
## Chapter 1

I think it is time to go over passenger car automotive engine oils in detail. I will be writing several articles to be published soon so I will try to get some of it out here. I feel this is a very general topic for all car owners on this board.

This is a very difficult topic to comprehend. Everybody including good mechanics think they are experts in this field but few understand engine oils. Most of what I hear is the opposite of the truth. It is however easy to see how people get mixed up as there is always some truth to the misconception.

Please forgive me if I am too wordy or even verbose at times. I will be redundant for certain. This will be in areas that people have to hear things over and over again to get it right. Some will never be able to understand these concepts unfortunately. I base my thoughts on those whom I have been listening to in various automotive chat rooms and discussion with mechanics. I will try to minimize technical terms and be somewhat vague rather than exact. I will round and average numbers to make the point simple rather than mathematically exact. Thickness has the same meaning as viscosity. Viscosity is a measure of the resistance of a fluid (liquid or gas) to flow. Fluids with high viscosity, such as molasses, flow more slowly than those with low viscosity, such as water. Again, I am trying to explain general principals as I know them.

The greatest confusion is because of the way motor oils are labeled. It is an old system and is confusing to many people. I know the person is confused when they say that a 0W-30 oil is too thin for their engine because the old manual says to use 10W-30. This is wrong.

More confusion occurs because people think in terms of the oil thinning when it gets hot. They think this thinning with heat is the problem with motor oil. It would be more correct to think that oil thickens when it cools to room temperature and this is the problem. In fact, this is the

problem. It is said that 90 percent of engine wear occurs at startup. If we are interested in engine longevity then we should concentrate our attention at reducing engine wear at startup.

Oils are chosen by the manufacturer to give the right thickness at the normal operating temperature of the engine. I will say this average oil temperature is 212°F, the boiling point of water. On the track that temperature is up to 302°F. It is important to realize that these are two different operating environments and require different oils.

I will discuss driving around town first. Everything I say will be based on these conditions. At a later time I will discuss track conditions. Everything I say will be as accurate as possible without looking everything up and footnoting. I am trying to be general not ultra-specific.

One thing that is no longer important is the ambient temperature. Older automotive owner manuals often recommended one oil for the summer and another for the winter. This is still necessary for air cooled engines but is no longer a consideration in pressurized water cooled engines. These engine blocks are kept at around 212°F all year round. The oil is around the same temperature as well. This allows for a single grade oil all year round. Again, this is not the same as on the track where the coolant temperature is slightly higher and the oil temperature is much higher.

Please forget those numbers on the oil can. They really should be letters as AW-M, BW-N or CW-P. The fact that we are dealing with a system of numbers on the can makes people think that they represent the viscosity of the oil inside the can. The problem is that the viscosity of oil varies with its temperature. A “30” grade oil has a viscosity of 3 at 302°F (150°C) and thickens to 10 at 212°F (100°C). It further thickens to a viscosity of 100 at 104°F (40°C) and is too thick to measure at the freezing point of 32°F (0°C).

Oils are divided into grades (not weights) such as a 20, 30 or 40 grade oils. This represents the viscosity range at operating temperature. But it is NOT the actual viscosity as we shall see. The issue is that viscosity is temperature dependent. Let’s look at a 30 grade oil and how the viscosity of this grade of oil varies with temperature:

| Temperature (° F) | Thickness |
|---|---|
| 302 | 3 |
| 212 | 10 |
| 104 | 100 |
| 32 | 250 |

(30 grade oil: aka 30 “weight” oil)

The automotive designers usually call for their engines to run at 212°F oil and water temperature with an oil thickness of 10. This is the viscosity of the oil, not the weight or grade as labeled on the oil can. I want to stay away from those numbers as they are confusing. We are talking about oil thickness, not oil can labeling. This will be discussed later. Forget the numbers on that oil can

for now. We are only discussing the thickness of the oil that the engine requires during normal operating conditions.

The engine is designed to run at 212°F at all external temperatures from Alaska to Florida. You can get in your car in Florida in September and drive zig-zag to Alaska arriving in November. The best thing for your engine would be that it was never turned off, you simply kept driving day and night. The oil thickness would be uniform, it would always be 10. In a perfect world the oil thickness would be 10 at all times and all temperatures.

If the thickness of oil was 10 when you got in your car in the morning and 10 while driving it would be perfect. You would not have to warm up your engine. You could just get in the car and step on the gas. There would be little wear and tear on your engine, almost none. Unfortunately the world is not perfect.

