetic	S	SJ/CF	146	-58	480	-	3.20	13.00	9.0	-	900	1280	3720 @ -25	1.10	Jul-01	727
Valvoline	HP Syn	S	SH/CD	155	-40	480	-	4.00	13.00	5.0	-	1200	1200	3150 @ -20	-	Jul-98	726
Valvoline	VR-1 Racing Syn	S	SH/CD	155	-40	480	-	4.00	13.00	5.0	-	1200	1200	3150 @ -20	-	Jul-98	726
Petro Canada	Duron XL Blend	B	CH-4/SL	158	-44	459	-	4.10	13.00	9.1	-	-	-	4943 @ -25	1.20	Aug-02	722
Torco	MPZ Motorcycle	S	SG/SH	180	-40	446	491	2.90	13.00	5.2	-	-	-	1750 @ -20	-	2001	695
76 Lubricants	4T Motorcycle	P	SG/CD	157	-35	450	-	3.90	13.00	7.1	-	-	1380	5060 @ -25	0.98	Jul-01	695
76 Lubricants	Nascar HP	P	SJ	153	-40	440	-	3.90	13.00	5.5	-	-	1360	5400 @-25	0.76	Jul-01	683
Valvoline	Durablend	B	SL/CD	155	-38	453	-	2.90	13.00	8.1	-	960	-	5700 @ -25	1.00	Apr-02	681
Castrol	Syntec	S	SL/CF	148	-27	450	450	3.80	13.00	5.0	-	900	1000	7000 @ -25	-	Jun-02	672
Petro Canada	Blend PCMO	B	SL	155	-38	444	-	2.90	13.00	6.6	-	900	-	5000 @ -25	0.80	Mar-02	669
Havoline	Petroleum	P	SL/SJ	148	-29	453	-	2.90	13.00	7.6	-	940	1030	6400 @ -25	0.90	Mar-03	664
Havoline	**Petroleum**	**P**	**SL/SJ**	**148**	**-29**	**453**	**-**	**2.90**	**13.00**	**7.6**	**-**	**940**	**1030**	**6400 @ -25**	**0.90**	**Jun-03**	**664**
HD-Plus	Syn-Guard	S	CH-4/SJ	146	-36	439	495	2.90	13.00	12.0	-	-	-	7000 @ -25	1.00	Jul-00	664
Chevron	Supreme	P	SL/SJ	148	-29	453	-	2.90	13.00	7.4	-	940	1030	6400 @ -25	0.90	Mar-03	664
Chevron	**Supreme**	**P**	**SL/SJ**	**148**	**-29**	**453**	**-**	**2.90**	**13.00**	**7.4**	**-**	**940**	**1030**	**6400 @ -25**	**0.90**	**Jun-03**	**664**
Exxon	Superflo	P	SL/SJ	147	-27	439	-	3.90	13.00	5.0	-	-	-	6400 @ -25	-	Oct-01	662
Exxon	Superflo	P	SL/SJ	147	-27	442	-	3.70	13.00	5.0	-	-	-	7000 @ -25	0.74	Mar-03	661
Q. State	4x4 Blend	B	SL	157	-25	450	478	2.90	13.00	5.0	-	-	-	7000 @ -25	-	May-02	661
Petro Canada	Max MultiGrade	P	SL	152	-27	444	-	2.90	13.00	6.6	-	-	-	5760 @ -25	0.80	Feb-02	655
Torco	T-4R Motorcycle	B	SG/SH	162	-22	437	471	2.90	13.00	5.2	-	-	-	2650 @ -20	-	2001	650
Petro Canada	Supreme MultiGrade	P	SL	154	-22	441	-	2.90	13.00	6.8	-	-	-	5330 @ -25	0.80	Mar-02	650
76 Lubricants	Super	P	SL	147	-33	420	-	3.80	13.00	6.2	-	-	990	5950 @ -25	0.80	Jul-01	649
Shell	FormulaShell	P	SL/SJ	152	-36	430	-	2.90	13.00	6.1	-	-	1110	6010 @ -25	0.96	2001 ?	649
Shell	FormulaShell	P	SL/SJ	151	-36	430	-	2.90	13.00	6.1	-	-	1110	6010 @ -25	0.96	Dec-02	648
BG	Shear Power	B	-	152	-30	432	-	2.90	13.00	6.6	-	-	-	5610 @ -25	-	Jun-03	646
Citgo	SuperGard	P	SL	148	-	455	-	3.60	13.00	5.0	-	-	-	6530 @ -25	-	Jul-00	646
Citgo	SuperGard	P	SL	148	-	455	-	3.60	13.00	5.0	-	-	-	6530 @ -25	-	Dec-02	646
Pennzoil	Multigrade	P	SL/SJ	153	-33	415	-	3.70	13.00	5.0	-	-	-	7000 @ -25	-	May-02	646
Pennzoil	Multigrade	P	SL/SJ	153	-33	415	-	3.70	13.00	5.0	-	-	-	7000 @ -25	-	Nov-02	646
Q. State	4x4 Blend	B	SJ/SH	142	-25	450	478	2.90	13.00	5.0	-	-	-	7000 @ -25	-	Feb-01	646

Superior Lub.	PCMO	P	SJ	175	-33	407	-	2.90	13.00	5.0	-	-	-	3200 @ -20	0.80	?	644
Royal Purple	RP	S	CF/SJ	149	-49	400	435	2.90	13.00	13.0	-	-	-	7000 @ -25	-	?	643
Mobil	Drive Clean Plus	B	SL/CF	150	-22	440	-	2.90	13.00	5.0	-	-	-	6270 @ -25	-	Apr-03	641
Mobil	**Drive Clean Plus**	**B**	**SL/CF**	**150**	**-22**	**440**	**-**	**2.90**	**13.00**	**5.0**	**-**	**-**	**-**	**6270 @ -25**	**-**	**Jun-03**	**641**
Q. State	Motorcycle	P	SJ/SH	152	-30	430	450	2.90	13.00	5.0	-	-	-	7000 @ -25	-	Jun-00	641
Walmart	**SuperTech**	**P**	**SL/SJ**	**152**	**-30**	**430**	**450**	**2.90**	**13.00**	**5.0**	**-**	**-**	**-**	**3500 @ -20**	**-**	**Sep-01**	**641**
76 Lubricants	Nascar HP	P	SL	147	-27	420	-	3.60	13.00	6.8	-	-	1120	6000 @ -25	0.88	Jul-02	641
Conoco	Hydroclear Super	P	SL/SJ	150	-40	421	-	2.90	13.00	5.0	-	-	-	6200 @ -25	-	Nov-01	640
Q. State	High Mileage	P	SJ/SH	159	-22	430	-	2.90	13.00	5.0	-	-	-	7000 @ -25	-	Sep-01	640
Valvoline	ATV 4-Stroke	P	SJ	160	-27	420	-	2.90	13.00	7.0	-	900	1050	6000 @ -25	0.80	Apr-02	640
Valvoline	4-Stroke Motorcycle	P	SJ	155	-27	421	-	2.90	13.00	7.9	-	1090	1200	6200 @ -25	0.70	Apr-03	638
Kendall	GT-1	P	SL/SJ	146	-26	419	-	3.60	13.00	6.2	-	-	1000	6700 @ -25	0.80	Mar-02	636
Castrol	Syntec Blend	B	SL/SJ	152	-22	415	415	3.80	13.00	5.0	-	1000	1100	7000 @ -25	-	Jun-02	636
Castrol	HIGH MILEAGE	P	SL/SJ	155	-22	415	415	3.50	13.00	5.0	-	1000	1100	7000 @ -25	-	Jun-02	633
Castrol	GTX	P	SL/SJ	150	-22	415	445	3.70	13.00	5.0	-	1000	1100	7000 @ -25	-	2001 ?	632
Castrol	GTX	P	SL/SJ	153	-22	405	430	4.00	13.00	5.0	-	1300	1400	3100 @ -20	1.06	2001 ?	631
TropArtic	Conventional	P	SL	145	-33	424	-	2.90	13.00	5.0	-	-	-	5566 @ -25	-	?	631
TropArtic	**Conventional**	**P**	**SL**	**145**	**-33**	**424**	**-**	**2.90**	**13.00**	**5.0**	**-**	**-**	**-**	**5566 @ -25**	**0.80**	**?**	**631**
Torco	MPZ Racing	P	SL/SJ	152	-15	433	453	2.90	13.00	5.2	-	-	-	2550 @ -20	-	2001	629
Q. State	Multigrade	P	SL/SJ	148	-22	430	450	2.90	13.00	5.0	-	-	-	7000 @ -25	-	Oct-01	629
Q. State	Peak Performance	P	SL/SJ	148	-22	430	450	2.90	13.00	5.0	-	-	-	7000 @ -25	-	Jan-02	629
Valvoline	All Climate	P	SL/SJ	148	-27	421	-	2.90	13.00	7.0	-	900	1050	6200 @ -25	0.80	Apr-02	629
BG	Shear Power	B	-	156	-40	402	-	2.90	13.00	5.9	-	-	-	3992 @ -25	-	Dec-02	629
Wolf's Head	Super Duty	P	SL/SJ	152	-17	430	-	2.90	13.00	5.0	-	-	-	3300 @ -25	<.9	Oct-01	628
Spectro	Golden Motor-Guard	B	SH	161	-17	421	-	2.90	13.00	5.0	-	-	-	7000 @ -25	-	?	627
Spectro	Golden Spectro4	B	SH	161	-17	421	-	2.90	13.00	5.0	-	-	-	7000 @ -25	-	?	627
Kendall	Superb 100	P	SJ	145	-29	424	-	2.90	13.00	5.0	-	-	-	5900 @ -25	-	Jun-00	627
Mystik	JT-8 Super HD	P	SL/CF	153	-27	410	-	2.90	15.00	11.0	-	-	-	6500 @ -25	1.30	Dec-02	625
Mystik	**JT-8 Super HD**	**P**	**SL/CF**	**153**	**-27**	**410**	**-**	**2.90**	**15.00**	**11.0**	**-**	**-**	**-**	**6500 @ -25**	**1.30**	**Aug-03**	**625**
Spectro	Spectro4	P	SH	155	-20	421	-	2.90	13.00	5.0	-	-	-	7000 @ -25	-	?	625
Citgo	UltraLife	P	SL/SJ	148	-	435	-	3.50	13.00	5.0	-	-	-	6170 @ -25	-	Dec-02	624
Wolf's Head	Super Duty	P	SL/SJ	147	-17	430	-	2.90	13.00	5.0	-	-	-	7000 @ -25	<.9	Jul-02	623
Torco	T-4R Racing	B	SJ/SL	161	-22	410	444	2.90	13.00	5.2	-	-	-	3300 @ -20	-	2001	622
Torco	MPZ Motorcycle	P	SG/SH	135	-18	432	460	2.90	13.00	5.2	-	-	-	2850 @ -20	-	2001	614
Torco	MPZ Motorcycle	P	SG/SH	135	-18	432	460	2.90	13.00	5.2	-	-	-	2850 @ -20	-	2001	614
Schaeffer	Micron Moly	P	SL	150	-	417	445	3.46	11.00	5.5	-	-	-	6884 @ -25	0.86	Jun-02	614
Lubriplate	Super Lo-Hi-Vis	-	SJ/CF	142	-40	390	420	2.90	13.00	5.0	-	-	-	2040 @ -20	-	May-97	601
CAM2	**Magnum Special**	**P**	**SC**	**145**	**-**	**425**	**-**	**2.90**	**13.00**	**5.0**	**-**	**-**	**-**	**7000 @ -25**	**-**	**?**	**599**
Mobil	Drive Clean	P	SL/SJ	147	-27	392	-	2.90	13.00	5.0	-	-	-	6100 @ -25	-	Apr-03	595
Mobil	**Drive Clean**	**P**	**SL/SJ**	**147**	**-27**	**392**	**-**	**2.90**	**13.00**	**5.0**	**-**	**-**	**-**	**6100 @ -25**	**-**	**Apr-03**	**595**
Royal Purple	Multi-Grade	S	SJ/CF	149	-	400	435	2.90	13.00	5.0	-	-	-	7000 @ -25	-	?	578
Valvoline	Maxlife	P	SL/SJ	-	-33	468	-	2.90	13.00	8.0	-	950	1080	7000 @ -25	-	Apr-02	536

Shell	Rotella T Blend	B	CH-4/SJ	-	-30	430	-	2.90	13.00	12.2	-	-	-	7000 @ -25	1.50	Dec-02	503
Klotz	MX4 Techniplate	S	SG	-	-30	425	-	2.90	13.00	5.0	-	-	-	7000 @ -25	-	May-02	484
Klotz	American V-Twin	S	SH/CG-4	-	-30	420	-	2.90	13.00	5.0	-	-	-	7000 @ -25	-	?	479
Klotz	Race Techniplate	S	SH/CD	-	-30	415	-	2.90	13.00	5.0	-	-	-	7000 @ -25	-	Dec-00	474
Lyondell	Supreme	P	SJ	-	-26	419	-	2.90	13.00	5.0	-	-	-	3300 @ -20	-	Dec-00	474
Shell	Rotella SB	B	CH-4/SJ	-	-30	405	-	2.90	13.00	9.5	-	-	-	7000 @ -25	1.30	?	473
Pennzoil	Motorcycle	P	SH/SG	151	-31	-	-	3.65	13.00	5.0	-	-	-	3300 @ -20	-	Apr-99	226
Pennzoil	High Mileage	P	SL/SJ	149	-22	-	-	3.93	13.00	5.0	-	-	-	7000 @ -25	-	Dec-02	221
CAM2	**Earth Friendly**	**P**	**SJ/SH**	**145**	**-30**	**-**	**-**	**2.90**	**13.00**	**5.0**	**-**	**-**	**-**	**7000 @ -25**	**0.60**	**Apr-97**	**204**
CAM2	**Magnum HD**	**P**	**SL/SJ**	**145**	**-30**	**-**	**-**	**2.90**	**13.00**	**5.0**	**-**	**-**	**-**	**7000 @ -25**	**0.60**	**Aug-02**	**204**
CAM2	**Magnum Plus**	**P**	**SL/SJ**	**145**	**-30**	**-**	**-**	**2.90**	**13.00**	**5.0**	**-**	**-**	**-**	**7000 @ -25**	**0.60**	**Apr-97**	**204**
CAM2	**Magnum XHD**	**P**	**SL/SJ**	**145**	**-30**	**-**	**-**	**2.90**	**13.00**	**5.0**	**-**	**-**	**-**	**7000 @ -25**	**0.60**	**Aug-02**	**204**
CAM2	**SuperPro**	**P**	**SL/SJ**	**145**	**-30**	**-**	**-**	**2.90**	**13.00**	**5.0**	**-**	**-**	**-**	**7000 @ -25**	**-**	**Oct-02**	**204**

15w40																	**RANKING**
Brand	**Product**	**P/S/B**	**API**	**VI**	**PP**	**FP**	**FRP**	**HT/HS**	**Noack**	**TBN**	**4 Ball**	**Phos**	**Zinc**	**CCS**	**Ash**	**Rev.**	**SCORE**
Red Line	40 Wt Race ONLY	S	-	146	-49	527	-	3.70	6.00	5.0	-	-	-	3300 @ -15	-	Apr-99	788
Neo	Neo	S	CF-4/SG	180	-50	470	520	4.70	13.00	10.5	-	-	-	3300 @ -15	1.12	?	776
Red Line	Passenger	S	SJ/CH-4	155	-45	495	-	3.70	6.00	5.0	-	-	-	2500 @ -15	-	May-00	761
AMSOIL	Diesel/Marine	S	CI-4/SJ	164	-47	453	-	4.10	6.70	12.0	0.35"	-	-	3600 @ -20	~1.5	Oct-01	750
AMSOIL	Diesel/Marine	S	CI-4/SJ	164	-47	453	-	4.10	6.70	12.0	0.35"	-	-	3600 @ -20	-	Oct-02	750
Precision	102P	P	CI-4/SL	140	-20	525	-	3.70	13.00	12.0	-	-	-	7000 @ -20	-	Jan-03	744
76 Lubricants	Royal Triton QLT	B	CH-4	148	-38	445	-	4.40	13.00	11.8	-	-	1300	3850 @ -20	1.50	Jul-01	704
76 Lubricants	Royal Triton QLT	B	CI-4	146	-38	445	-	4.30	13.00	13.1	-	-	1270	4070 @ -20	1.65	Sep-02	702
Lubriplate	Super GPO	-	CG-4/SJ	141	-35	465	520	3.70	13.00	13.0	-	-	-	5122 @ -20	-	Mar-02	702
Petro Canada	Duron XL Blend	B	CI-4/SL	148	-38	448	-	4.20	13.00	10.0	-	-	-	4147 @ -20	1.40	Aug-02	699
76 Lubricants	Triton QLT	P	CH-4/SJ	137	-38	450	-	4.40	13.00	11.8	-	-	1300	6250 @ -20	1.50	Jul-01	698
Petro Canada	Duron HD	B	CI-4/SL	145	-38	448	-	4.30	13.00	9.1	-	-	-	4446 @ -20	1.20	Aug-02	696
Texaco	Ursa Premium TDX	P	CI-4/SL	138	-38	460	-	3.70	13.00	11.6	-	1390	1510	6400 @ -20	1.50	Oct-02	694
AMSOIL	Blend	B	CH-4/SJ	146	-32	446	-	3.70	9.30	12.0	0.38"	-	-	2560 @ -15	~1.5	Apr-01	694