The night before when you drove home from work the car was up to the correct operating temperature and the oil was the correct thickness, 10. Overnight the engine cooled to room temperature and the oil thickened. It is 75°F in the morning now (I do live in Florida). The oil thickness is now around 150. It is too thick to lubricate an engine designed to run with an oil having a thickness of 10.

## Chapter 2: It gets more difficult

We left off discussing that a 0W-30 grade oil is not thinner than a 10W-30 oil. They both have the same thickness at operating temperature. The 0W-30 simply does not get as thick on cooling as the 10W-30. Both are still way too thick to lubricate an engine at startup.

I have heard several people say that Porsche specifically prohibits a 0W-XX engine oil, that it is too thin. Now here is the partial truth I spoke of earlier. We will discuss multi-grade oils. Earlier we said that a straight 30 grade oil has a thickness of 10 at the normal operating temperature of your engine. The multi-grade oils 0W-30 and 10W-30 also have a thickness of 10 at 212°F.

The difference is at 75°F, your startup temperature in the morning.

| Oil Type | Thickness at 75° F | Thickness at 212° F |
|---|---|---|
| Straight 30 | 250 | 10 |
| 10W-30 | 100 | 10 |
| 0W-30 | 40 | 10 |
| Straight 10 | 30 | 6 |

(Oil Type varying Thickness)

Now you can see that the difference between the desired thickness your engine requires (= 10) is closest to the 0W-30 oil at startup. It is still too thick for normal operation. But it does not have far to go before it warms up and thins to the correct viscosity. Remember that most engine wear occurs at startup when the oil is too thick to lubricate properly. It cannot flow and therefore cannot lubricate. Most of the thick oil at startup actually goes through the bypass valve back to the engine oil sump and not into your engine oil ways. This is especially true when you really step on that gas pedal. You really need more lubrication and you actually get less.

Note that a straight 10 grade oil is also too thick for your engine at startup. It has a thickness of 30. Yet at operating temperatures it is too thin having a thickness of 6. It needs to be around 10. The oil companies have added viscosity index improvers or VII to oils to solve this dilemma. They take a mineral based oil and add VI improvers so that it does not thin as much when it gets hotter. Now instead of only having a thickness of 6 when hot it has a thickness of 10, just as we need.

The penalty is the startup thickness also goes up to 100. This is better than being up at 250 as a straight 30 grade oil though. Oil with a startup thickness of 100 that becomes the appropriate thickness of 10 when fully warmed up is called a 10W-30 grade motor oil. This is NOT as thick as a straight 30 grade oil at startup and it is NOT as thin as a straight 10 grade oil at full operating temperature.

The downside of a mineral based multi-grade oil is that this VII additive wears out over time and you end up with the original straight 10 grade oil. It will go back to being too thin when hot. It

will have a thickness of 6 instead of 10. This may be why Porsche (according to some people) does not want a 0W-30 but rather a 10W-30. If the VII wears out the 0W-30 will ultimately be thinner, a straight 0 grade oil. When the VII is used up in the 10W-30 oil it too is thinner. It goes back to a straight 10 grade oil. They are both still too thick at startup, both of them. The straight 0 grade oil, a 5 grade oil and a 10 grade oil are all too thick at startup.

This is just theory however. With normal oil change intervals the VI improver will not wear out and so the problem does not really exist. In fact, oils do thin a little with use. This is partly from dilution with blow by gasoline and partly from VI improvers being used up. What is more interesting is that with further use motor oils actually thicken and this is much worse than the minimal thinning that may have occurred earlier.

Synthetic oils are a whole different story. There is no VI improver added so there is nothing to wear out. The actual oil molecules never wear out. You could almost use the same oil forever. The problem is that there are other additives and they do get used up. I suppose if there was a good way to keep oil clean you could just add a can of additives every 6 months and just change the filter, never changing the oil.

When the additives wear out in a synthetic oil it still has the same viscosity. It will not thin as a mineral oil. The fear that some say Porsche has that oils thin when the VII runs out is not applicable to these synthetic oils. These oils will always have the correct thickness when hot and will still be too thick at startup as with all oils of all types, regardless of the API / SAE viscosity rating.

Automotive engine manufacturers know these principals of motor oils. They know there is thinning or thickening that will occur. They take these things into account when they write that owner's manual. Mineral oil change recommendations will generally include shorter time intervals than those of synthetic oils.