AMSOIL	Blend	B	CI-4/SJ	146	-32	446	-	3.70	9.30	12.0	0.38"	-	-	2560 @ -15	~1.5	Apr-01	694
Chevron	RPM Heavy Duty	P	CI-4/SL	140	-38	460	-	3.70	13.00	10.5	-	1270	1370	6400 @ -20	1.37	Sep-02	694
Chevron	RPM Heavy Duty	P	CI-4/SL	140	-38	460	-	3.70	13.00	10.5	-	1270	1370	6400 @ -20	1.37	Jun-03	694
Texaco	Ursa Super Plus	P	CI-4/SL	140	-38	460	-	3.70	13.00	10.5	-	1270	1370	6400 @ -20	1.37	Jul-02	694
Texaco	Ursa Super Plus	P	CI-4/SL	140	-38	460	-	3.70	13.00	10.5	-	1270	1370	6400 @ -20	1.37	Jun-03	694
Pennzoil	LongLife HD	P	CH-4/SJ	145	-27	450	-	4.30	13.00	11.0	-	-	-	7000 @ -20	1.35	May-01	691
HD-Plus	Syn-Guard	S	CH-4/SJ	147	-32	450	478	3.70	13.00	12.0	-	-	-	7000 @ -20	1.00	Jul-00	688
76 Lubricants	T5X HD Multi.	P	CI-4/SL	136	-27	465	-	3.90	13.00	10.1	-	-	1330	6425 @ -20	1.10	Aug-02	687
Exxon	XD3 Elite	B	CH-4/SJ	138	-38	441	-	4.34	13.00	10.0	-	-	-	7000 @ -20	1.00	Oct-99	685
Mobil	Delvac 1300 Super	P	CI-4/SL	140	-27	446	-	4.30	13.00	12.0	-	-	-	6000 @ -20	1.30	Mar-03	684
Mobil	**Delvac 1300 Super**	**P**	**CI-4/SL**	**140**	**-27**	**446**	**-**	**4.30**	**13.00**	**12.0**	**-**	**-**	**-**	**7000 @ -20**	**1.30**	**Jun-03**	**684**

76 Lubricants	Guardol QLT	P	CH-4/SH	141	-33	440	-	4.40	13.00	10.1	-	-	1300	5250 @ -20	1.30	Jul-01	683
Schaeffer	**Supreme 7000**	**B**	**CI-4/SL**	**145**	**-**	**457**	**495**	**4.30**	**10.80**	**12.0**	**-**	**-**	**-**	**2804 @ -20**	**1.50**	**Jun-03**	**680**
CAM2	**Super HD Prem Plus**	**P**	**CI-4/SL**	**146**	**-26**	**448**	**-**	**3.70**	**13.00**	**12.0**	**-**	**-**	**-**	**7000 @ -20**	**1.38**	**?**	**679**
Chevron	Delo 400	P	CI-4/SL	134	-38	446	-	3.70	13.00	12.5	-	1360	1510	6400 @ -20	1.50	Nov-02	678
Citgo	Citgard 600	P	CI-4/SL	134	-17	449	-	4.30	11.00	12.0	-	-	-	6700 @ -20	1.60	Dec-02	677
Phillips 66	Super HD 3000	B	CH-4/SJ	138	-38	446	-	3.70	13.00	10.0	-	-	-	3000 @ -15	1.00	?	677
Valvoline	Durablend	B	SL/CD	136	-27	450	-	3.70	8.92	8.1	-	960	-	5700 @ -20	1.00	Apr-02	676
Citgo	**Citgard 600**	**P**	**CI-4/SL**	**134**	**-17**	**449**	**-**	**4.30**	**11.00**	**11.5**	**-**	**-**	**-**	**6700 @ -20**	**1.47**	**Aug-03**	**676**
Kendall	Super-D 3	P	CI-4/SL	139	-27	439	-	4.20	13.00	13.0	-	-	1300	6520 @ -20	1.50	Sep-02	676
Chevron	Delo 400	P	CH-4/SL	134	-38	446	-	3.70	13.00	11.3	-	1360	1510	3150 @ -15	1.34	Oct-01	676
Chevron	**Delo 400**	**P**	**CI-4/SL**	**134**	**-38**	**446**	**-**	**3.70**	**13.00**	**11.3**	**-**	**1280**	**1510**	**6400 @ -20**	**1.35**	**Jun-03**	**676**
Schaeffer	Supreme 7000	B	CI-4/SL	145	-	457	495	4.30	10.80	10.0	-	-	-	2804 @ -20	1.35	Jun-02	676
76 Lubricants	Firebird HD	P	CH-4/SJ	142	-31	435	-	4.40	13.00	9.2	-	-	1270	5850 @ -20	1.20	Jul-01	675
Pennzoil	LongLife HD	P	CI-4/SL	136	-33	435	-	4.30	13.00	12.0	-	-	-	6400 @ -20	1.50	Jul-02	675
76 Lubricants	Guardol QLT	P	CI-4/SL	137	-22	440	-	4.40	13.00	12.0	-	-	1270	6600 @ -20	1.50	Sep-02	672
Citgo	Citgard 500	P	CI-4/SL	132	-17	446	-	4.40	11.00	11.0	-	-	-	6600 @ -20	1.50	Dec-02	672
Citgo	**Citgard 500**	**P**	**CI-4/SL**	**132**	**-17**	**446**	**-**	**4.40**	**11.00**	**11.0**	**-**	**-**	**-**	**6600 @ -20**	**1.40**	**Aug-03**	**672**
Exxon	**XD3 Extra**	**P**	**CI-4/SL**	**139**	**-27**	**446**	**-**	**3.70**	**13.00**	**12.0**	**-**	**-**	**-**	**7000 @ -20**	**1.60**	**Mar-03**	**671**
Mystik	SX-8 Blend	B	CI-4/SL	138	-33	435	-	3.70	12.00	12.6	-	-	-	6550 @ -20	1.70	Sep-02	669
Mystik	SX-8 Blend	B	CI-4/SL	138	-33	435	-	3.70	12.00	12.6	-	-	-	6550 @ -20	1.70	Dec-02	669
Exxon	**XD3 Elite**	**B**	**CI-4/SL**	**141**	**-22**	**446**	**-**	**3.70**	**13.00**	**12.5**	**-**	**-**	**-**	**7000 @ -20**	**1.30**	**Mar-03**	**669**
Shell	Rimula Premium	P	CI-4/SL	139	-30	445	-	3.70	13.00	10.0	-	-	-	7000 @ -20	1.20	Dec-02	669
Pure Power	Pure Power	P	CH-4/SJ	140	-27	440	-	3.70	13.00	13.1	0.40""	-	-	7000 @ -20	0.92	Nov-98	668
Kendall	SHP Diesel	B	CI-4	132	-27	430	-	4.50	13.00	14.0	-	-	1300	6800 @ -20	1.65	Sep-02	668
TropArtic	Racing Blend	B	SJ/CD	138	-38	446	-	3.70	13.00	5.0	-	-	-	3000 @ -15	-	?	667
76 Lubricants	T5X HD Multi.	P	CI-4/SL	137	-24	440	-	4.10	13.00	9.3	-	-	1280	6400 @ -20	1.20	Aug-02	663
Phillips 66	HDS	P	CH-4/SJ	137	-38	432	-	3.70	13.00	10.0	-	-	-	2900 @ -15	1.00	?	662
Chevron	ECO	P	CH-4/SJ	151	-20	439	-	3.70	13.00	8.0	-	1000	1100	2800 @ -15	1.20	Aug-00	661
Phillips 66	Super HD II	P	CI-4/SL	136	-27	440	-	3.70	13.00	10.6	-	-	-	6750 @ -20	1.30	?	659
Kendall	Super-D 3	P	CH-4/SJ	140	-27	435	-	3.70	13.00	11.0	-	-	-	3100 @ -15	1.30	Mar-00	659
Kendall	SHP Diesel	B	CH-4/SJ	142	-33	421	-	3.70	13.00	13.0	-	-	-	3150 @ -15	1.50	Mar-00	657
Mystik	Power Lubricants	P	CI-4/SL	132	-17	446	-	3.70	12.00	11.0	-	-	-	6600 @ -20	1.50	Sep-02	655
Mystik	Power Lubricants	P	CI-4/SL	132	-17	446	-	3.70	12.00	11.0	-	-	-	6600 @ -20	1.50	Dec-02	655
Conoco	HD Fleet Supreme	P	CI-4/SL	125	-22	450	-	3.70	13.00	10.4	-	-	-	7000 @ -25	1.40	Aug-02	653
Mystik	JT-8 Super HD	P	CI-4/SL	136	-17	435	-	3.70	12.00	13.0	-	-	-	6550 @ -20	1.70	Dec-02	652
Exxon	**XD3**	**P**	**CI-4/SL**	**138**	**-27**	**430**	**-**	**3.70**	**13.00**	**10.0**	**-**	**-**	**-**	**7000 @ -20**	**1.10**	**Mar-03**	**650**
Mystik	**JT-8 Super HD**	**P**	**CI-4/SL**	**136**	**-17**	**435**	**-**	**3.70**	**12.00**	**12.0**	**-**	**-**	**-**	**6550 @ -20**	**1.50**	**Aug-03**	**650**
Q. State	FCI HDX Plus	P	CH-4/SJ	140	-25	410	-	4.50	13.00	12.0	-	-	-	3500 @ -15	1.20	Feb-01	650
BG	Extra Duty	P	CI-4/SL	138	-30	424	-	3.70	13.00	11.0	-	-	-	6392 @ -20	1.35	Jun-03	649
Schaeffer	**Moly Bond X-200**	**P**	**CI-4/SL**	**140**	**-**	**442**	**485**	**4.08**	**13.00**	**12.0**	**-**	**-**	**-**	**2791 @ -20**	**1.50**	**Jun-03**	**649**
Kendall	GT-1	P	SJ	135	-20	446	-	3.70	13.00	5.0	-	-	-	5700 @ -20	-	Jul-00	646
Schaeffer	Moly Bond X-200	P	CI-4/SL	140	-	442	485	4.08	13.00	10.0	-	-	-	2791 @ -20	1.35	Jun-02	645

Q. State	4x4 Blend	B	SJ/CH-4	145	-25	428	464	3.70	13.00	5.0	-	-	-	7000 @ -20	-	Feb-01	643
Q. State	4x4 Blend	B	SL/CH-4	145	-25	428	464	3.70	13.00	5.0	-	-	-	7000 @ -20	-	May-02	643
Q. State	Special Blend	B	CG-4	138	-30	428	453	3.70	13.00	5.0	-	-	-	3500 @ -20	-	Aug-01	641
Castrol	RX SHD	P	CH-4/SJ	132	-17	446	470	3.70	13.00	5.0	-	1000	1100	7000 @ -20	1.00	2002 ?	640
Lyondell	Fleet S3 Plus	P	CH-4/SJ	134	-15	440	-	3.70	13.00	8.0	-	-	-	3100 @ -15	0.90	Dec-00	640
Torco	MPZ Super Diesel	P	CH-4/SJ	138	-9	439	484	3.70	13.00	9.0	-	-	-	3100 @ -15	-	2001	639
Wolf's Head	Special Duty	P	CH-4/SJ	140	-25	410	-	4.00	13.00	9.2	-	-	-	7000 @ -20	<1.0	Sep-01	634
BG	Shear Power HD	B	-	140	-31	406	-	3.70	13.00	10.3	-	-	-	4403 @ -10	-	Dec-02	633
BG	Shear Power HD	B	-	140	-31	406	-	3.70	13.00	10.3	-	-	-	4403 @ -10	1.25	Jun-03	633
Shell	Rotella T MG	P	CH-4/SL	146	-15	415	-	3.70	13.00	10.2	-	-	-	7000 @ -20	1.35	2001 ?	631
Shell	Rotella T MG	P	CI-4/SL	141	-15	415	-	3.70	13.00	11.5	-	-	-	7000 @ -20	1.47	Dec-02	629
Castrol	Syntec Blend Trk.	B	CH-4/SL	139	-27	410	430	4.00	13.00	5.0	-	1000	1100	3200 @ -15	1.00	2001 ?	627
LE	Monolec Ultra	P	CH-4/SJ	130	-27	415	-	3.70	13.00	10.0	-	-	-	3500 @ -15	1.00	?	627
BG	Extra Duty	P	-	140	-25	405	-	3.70	13.00	10.0	-	-	-	2725 @ -15	1.03	Dec-00	625
Exxon	Superflo Diesel	P	CH-4/SJ	139	-22	419	-	3.70	13.00	5.0	-	-	-	7000 @ -20	-	Oct-99	625
Q. State	Universal HDX	P	CI-4/SL	137	-22	410	-	3.70	13.00	10.0	-	-	-	7000 @ -20	1.20	Aug-02	624
Superior Lub.	HD	P	CG-4-SJ	137	-25	410	-	3.70	13.00	8.0	-	-	-	3300 @ -15	0.95	?	623
Q. State	FCI HDX	P	CH-4/SJ	137	-20	410	433	3.70	13.00	9.2	-	-	-	3500 @ -15	-	Sep-02	620
Royal Purple	Multi-Grade	S	SJ/CH-4	140	-	435	470	3.70	13.00	5.0	-	-	-	7000 @ -20	-	?	620
Conoco	Hydroclear Power D	P	CI-4/SL	126	-22	376	-	3.70	13.00	12.0	-	-	-	7000 @ --20	1.60	Aug-02	583
Mobil	Delvac 1200 Super	P	CH-4/SJ	-	-33	439	-	4.40	13.00	8.1	-	-	-	2200 @ -15	0.90	Apr-01	537
Torco	MPZ Syn. Diesel	S	CH-4/SJ	-	-15	428	446	3.70	13.00	9.0	-	-	-	3000 @ -15	-	2001	496
Neo	Street	?	SJ/CG-4	-	-20	420	-	3.70	13.00	8.5	-	-	1200	3500 @ -15	1.00	?	492
Spectro	Diesel Guard	P	CG-4/SH	-	-15	360	-	3.70	13.00	7.8	-	-	-	7000 @ -20	0.83	?	426
Valvoline	Prem. Blue 2000	B	CH-4/SJ	137	-27	-	-	4.30	13.00	12.0	-	-	-	6000 @ -20	1.60	Feb-02	235
Exxon	XD3 Extra	P	CI-4/SL	138	-27	-	-	4.30	13.00	11.0	-	-	-	7000 @ -20	1.60	Dec-02	234
Exxon	XD3	P	CI-4/SL	138	-27	-	-	4.30	13.00	10.0	-	-	-	7000 @ -20	1.20	Nov-02	232
Valvoline	Prem. Blue	P	CI-4/SL	135	-22	-	-	4.23	11.22	12.0	-	-	-	6600 @ -20	1.60	Aug-02	232
Valvoline	All Fleet Extra	P	CI-4/SL	133	-22	-	-	4.20	13.00	11.0	-	-	1600	6600 @ -20	1.50	Jul-02	222
Valvoline	All Fleet Extra	P	CI-4/SL	133	-22	-	-	4.20	13.00	11.0	-	-	1600	6600 @ -20	1.50	Feb-03	222
Valvoline	All Fleet Super	P	CD	135	-17	-	-	3.70	13.00	14.0	-	-	1200	6600 @ -20	1.80	Sep-01	215
Valvoline	All Climate	P	CH-4/SJ	136	-17	-	-	4.00	13.00	10.1	-	-	1600	7000 @ -20	1.30	Jul-01	214
Valvoline	All Fleet Plus	P	CI-4/SL	131	-17	-	-	4.10	13.00	10.3	-	-	1600	6600 @ -20	1.40	Jul-02	212
Valvoline	All Fleet Plus	P	CI-4/SL	131	-17	-	-	4.10	13.00	10.3	-	-	1600	6600 @ -20	1.40	Feb-03	212
Pennzoil	Synthetic Blend	B	CH-4/SJ	135	-17	-	-	4.10	13.00	5.0	-	-	-	7000 @ -20	-	Jan-02	205
20w40																	**RANKING**
Brand	**Product**	**P/S/B**	**API**	**VI**	**PP**	**FP**	**FRP**	**HT/HS**	**Noack**	**TBN**	**4 Ball**	**Phos**	**Zinc**	**CCS**	**Ash**	**Rev.**	**SCORE**
Spectro	Spectro4	P	SH	122	-9	428	-	3.70	13.00	5.0	-	-	-	-	-	?	604

SAE 50																	RANKING
Brand	Product	P/S/B	API	VI	PP	FP	FRP	HT/HS	Noack	TBN	4 Ball	Phos	Zinc	CCS	Ash	Rev.	SCORE
Schaeffer	Moly Pure	S	SG/CE	144	-40	500	560	5.50	13.00	10.0	-	-	-	n/a	1.00	Oct-91	775
76 Lubricants	T5X HD Mono.	P	CF/SJ	112	-20	520	-	5.60	13.00	8.1	-	-	1300	n/a	0.90	Jul-01	741
76 Lubricants	Guardol QLT	P	SL/CF	107	-22	500	-	5.70	13.00	10.5	-	-	1380	n/a	1.37	Sep-02	725
Mobil	Delvac 1350	P	CF/SF	110	0	554	-	3.70	13.00	12.0	-	-	-	n/a	1.40	Mar-03	723
Mobil	**Delvac 1350**	**P**	**CF/SF**	**110**	**0**	**554**	**-**	**3.70**	**13.00**	**12.0**	**-**	**-**	**-**	**n/a**	**1.40**	**Jun-03**	**723**