The reality is that motor oils do not need to be changed because they thin with use. It is the eventual thickening that limits the time you may keep oil in your engine. The limit is both time itself (with no motor use) and/or mileage use. The storage of motor oil in your garage, particularly mineral based oils, slowly ages the oil limiting its use later. Do not store huge volumes of oil in your garage that is exposed to extremes of temperature.

## Chapter 3: You have a synthetic mind

Let us compare mineral and synthetic oils. I will not talk about chemical but rather functional differences. We discussed before how mineral oils are too thick at startup yet too thin when hot. The viscosity was corrected with the hot engine by adding VI improvers.

A 10W-30 multi-grade mineral based oil is made from a 10 grade oil and has VI improvers added to thicken the product in a 212°F engine. It acts as a 30 grade oil when hot. It acts more as a 10 grade oil at startup. I remind you that a 10, 5 or 2 grade oil is still too thick to provide lubrication at startup. They are all too thick at startup. There is currently no engine oil thin enough to operate correctly at startup. They all cause excessive wear at startup. Again, we are discussing the needs of my single hypothetical engine for around town driving.

| Oil Type | Thickness at 75° F | Thickness at 212° F |
|---|---|---|
| Straight 30 | 250 | 10 |
| 10W-30 | 100 | 10 |
| 0W-30 | 40 | 10 |
| Straight 10 | 30 | 6 |
| Straight 5 | 20 | 4 |
| Straight 2 | 15 | 3 |
| Straight 0 | 12 | 3 (est) |

(Oil Types – Synthetic / Straight varying Thickness)

Let's look at the make up of synthetic based oils. A 10W-30 synthetic oil is based on a 30 grade oil. This is unlike the counterpart mineral oil based on a 10 grade oil. There is no VI improver needed. The oil is already correct for the normal operating temperature of 212°F. It has a thickness of 10 while you drive to work. It will never thin yet has the same long term problem as the mineral based oil. They both thicken with extended age.

Synthetic oils are derived in the laboratory. They are pure, usually nearly clear. I describe mineral based motor oils as a distilled, concentrated product. The impurities need to be removed from the raw petroleum. These oils are therefore less clean and contain many impurities. Again, the problem is really more of theory than practice but the difference does exist.

People repeatedly say that synthetic oils are more stable in a hot engine. I hear that they lubricate better. The answer is yes and no. Oil molecules do not break down, just the additives. Generally, the synthetic oils do not have VI improvers so have less to lose.

There are some properties of synthetic oils that actually result in less wear than with mineral oils. These help increase your gas mileage as well. Due to a reduction of internal friction of the

synthetic oil your engine will run a bit cooler. Wear increases as temperature increases, all other things being constant.

A main advantage that the synthetic has over the mineral based oil is the ability to lubricate at startup. Both types of oil have the same specifications at 104°F, 212°F and 302°F. It is the startup viscosity characteristics that separate these oils. Synthetic oils do not thicken as much on cooling. They have better fluidity as the temperature drops.

A synthetic oil that is labeled as 10W-30 is less honey like as a mineral based 10W-30 motor oil at startup. They both have a thickness of 10 at normal operating temperatures. At 75°F the synthetic is not as thick. At 32°F the difference between the two is even greater. At 0°F the mineral oil is useless yet the synthetic works fairly well. Just keep the RPM to a minimum.

At temperatures below zero you will not be able to start your car with mineral oils while the synthetic oils may be used to -40° or -50°F. Oils are so thick that the normal method of viscosity measurement is not possible. Instead we measure if the oil can even be pumped or poured. Again, we are only discussing a single category of oil, the multi-grade 10W-30 API / SAE grade.

I took an excerpt from the web about Mobil 1 oils. They compared a 5W-30 synthetic Mobil 1 oil to a mineral based 10W-30 and a 10W-40 in ice cold conditions. The engine turned over at 152 RPM with the synthetic 5W-30 Mobil 1. The 10W-30 and 10W-40 mineral oils turned over at 45 and 32 RPM respectively. Neither of those engines started.

Motor oil becomes permanently thicker with exposure to northerly winter type weather. This is more of a problem to mineral based oils. Waxes form. This is why it is a bad idea to even store a bottle of oil in a cold garage. It goes bad on the garage shelf just because it is exposed to the cold.