Mobil	Delvac 1650	P	CF/SF	110	0	554	-	3.70	13.00	12.0	-	-	-	n/a	1.40	May-03	723
Mobil	**Delvac 1650**	**P**	**CF/SF**	**110**	**0**	**554**	**-**	**3.70**	**13.00**	**12.0**	**-**	**-**	**-**	**n/a**	**1.40**	**Jun-03**	**723**
76 Lubricants	Guardol	P	CF/SJ	110	-15	500	-	5.60	13.00	9.2	-	-	1190	n/a	1.20	Jul-01	716
Conoco	HD Fleet	P	CF/CF-2	99	-24	531	-	3.70	13.00	7.1	-	-	-	n/a	1.00	Oct-02	703
Conoco	Hydroclear Power D	P	CF/SH	99	-24	531	-	3.70	13.00	7.1	-	-	-	n/a	1.00	Aug-02	703
Kendall	Super-D 3	P	SL/CF	103	-11	496	-	5.50	13.00	10.5	-	-	1400	n/a	1.40	Sep-02	702
Pennzoil	LongLife HD	P	CF/SL	102	-4	500	-	5.70	13.00	7.0	-	-	-	n/a	<1.0	Jul-02	695
Kendall	GT-1	P	-	98	-6	536	-	3.70	13.00	6.5	-	-	1100	n/a	0.85	Mar-02	688
Precision	102P	P	SJ/CF-4	112	+5	521	-	3.70	13.00	12.0	-	-	-	n/a	-	Jan-03	687
76 Lubricants	T5X HD Mono.	P	CF	103	-11	485	-	5.50	13.00	7.2	-	-	980	n/a	0.88	Sep-02	684
Pennzoil	LongLife HD	P	CF-2/CF	99	+5	500	-	5.50	13.00	7.5	-	-	-	n/a	<1.0	May-01	680
Chevron	RPM Heavy Duty	P	SL/CF	101	-22	500	-	3.70	13.00	7.6	-	1080	1200	n/a	0.85	Sep-02	673
Exxon	**XD3**	**P**	**CF/SF**	**99**	**-17**	**507**	**-**	**3.70**	**13.00**	**7.3**	**-**	**-**	**-**	**n/a**	**0.80**	**Mar-03**	**673**
Chevron	RPM Heavy Duty	P	SL/CF	101	-22	500	-	3.70	13.00	7.2	-	1000	1090	n/a	0.95	Jun-03	672
Chevron	Delo 400	P	CF/SJ	98	-22	498	-	3.70	13.00	8.7	-	1190	1320	n/a	0.96	Aug-00	670
Chevron	Delo 400	P	CF/SJ	98	-24	489	-	3.70	13.00	10.2	-	1160	1270	n/a	1.35	Aug-00	666
Chevron	**Delo 100**	**P**	**CF**	**98**	**-17**	**498**	**-**	**3.70**	**13.00**	**7.0**	**-**	**980**	**1080**	**n/a**	**0.76**	**Sep-00**	**662**
Kendall	Super-D 3	P	SJ/CF	106	+5	496	-	3.70	13.00	10.3	-	-	-	n/a	1.20	Mar-00	653
Citgo	Citgard 500	P	CF/SL	99	+10	475	-	5.50	13.00	8.0	-	-	1040	n/a	1.00	Sep-02	651
Citgo	Citgard 500	P	CF/SL	99	+10	475	-	5.50	13.00	8.0	-	-	-	n/a	1.00	Dec-02	651
Citgo	Citgard 600	P	CF/SL	99	+10	467	-	5.56	13.00	11.0	-	-	1400	n/a	1.50	Sep-02	650
Citgo	Citgard 600	P	CF/SL	99	+10	467	-	5.56	13.00	11.0	-	-	-	n/a	1.50	Dec-02	650
Texaco	Ursa Super Plus	P	SL/CF	101	+9	500	-	3.70	13.00	7.6	-	1080	1200	n/a	0.85	Jul-02	642
Mystik	JT-8 Super HD	P	SL/CF	101	+5	485	-	3.70	13.00	12.0	-	-	-	n/a	1.60	Dec-02	640
Mystik	**JT-8 Super HD**	**P**	**SL/CF**	**101**	**+5**	**485**	**-**	**3.70**	**13.00**	**12.0**	**-**	**-**	**-**	**n/a**	**1.60**	**Aug-03**	**640**
Schaeffer	Micron Moly Racing	P	SJ	102	+20	500	535	4.00	13.00	8.3	-	-	-	n/a	1.00	?	640
Valvoline	VR-1 Racing	P	SJ/CD	105	+16	490	-	3.70	13.00	12.0	-	1140	1200	n/a	1.50	Sep-99	638
Texaco	Ursa	P	CF/CD	98	+8	498	-	3.70	13.00	7.0	-	980	1080	n/a	0.76	Feb-02	637
Mobil	Delvac 1250	P	CF/SH	106	+10	453	-	5.20	13.00	7.8	-	-	-	n/a	0.83	Apr-97	630
LE	Monolec GFS	P	CF/SJ	95	-	475	-	3.70	13.00	10.0	-	-	-	n/a	1.00	?	625
Phillips 66	Super HD II	P	SJ/CF	102	-	471	-	3.70	13.00	8.0	-	-	-	n/a	0.85	?	624
Valvoline	Special Racing	P	-	105	+16	490	-	3.70	13.00	5.0	-	1200	1200	n/a	-	Dec-02	624
Mystik	Power Lubricants	P	SL/CF	99	+10	475	-	3.70	12.00	8.0	-	-	-	n/a	1.00	Sep-02	618
Pennzoil	HD	P	SJ	96	-17	460	-	3.70	13.00	5.0	-	-	-	n/a	-	Jul-01	618

Torco	MPZ Racing	P	SL/SJ	125	+10	455	480	3.70	13.00	5.2	-	-	-	n/a	-	2001	615
Mystik	Power Lubricants	P	SL/CF	99	+10	475	-	3.70	13.00	8.0	-	-	-	n/a	1.00	Dec-02	615
Royal Purple	MonoGrade	S	SJ/CF	108	-	460	515	3.70	13.00	5.0	-	-	-	n/a	-	?	613
Lubriplate	Super HDS	-	SJ/CF	99	-10	455	505	3.70	13.00	5.0	-	-	-	n/a	-	May-97	609
Q. State	FCI HDX Plus	P	CF/SJ	108	+10	445	-	3.70	13.00	12.0	-	-	-	n/a	1.20	Feb-01	602
Synergyn	**Racing Oil**	**S**	**-**	**120**	**-18**	**411**	**-**	**3.70**	**13.00**	**5.0**	**-**	**-**	**-**	**n/a**	**-**	**?**	**594**
Q. State	FCI HDX	P	-	107	+10	445	470	3.70	13.00	5.0	-	-	-	n/a	-	Sep-02	587
Pennzoil	GT Perf. Racing	P	SJ	115	+15	430	-	3.70	13.00	5.0	-	-	-	n/a	0.90	Apr-99	575
Synergyn	Racing Oil	S	-	120	+7	411	-	3.70	13.00	5.0	-	-	-	n/a	-	?	569
Spectro	**HD MCO**	**P**	**-**	**-**	**0**	**510**	**-**	**3.70**	**13.00**	**5.0**	**-**	**-**	**-**	**n/a**	**-**	**?**	**555**
Spectro	HD MCO	P	-	-	+6	510	-	3.70	13.00	5.0	-	-	-	n/a	-	?	549
Shell	Rotella T Mono	P	CF/SH	-	+5	465	-	3.70	13.00	7.3	-	-	-	n/a	1.00	Dec-02	510
Klotz	American V-Twin	S	SH/CG-4	-	-10	400	-	3.70	13.00	5.0	-	-	-	n/a	-	?	455
Exxon	XD3	P	CF	97	-6	-	-	5.20	13.00	7.3	-	-	-	n/a	0.80	Nov-02	183
Valvoline	All Fleet Plus	P	CF-4/SL	113	-	-	-	3.70	13.00	8.0	-	-	1100	n/a	<1.0	Jul-02	164
Valvoline	All Fleet Plus	P	CF-4/SL	113	0	-	-	3.70	13.00	8.0	-	-	1100	n/a	<1.0	Feb-03	164
5w50																	**RANKING**
Brand	**Product**	**P/S/B**	**API**	**VI**	**PP**	**FP**	**FRP**	**HT/HS**	**Noack**	**TBN**	**4 Ball**	**Phos**	**Zinc**	**CCS**	**Ash**	**Rev.**	**SCORE**
Kendall	Elite	S	SJ/CF	179	-44	468	-	4.60	13.00	5.0	-	-	-	3050 @ -25	-	Oct-00	754
Castrol	Syntec	S	SL/CF	180	-38	465	480	4.80	13.00	5.0	0.58'	900	1100	3050 @ -25	0.93	2001 ?	750
CAM2	**Full Synthetic**	**S**	**SJ/SH**	**201**	**-49**	**448**	**-**	**3.70**	**13.00**	**5.0**	**-**	**-**	**-**	**3000 @ -25**	**-**	**?**	**743**
TropArtic	Synthetic	S	SJ	208	-58	428	-	3.70	13.00	5.0	-	-	-	2300 @ -25	0.70	?	739
Castrol	Syntec	S	SL/CF	175	-38	437	450	4.50	13.00	5.0	0.58'	900	1100	6600 @ -30	-	Jun-02	711
Q. State	Synthetic	S	SL/CF	193	-35	425	482	3.70	13.00	5.0	-	-	-	6600 @ -30	-	Oct-02	698
Q. State	Synthetic	S	SJ/CF	177	-35	435	482	3.70	13.00	5.0	-	-	-	3500 @ -25	-	May-01	692
Torco	MPZ Racing	S	SL/SJ	175	-38	415	442	3.70	13.00	5.2	-	-	-	3300 @ -25	-	2001	673
Synergyn	Racing Oil	S	-	162	-36	410	-	3.70	13.00	5.0	-	-	-	-	-	?	653
Pennzoil	Synthetic	S	SL	194	-58	-	-	4.29	13.00	5.0	-	-	-	6600 @ -30	-	Jan-03	309
Pennzoil	Synthetic	S	SJ	176	-50	-	-	4.45	8.10	5.0	-	-	-	3300 @ -25	-	May-00	301
Exxon	Superflo Syn.	S	SJ	162	-54	-	-	4.70	13.00	5.0	-	-	-	2510 @ -25	-	Oct-99	281
10w50																	**RANKING**
Brand	**Product**	**P/S/B**	**API**	**VI**	**PP**	**FP**	**FRP**	**HT/HS**	**Noack**	**TBN**	**4 Ball**	**Phos**	**Zinc**	**CCS**	**Ash**	**Rev.**	**SCORE**
Spectro	SPL Race	S	SH/CD	136	-33	473	-	3.70	13.00	5.0	-	-	-	-	-	?	687
Spectro	Supreme Syn	S	SH	136	-33	473	-	3.70	13.00	5.0	-	-	-	-	-	?	687
Kendall	GT-1 Synthetic Blend	B	SL/SJ	155	-29	442	-	3.90	13.00	8.0	-	-	1300	6800 @ -25	1.00	Mar-02	681
Kendall	Victory	B	SJ	158	-33	432	-	3.70	13.00	5.0	-	-	-	6350 @ -25	1.00	Aug-00	668

15w50																	RANKING
Brand	**Product**	**P/S/B**	**API**	**VI**	**PP**	**FP**	**FRP**	**HT/HS**	**Noack**	**TBN**	**4 Ball**	**Phos**	**Zinc**	**CCS**	**Ash**	**Rev.**	**SCORE**
Red Line	50 Wt Race ONLY	S	-	146	-49	522	-	3.70	6.00	5.0	-	-	-	3400 @ -15	-	Apr-99	783
Red Line	Passenger	S	SJ/CF	160	-49	503	-	3.70	5.00	5.0	-	-	-	3200 @ -15	-	May-00	781
Kendall	Elite	S	SJ/CF	152	-54	493	-	5.10	13.00	5.0	-	-	-	3120 @ -15	-	Oct-00	772
Precision	102P	P	CI-4/SL	135	-20	532	-	3.70	13.00	12.0	-	-	-	-	-	Jan-03	746
Valvoline	SynPower	S	SL/CF	163	-44	460	-	3.70	9.00	9.0	-	1000	-	5000 @ -20	1.10	Apr-02	732
Valvoline	SynPower	S	SL/CF	163	-44	460	-	3.70	9.00	9.0	-	1000	-	5000 @ -20	1.10	Mar-03	732
Mobil 1	SuperSyn	S	SL/CF	153	-49	446	-	5.11	13.00	5.0	-	-	-	7000 @ -20	1.30	Mar-03	721
Mobil 1	**SuperSyn**	**S**	**SL/CF**	**153**	**-49**	**446**	**-**	**5.11**	**13.00**	**5.0**	**-**	**-**	**-**	**7000 @ -20**	**1.30**	**Jun-03**	**721**
Chevron	Supreme Syn.	S	SJ	154	-38	464	-	3.70	13.00	11.9	-	1300	1450	2400 @ -15	1.11	Aug-01	715
Spectro	Golden Spectro	S	SH	151	-22	473	-	3.70	13.00	5.0	-	-	-	-	-	?	691
Spectro	Supreme Syn	S	SH	151	-22	473	-	3.70	13.00	5.0	-	-	-	-	-	?	691
Mystik	JT-8 Super HD	P	CI-4/SL	138	-17	430	-	3.70	12.00	13.0	-	-	-	6600 @ -20	1.70	Dec-02	649
Mystik	**JT-8 Super HD**	**P**	**CI-4/SL**	**138**	**-17**	**430**	**-**	**3.70**	**12.00**	**13.0**	**-**	**-**	**-**	**6600 @ -20**	**1.70**	**Aug-03**	**649**
BG	Extra Duty	P	-	155	-25	402	-	3.70	13.00	10.0	-	-	-	3050 @ -15	1.03	Dec-00	637
Synergyn	Racing Oil	S	-	154	-20	410	-	3.70	13.00	5.0	-	-	-	-	-	?	629
Klotz	MC Techniplate	S	SG	-	-30	425	-	3.70	13.00	5.0	-	-	-	-	-	Dec-00	500
Klotz	MC Techniplate	S	SG	-	-30	425	-	3.70	13.00	5.0	-	-	-	-	-	May-02	500

20w50																	RANKING
Brand	**Product**	**P/S/B**	**API**	**VI**	**PP**	**FP**	**FRP**	**HT/HS**	**Noack**	**TBN**	**4 Ball**	**Phos**	**Zinc**	**CCS**	**Ash**	**Rev.**	**SCORE**
76 Lubricants	Nascar Synthetic	S	SJ/CF	149	-49	495	-	5.70	13.00	9.0	-	900	1280	3350 @ -10	1.10	Jul-01	786
76 Lubricants	Nascar Synthetic	S	SJ/CF	149	-49	495	-	5.70	13.00	9.0	-	920	1280	3350 @ -10	1.10	Sep-02	786
Red Line	Passenger	S	SJ/CF-4	157	-49	503	-	3.70	5.00	5.0	-	-	-	2200 @ -10	-	May-00	778
Mobil 1	V-Twin	S	SH/CF	150	-60	518	-	3.70	13.00	5.0	-	-	-	2930 @ -10	-	Apr-03	773
Mobil 1	**V-Twin**	**S**	**SH/CF**	**150**	**-60**	**518**	**-**	**3.70**	**13.00**	**5.0**	**-**	**-**	**-**	**2930 @ -10**	**-**	**Jun-03**	**773**
Valvoline	HP Syn	S	SH/CD	152	-40	500	-	5.30	13.00	5.0	-	1200	1200	2900 @ -10	-	Jul-98	769
Valvoline	VR-1 Racing Syn	S	SH/CD	152	-40	500	-	5.30	13.00	5.0	-	1200	1200	2900 @ -10	-	Jul-98	769
AMSOIL	High Performance	S	SL/CH-4	161	-35	457	-	4.90	6.00	12.0	0.39'	-	-	3550 @ -15	-	Mar-03	757
AMSOIL	High Performance	S	SH/CF	169	-33	450	-	4.90	6.40	12.0	0.39'	1150	1270	3990 @ -15	~1.0	Aug-01	755
AMSOIL	V-Twin	S	SH/CF	169	-33	450	-	4.90	6.40	12.0	0.39'	1150	1270	3990 @ -15	~1.0	Aug-01	755
AMSOIL	V-Twin	S	CI-4/SJ	169	-33	450	-	4.90	6.40	12.0	0.39'	1150	1270	3990 @ -15	~1.0	Sep-02	755
AMSOIL	S2000	S	SL/CF	160	-33	453	489	5.10	5.90	11.0	0.44""	-	-	2343 @ -10	~1.0	Dec-00	752
Valvoline	SynPower Racing	S	-	158	-49	500	-	3.70	13.00	5.0	-	-	-	3000 @ -10	-	Oct-99	752
AMSOIL	S2000	S	SL/CF	155	-33	446	496	5.20	6.40	12.0	0.35""	-	-	4401 @ -15	~1.0	Dec-01	743
Neo	Neo	S	CD/SG	180	-40	470	520	3.70	13.00	8.0	-	-	-	3980 @ -10	1.03	?	741
Valvoline	Special Syn. Racing	S	-	153	-40	500	-	3.70	13.00	5.0	-	1200	1200	4000 @ -15	-	Mar-03	738
Valvoline	SynPower	S	SL/CF	160	-44	460	-	3.70	8.00	9.0	0.74""	1000	-	4600 @ -15	1.10	Apr-02	732

Valvoline	SynPower	S	SL/CF	160	-44	460	-	3.70	8.00	9.0	0.74""	1000	-	4600 @ -15	1.10	Mar-03	732