To recap, synthetic oils have similar characteristics as mineral oils at operating temperatures. The synthetic oil will however be less honey – like at startup even though it has the same API / SAE rating. Yet the synthetic 10W-30 grade oil is based on a heavier 30 grade oil while the mineral based 10W-30 oil is based on a thinner 10 grade oil. They are both similar at operating temperatures yet the 30 grade based synthetic is actually less thick at startup and much less honey – like at low temperatures. This is the opposite of what common sense dictates.

This is worth repeating: The synthetic 10W-30 grade oil is based on a heavier 30 grade oil while the mineral based 10W-30 oil is based on a thinner 10 grade oil. They are both similar at operating temperatures yet the 30 grade based synthetic is actually less thick at startup and much less honey – like at low temperatures. This is the opposite of what common sense dictates.

As one can see this is no easy topic. Are you with me?

## Chapter 4: It's not what we thought

Now let us finish talking about the differences of mineral verses synthetic oils. I will compare the same weigh or grade of oils showing that the operating viscosities are the same whereas the startup viscosities vary:

| Oil Type | Thickness at 75°F | Thickness at 212°F | Thickness at 302°F |
|---|---|---|---|
| Straight 30 | 250 | 10 | 3 |
| 10W-30 | 100 | 10 | 3 |
| 0W-30 | N/A | N/A | N/A |

(Mineral Oil – varying Thickness)

| Oil Type | Thickness at 75°F | Thickness at 212°F | Thickness at 302°F |
|---|---|---|---|
| Straight 30 | 100 | 10 | 3 |
| 10W-30 | 75 | 10 | 3 |
| 0W-30 | 40 | 10 | 3 |

(Synthetic Oil – varying Thickness)

Since the synthetic oil thickens less on shutdown your startup will be easier and so will the stress on your engine. This is perhaps the best thing the synthetic class has over the mineral based oils.

People sometimes use a thicker oil to minimize gasket leaks. This seems obvious to me. Repair the gasket. Do not destroy your engine with an oil that is too thick for proper function.

Some people have said they use thicker oils because they only use their cars every 2, 3 or 4 weeks. They are afraid that thin oils will fall off the engine parts and result in a lack of lubrication at startup. Think about your lawn mower over the winter. It gets gummed up solid. The oil and fuel thicken over time resulting in engine failure. Anyway, oil on the surface of parts does not lubricate. It is the FLOW of oil between parts that lubricates. Thick, old, waxy oil can only be bad.

I have seen several car owner manuals that are now stating that oils do not need to be changed but every 7,500 miles or more. The same manual also states OR every 12 months, whichever occurs first. My feeling is that you can probably go 5,000 miles on the average (in a sports car) but you must change your oil in the spring time at a minimum, particularly up north. Oils form waxes in icy cold weather. There is a permanent thickening of the oil.

Some automotive manufacturers are backing down on oil change intervals to 5,000 miles or less and some advocate changing the oil at least every 6 months as well. I think this is because of the tendency for oils to thicken in very hot engines (not ambient conditions, just hot engines). Also

because of thickening from the cold of winter and from sludge build up that cannot be filtered out.

I truly believe that oil is much better being too thin than too thick. Over the years we have been going to thinner and thinner oils despite hotter engines with turbo and the like. The tendency is that people figure they need a 40 grade oils but then use a 50 instead. Better thinking is that if you think you need a 40, use a 30 grade oil instead. I firmly believe this based on all I know about oils.

As it turns out synthetic oils do cling to parts better as they have higher film strength than mineral oils. Synthetics are thinner overall. They have greater slipperiness. Yet they stick better to engine parts. Again, this concept is the opposite of normal thinking.

The thickness of moving oil is measured in centiStokes or cS. Most engines want the oil viscosity to be around 10 cS at normal operating temperature. The really thick multi-grade oils have a viscosity of 20 cS at operating temperature. One is not twice as thick as the other, it is only 10 cS thicker.

As we increase the heat from 212°F to 302°F the most commonly recommended oil thins from 10 cS to 3 cS. The thicker oil drops from 20 cS to 4 cS. Note that in a very hot engine the difference between the two oils is now only 1 – 2 cS. In other words they have about the same thickness. There is little advantage to a thicker based oil as a 20W-50 at very high temperatures. No, the 4 cS oil is not twice as thick as the 2 or 3 cS oil. This difference is almost insignificant.