Precision	102P	P	CI-4/SL	130	-4	528	-	3.70	13.00	12.0	-	-	-	9500 @ -15	-	Jan-03	721
76 Lubricants	4T Motorcycle	P	SG/CD	134	-20	485	-	4.90	13.00	7.1	-	-	1380	6210 @ -15	0.98	Jul-01	712
76 Lubricants	Nascar HP	P	SJ	136	-20	480	-	5.20	13.00	5.5	-	-	1360	6210 @ -15	0.76	Jul-01	712
Citgo	Citgard 500	P	CF-4/SL	121	-11	486	-	4.50	9.00	11.0	-	-	-	7900 @ -15	1.50	Dec-02	703
Citgo	**Citgard 500**	**P**	**CF-4/SL**	**121**	**-11**	**486**	**-**	**4.50**	**9.00**	**11.0**	**-**	**-**	**-**	**7900 @ -15**	**1.50**	**Aug-03**	**703**
Valvoline	Durablend	B	SL/CD	129	-22	474	-	3.70	8.46	8.1	-	960	-	7800 @ -15	1.00	Apr-02	690
Havoline	Petroleum	P	SL/SJ	122	-20	496	-	3.70	13.00	7.6	-	940	1030	8000 @ -15	0.90	Mar-03	688
Havoline	**Petroleum**	**P**	**SL/SJ**	**122**	**-20**	**496**	**-**	**3.70**	**13.00**	**7.6**	**-**	**940**	**1030**	**8000 @ -15**	**0.90**	**Jun-03**	**688**
Chevron	Supreme	P	SL/SJ	122	-20	496	-	3.70	13.00	7.4	-	940	1030	8000 @ -15	0.90	Mar-03	688
Chevron	**Supreme**	**P**	**SL/SJ**	**122**	**-20**	**496**	**-**	**3.70**	**13.00**	**7.4**	**-**	**940**	**1030**	**8000 @ -15**	**0.90**	**Jun-03**	**688**
Torco	MPZ Motorcycle	S	SG/SH	140	-36	464	500	3.70	13.00	5.2	-	-	-	3570 @ -10	-	2001	685
BG	Shear Power	B	-	126	-22	486	-	3.70	13.00	6.7	-	-	-	7232 @ -15	-	Jun-03	682
BG	PM Racing	S	-	132	-20	485	-	3.70	13.00	5.0	-	-	-	9500 @ -15	-	Dec-02	682
Valvoline	VR-1 Racing	P	SJ/CD	132	-11	480	-	3.70	13.00	12.0	-	1200	1140	9500 @ -15	1.50	Sep-99	682
Schaeffer	Supreme 7000	B	SL	140	-	465	505	4.55	10.50	7.1	-	-	-	2950 @ -15	0.90	Jul-02	679
Torco	T-4R Motorcycle	B	SG/SH	158	-13	455	491	3.70	13.00	5.2	-	-	-	2500 @ -10	-	2001	671
Shell	FormulaShell	P	SL/SJ	126	-27	464	-	3.70	13.00	6.2	-	-	1170	6870 @ -15	0.90	2001 ?	664
Pennzoil	GT Performance	P	SL/SJ	130	-11	450	-	5.10	13.00	5.0	-	-	-	4300 @ -10	-	Jul-01	664
Shell	FormulaShell	P	SL/SJ	125	-27	464	-	3.70	13.00	6.2	-	-	1170	6870 @ -15	0.90	Dec-02	663
Petro Canada	Supreme MultiGrade	P	SL	123	-11	480	-	3.70	13.00	6.8	-	-	-	6750 @ -15	0.80	Mar-02	663
Exxon	Superflo	P	SL/SJ	125	-6	464	-	4.80	13.00	5.0	-	-	-	9500 @ -15	0.74	Mar-03	662
Exxon	Superflo	P	SL/SJ	124	-6	464	-	4.70	13.00	5.0	-	-	-	8200 @ -15	-	Oct-01	659
Citgo	SuperGard	P	SL	121	-	473	-	4.60	13.00	5.0	-	-	-	7990 @ -15	-	Jul-00	657
Citgo	SuperGard	P	SL	121	-	473	-	4.60	13.00	5.0	-	-	-	7990 @ -15	-	Dec-02	657
Kendall	GT-1	P	SL/SJ	124	-26	446	-	4.30	13.00	6.5	-	-	1100	7350 @ -15	0.85	Mar-02	656
Valvoline	Special Racing	P	-	119	-11	480	-	3.70	13.00	5.0	-	1200	1200	8740 @ -15	-	Dec-02	655
Castrol	Syntec Blend	B	SL/SJ	135	-17	440	465	4.50	13.00	5.0	-	900	1000	3100 @ -10	1.00	2001 ?	653
Castrol	Syntec Blend	B	SL/SJ	135	-17	440	440	4.50	13.00	5.0	-	1000	1100	9500 @ -15	-	Jun-02	653
Schaeffer	Micron Moly Racing	P	SL	125	-11	450	500	4.47	12.20	7.1	-	-	-	3466 @ -15	0.90	Jun-02	653
TropArtic	Racing	P	SL/CD	130	-24	451	-	3.70	13.00	6.5	-	-	1000	7441 @ -15	0.80	?	653
76 Lubricants	Super	P	SL	129	-22	430	-	4.90	13.00	6.2	-	-	990	7300 @ -15	0.80	Jul-01	652
Torco	T-4R Racing	B	SJ/SL	153	-18	435	446	3.70	13.00	5.2	-	-	-	4000 @ -10	-	2001	651
76 Lubricants	Firebird LD	P	SJ	132	-15	430	-	5.10	13.00	5.5	-	-	1350	3620 @ -10	0.75	Jul-01	651
Q. State	Motorcycle	P	SJ/SH	140	-25	440	455	3.70	13.00	5.0	-	-	-	4500 @ -10	-	Jun-00	650
Valvoline	4-Stroke Motorcycle	P	SJ	124	-11	446	-	3.70	7.30	7.9	-	1090	1200	7800 @ -15	0.70	Apr-03	649
76 Lubricants	Nascar HP	P	SL	124	-26	430	-	4.70	13.00	6.8	-	-	1120	7300 @ -15	0.88	Jul-02	649
Spectro	Golden Motor-Guard	B	SH	146	-9	446	-	3.70	13.00	5.0	-	-	-	9500 @ -15	-	?	646
Spectro	Golden Spectro4	B	SH	146	-9	446	-	3.70	13.00	5.0	-	-	-	9500 @ -15	-	?	646
Castrol	HIGH MILEAGE	P	SL/SJ	138	-6	440	440	4.50	13.00	5.0	-	1000	1100	9500 @ -15	-	Jun-02	645
Spectro	Golden American4	B	CD	146	-9	445	-	3.70	13.00	5.0	-	-	-	9500 @ -15	-	?	645
Wolf's Head	Super Duty	P	SL/SJ	123	-11	460	-	3.70	13.00	5.0	-	-	-	9500 @ -15	<.9	Jul-02	639

Kendall	GT-1	P	SJ	130	-11	451	-	3.70	13.00	5.0	-	-	-	7000 @ -15	-	Jul-00	637
Wolf's Head	Super Duty	P	SL/SJ	121	-11	460	-	3.70	13.00	5.0	-	-	-	4300 @ -15	<.9	Oct-01	637
Castrol	GTX	P	SL/SJ	122	-11	440	470	4.60	13.00	5.0	-	1300	1400	4000 @ -10	1.06	2001 ?	636
BG	Shear Power	B	-	124	-15	446	-	3.70	13.00	6.0	-	-	-	7522 @ -15	-	Dec-02	632
Valvoline	All Climate	P	SL/SJ	125	-11	446	-	3.70	13.00	7.0	-	900	1050	7300 @ -15	0.80	Apr-02	631
Walmart	**SuperTech**	**P**	**SL/SJ**	**121**	**-20**	**441**	**455**	**3.70**	**13.00**	**5.0**	**-**	**-**	**-**	**4500 @ -10**	**-**	**Sep-01**	**627**
Castrol	GTX	P	SL/SJ	128	-6	440	470	4.00	13.00	5.0	-	800	900	9500 @ -15	-	Jun-02	625
Q. State	HP Blend	B	SL/CF	128	-6	446	493	3.70	13.00	5.0	0.79""	-	-	9500 @ -15	-	May-02	625
Q. State	Synthetic Blend	B	SL/CF	128	-6	446	493	3.70	13.00	5.0	-	-	-	9500 @ -15	-	May-02	625
Q. State	HP Blend	B	SJ/CF	126	-6	446	493	3.70	13.00	5.0	0.79""	-	-	9500 @ -15	-	Jun-00	623
Spectro	Spectro4	P	SH	132	0	446	-	3.70	13.00	5.0	-	-	-	9500 @ -15	-	?	623
LE	Monolec 8820	P	CF-4/SJ	125	-11	430	-	3.70	13.00	10.0	-	-	-	9500 @ -15	-	?	621
Torco	MPZ Motorcycle	P	SG/SH	125	-4	444	475	3.70	13.00	5.2	-	-	-	3700 @ -10	-	2001	618
Torco	MPZ Racing	P	SL/SJ	125	-4	444	475	3.70	13.00	5.2	-	-	-	3100 @ -10	-	2001	618
Royal Purple	Multi-Grade	S	SJ/CF-4	138	-	435	470	3.70	13.00	5.0	-	-	-	9500 @ -15	-	?	618
Lubriplate	Super Lo-Hi-Vis	-	SJ/CF	130	-25	415	445	3.70	13.00	5.0	-	-	-	2630 @ -10	-	May-97	615
Q. State	Multigrade	P	SL/SJ	120	-6	441	455	3.70	13.00	5.0	-	-	-	9500 @ -15	-	Oct-01	612
Q. State	Peak Performance	P	SL/SJ	120	-6	441	455	3.70	13.00	5.0	-	-	-	9500 @ -15	-	Jan-02	612
Castrol	Syntec	S	SL/CF	135	22	437	450	4.50	13.00	5.0	-	900	1000	9500 @ -15	1.00	Jun-02	611
Conoco	Hydroclear HP	P	SL	122	-27	410	-	3.70	13.00	5.0	-	-	-	8800 @ -15	-	Nov-01	604
Mobil	Drive Clean	P	SL	124	-17	392	-	3.70	13.00	5.0	-	-	-	8200 @ -15	-	May-02	578
Mobil	Drive Clean	P	SL/SJ	124	-17	392	-	3.70	13.00	5.0	-	-	-	8200 @ -15	-	Apr-03	578
Mobil	**Drive Clean**	**P**	**SL/SJ**	**124**	**-17**	**392**	**-**	**3.70**	**13.00**	**5.0**	**-**	**-**	**-**	**8200 @ -15**	**-**	**Jun-03**	**578**
Spectro	HD MCO	P	-	-	-25	485	-	3.70	13.00	5.0	-	-	-	9500 @ -15	-	?	555
Valvoline	Maxlife	P	SL/SJ	-	-27	473	-	3.70	13.00	8.0	-	950	1080	9500 @ -15	-	Apr-02	551
Klotz	American V-Twin	S	SH/CG-4	-	-30	425	-	3.70	13.00	5.0	-	-	-	9500 @ -15	-	?	500
Klotz	MC Techniplate	S	SG	-	-30	425	-	3.70	13.00	5.0	-	-	-	9500 @ -15	-	Dec-00	500
Klotz	Race Techniplate	S	SH/CD	-	-30	415	-	3.70	13.00	5.0	-	-	-	9500 @ -15	-	Dec-00	490
Lyondell	Supreme	P	SJ	-	-9	410	-	3.70	13.00	5.0	-	-	-	4100 @ -10	-	Dec-00	464
Torco	MPZ Racing	S	SL/SJ	146	-38	-	500	3.70	13.00	5.2	-	-	-	4000 @ -10	-	2001	229
CAM2	**Magnum HD**	**P**	**SL/SJ**	**130**	**-22**	**-**	**-**	**3.70**	**13.00**	**5.0**	**-**	**-**	**-**	**9500 @ -15**	**0.60**	**Aug-02**	**197**
CAM2	**Magnum Plus**	**P**	**SL/SJ**	**130**	**-22**	**-**	**-**	**3.70**	**13.00**	**5.0**	**-**	**-**	**-**	**9500 @ -15**	**0.60**	**Apr-97**	**197**
CAM2	**Magnum XHD**	**P**	**SL/SJ**	**130**	**-22**	**-**	**-**	**3.70**	**13.00**	**5.0**	**-**	**-**	**-**	**9500 @ -15**	**0.60**	**Aug-02**	**197**
CAM2	**SuperPro**	**P**	**SL/SJ**	**130**	**-22**	**-**	**-**	**3.70**	**13.00**	**5.0**	**-**	**-**	**-**	**9500 @ -15**	**-**	**Oct-02**	**197**
Pennzoil	Motorcycle	P	SH/SG	122	-11	-	-	4.65	13.00	5.0	-	-	-	4000 @ -10	-	Apr-99	197

25w50																	**RANKING**
Brand	**Product**	**P/S/B**	**API**	**VI**	**PP**	**FP**	**FRP**	**HT/HS**	**Noack**	**TBN**	**4 Ball**	**Phos**	**Zinc**	**CCS**	**Ash**	**Rev.**	**SCORE**
Pennzoil	GT Perf. Racing	P	SJ	110	-5	440	-	3.70	13.00	5.0	-	-	-	6000 @ -5	0.90	Apr-99	600

SAE 60																	RANKING
Brand	Product	P/S/B	API	VI	PP	FP	FRP	HT/HS	Noack	TBN	4 Ball	Phos	Zinc	CCS	Ash	Rev.	SCORE
AMSOIL	SHW Racing	S	SJ/CF	140	-33	467	-	3.70	5.17	12.0	0.39'''	-	-	n/a	-	Feb-03	722
AMSOIL	SHW Racing	S	SL/CF	132	-27	453	-	3.70	5.80	8.9	0.39'''	-	-	n/a	-		686
Precision	102P	P	SJ/CF-4	111	+14	522	-	3.70	13.00	12.0	-	-	-	n/a	-	Jan-03	678
Valvoline	VR-1 Racing	P	SH/CD	104	+27	490	-	3.70	13.00	12.0	-	1140	1200	n/a	1.50	Sep-99	626
Torco	MPZ Racing	P	SL/SJ	117	+10	469	500	3.70	13.00	5.2	-	-	-	n/a	-	2001	621
Pennzoil	GT Perf. Racing	P	SJ	109	+15	455	-	3.70	13.00	5.0	-	-	-	n/a	0.90	Apr-99	594
Spectro	HD MCO	P	-	-	+5	515	-	3.70	13.00	5.0	-	-	-	n/a	-	?	555
Klotz	American V-Twin	S	SH/CG-4	-	-10	400	-	3.70	13.00	5.0	-	-	-	n/a	-	?	455
Valvoline	SynPower Racing	S	-	155	-49	-	-	3.70	13.00	5.0	-	-	-	n/a	-	Oct-99	249
25w60																	RANKING
Brand	Product	P/S/B	API	VI	PP	FP	FRP	HT/HS	Noack	TBN	4 Ball	Phos	Zinc	CCS	Ash	Rev.	SCORE
Torco	T-4R Racing	B	SJ/SL	158	-15	446	473	3.70	13.00	5.2	-	-	-	2000 @ -5	-	2001	664
Spectro	HD MCO	P	-	-	-15	495	-	3.70	13.00	5.0	-	-	-	-	-	?	555
Klotz	American V-Twin	S	SH/CG-4	-	-20	420	-	3.70	13.00	5.0	-	-	-	-	-	?	485
SAE 70																	RANKING
Brand	Product	P/S/B	API	VI	PP	FP	FRP	HT/HS	Noack	TBN	4 Ball	Phos	Zinc	CCS	Ash	Rev.	SCORE
Red Line	70 Wt Race ONLY	S	-	150	-	428	-	3.70	6.00	5.0	-	-	-	n/a	-	Apr-99	644
Torco	MPZ Racing	P	SL/SJ	121	+10	469	500	3.70	13.00	5.2	-	-	-	n/a	-	2001	625
Kendall	GT-1 Nitro	P	-	113	+16	446	-	3.70	13.00	15.0	-	-	2600	n/a	1.70	Mar-02	608
Synergyn	Racing Oil	S	-	124	-15	411	-	3.70	13.00	5.0	-	-	-	n/a	-	?	595
Spectro	HD MCO	P	-	-	+15	520	-	3.70	13.00	5.0	-	-	-	n/a	-	?	550
Klotz	American V-Twin	S	SH/CG-4	-	-	400	-	3.70	13.00	5.0	-	-	-	n/a	-	?	445
20w70																	RANKING
Brand	Product	P/S/B	API	VI	PP	FP	FRP	HT/HS	Noack	TBN	4 Ball	Phos	Zinc	CCS	Ash	Rev.	SCORE
Pure Power	Nitro	P	?	149	-	-	-	3.70	13.00	13.0	-	-	-	-	0.92	Sep-99	210

' Four ball test performed at 40 kg x 150 C x 1800 RPM. See note below.
'' Four ball test performed at 40 kg x 75 C x 1200 RPM. See note below.
''' Four ball test performed at 40 kg x 150 C x 1200 RPM. See note below.
'''' Four ball test performed at 60 kg x 150 C x 1800 RPM. See note below.
*** Four ball test performed at unknown parameters**