There is a huge advantage of using the thinner, 10W-30 at startup where 90 percent of the engine wear occurs. At 75°F the thicker oil has a viscosity in the range of 250 cS while the thinner oil has a viscosity of 100 cS. The thicker stuff is 150 cS thicker. This is a very big difference. I am using the 20W-50 as my thicker oil example here.

People are always asking about adding things as Slick 50 into the oil tank. Do not do this. The oil companies and engine manufacturers work together very hard to give you the product you need. Engines are running hotter, longer with more BHP from less CID. Smaller, more efficient engines are getting us more MPG and yet better acceleration. These engines last longer and are more reliable.

Part of that reason is the nature of the lubricants. There is a lot of competition to get us the best working motor oil. Independent additives cannot make the oil better and in many cases makes things worse. There have been engine failures as a result of adding some of these aftermarket additives to motor oil.

Motor oil that is labeled for RACING ONLY is not usable for every day driving. Often these have more additives that are toxic to your catalytic converters and the environment. These oils generally do not have detergents. These are very important for your engine unless you plan on taking it apart every few weeks and cleaning every single surface. The oils do not meet the API / SAE requirements for ratings as SJ, SL or now SM.

You do not need to use the exact oil type and brand that your car manual tells you to use. Oils are pretty general. They are not that different. Ferrari is married to Shell. If you call them up and ask to use Valvoline instead they will tell you that they have not tested that brand in their cars. They only tested the engine with Shell oils. They cannot comment on the performance of other oils in their engines. This is a fair statement. The reality is that the Shell and Valvoline oils of the same specification (viscosity, API and SAE ratings, synthetic or not) are very similar. (I do have my bullet proof vest on).

People often say that their old 1980 car manual says to use a specific Brand-X motor oil. They keep trying to locate these older oils. First, just about any oil brand that meets the original specifications will do. Second, all oils are much, much better now. They are all much better. One could say that synthetic oils are better than mineral oils but it is hard to say that one brand is that much better than any other. Personally, I do stick to the big names. It does not mean that small motor oil companies are not as good. They could be better for all I know.

Using an oil that is less thick at startup has other benefits. Let us compare a synthetic 10W-30 to a mineral based 10W-30. Both give you a viscosity of 10 cS at normal engine operating temperatures. They both thin to 3 cS at high temperatures. At 75°F tomorrow morning the story will be different. The startup viscosity of the synthetic will be 50 whereas the mineral based 10W-30 will be 100. Again, both are too thick at startup but the synthetic will cause less startup time period wear and tear. You will get a little better gas mileage too.

The synthetic lubricated engine will turn over easier. This has the effect of using less power from your starter motor. It will last longer. Your battery has less of a current draw. This will also last longer. The battery was discharged less during the start so the alternator will rob less power from your engine to recharge. The alternator lasts longer and you get a little better gas economy. The only downside of synthetic lubricants is the cost. They cost 2 or 3 times as much as mineral based oils. Nevertheless, I use plain Pennzoil multi-grade mineral based 5W-20 in my Ford Expedition. This oil is thin enough at startup to have many of the attributes I just mentioned.

## Chapter 5: Let's use top gear

Let's go racing. I will discuss driving in traffic jams in the Florida summer as well as racing in Sebring though there is no commonality. People lump these two driving situations together but there is no overlap.

On the race track one usually uses all the BHP their engine can give them. You briefly step on the brakes for the corner then put the pedal to the metal the rest of the time. Your oil will get up to 302°F, but your cooling system is around 212°F. The engine produces tremendous heat but can only pass it off so fast to the cooling system. There is a lot of air moving past the cooling radiator so the antifreeze / coolant is able to get rid of the extra heat from this part of the system with relative ease.

The temperature of oil on your gauge is not as hot as it really gets. This temperature is an average with oil from different parts of the motor. Some parts are hotter than others. It is said that some of the oil gets as hot as 400° or 500°F in these racing situations.

In an earlier section I said that thicker oils are usually needed in racing situations but not necessarily. Remember that a major function of oil is to cool the inside of your engine. In ASTM D 4485 3.1.4: "Terminology: Engine oil- a liquid that reduces friction and wear between moving parts within an engine, and also serves as a coolant." Since the oil with a viscosity of 10 cS at 212°F thins to a viscosity of 3 cS at 302°F we will get more flow. The pressure will go down some as well. This is OK as long as we have a minimum of pressure to move the oil.

This increased flow will result in increased cooling by the oil. This is a good thing. You would probably want more oil flow in these situations and you get it. The hotter oil thins and this increases flow. The higher flow works harder to separate the engine parts that are under very high stress. It all works out for the better. Higher revving engines need thinner oils. You do not necessarily need to go to a thicker oil while racing. Only experimentation will tell.

The best way to figure out what viscosity of oil you need is to drive the car in the conditions you will use. Then use the oil viscosity that gives you 10 PSI per 1,000 RPM under those circumstances. For some reason very few people are able to get this simple principal correct. I cannot explain further.

These same rules apply to engines of any age, loose or tight. Just because your engine is old does not mean it needs a thicker oil. It will need a thicker oil only if it is overly worn, whether new or old. Yet the same principals of 10 PSI per 1,000 RPM still apply. In all cases you need to try different grade oils and see what happens. Then choose the correct viscosity.

I used 0W-20 in my Ferrari 575 Maranello. It had over 5,000 miles on the clock. There will be a day (my estimate is 50,000 miles) when one will have to go to a 0W-30. In the future one will have to increase the viscosity to a 0W-40, then a 0W-50, maybe. You should use whatever it takes to get 75 PSI at 6,000 RPM during the lifetime of the engine. This formula works in all situations.

Some people have tried this and occasionally get a somewhat low oil pressure while at idle. This is fine. There is no stress on parts at idle, the smallest oil flow will do the trick. It is at higher RPM where more BHP is produced. This is where we need the flow. Remember that Ferrari uses 75 PSI at 6,000 RPM as the place to test your oil viscosity needs. If your oil gives this value under your driving conditions then your lubrication system has been maximized. Period.

Do not go 5,000 miles with the same oil if you are racing your car. You should change the oil every 1 or 2,000 miles. If you drive your car around town then you need to change the oil for that situation. Use racing oil on the track and urban oil around town. The best situation as described by Ferrari is to use the 0W-40 around town and the 10W-60 "racing oil" on the track. It has to be that "hot" track though. A compromise situation would be to use the 5W-40 for both but this may not be optimal. Certainly, if you are just an urban driver as me use the 0W-40 or even a thinner oil as I do in my Maranello. Again, I used the 0W-20 grade.

FYI. The Formula 1 cars that run at 15,000 RPM and higher use straight 5 and 10 grade oils.

Now let me discuss what people think is a similar situation to racing. That is hot summer traffic jam driving. Your car should be able to handle this. If you have problems then you have a problem with your car, most likely in need of a cooling system overhaul.

When you drive that car down the road mid-winter in upstate New York or mid-summer in Florida the engine and oil temperatures will be around 212°F. But your Florida vacation is suddenly altered by a hurricane. You have to get out of Tampa, but so do a million other people. It is now 95°F and you are in a snarl. Everyone thinks they need a thicker oil for this situation. This is false.

Your engine is not producing much heat at low RPM and low BHP output. The production of heat is relatively slow. It can easily be transmitted to your cooling system. The problem is that your cooling system has trouble getting rid of the heat. The oil and the coolant will slowly rise in temperature. They both rise together. The increase is no big deal for your oil. It goes to 220°, then 230°F. The problem is that the cooling system can only handle heat up to 230°F. After that you overheat the cooling system and the car must be shut off. The oil never got that hot, It was just that the water got a little hotter than its system design.

You now see that overheating in traffic is a cooling system problem and not an oil system problem. Do not change to a thicker oil based on your traffic situation.

*Chapter 6: A personal preference*

These are the motor oils I recommend. This is based on information that I just happened to collect. I have not gotten the specifications of all oils out there. My opinion on these oils is most based on viscosities. By this I mean less honey like at start up temperatures and appropriate for the required viscosity at operating temperature. I also looks at the oil tests others have done.

I broke it down to several classes:

- Fully Synthetic
- Race Track Oils for Street Use
- Semi-Synthetic
- Mineral (dinosaur) Oils

The asterisk (*) is my preferred from each group of very similar products. And these are usually easier to find in my experience. Remember, all oils are too thick at start up. There is no such thing as an oil that is too thin below 100°F. The thinnest motor oil made is still too thick at start up temperatures of 75°F.

It seems that many engines work best with a multi-grade 30 weight / grade oils. Others would do better with a 20 grade oil and few would require a 40 grade oil. You can only determine what is best by experimenting. Admittedly I did not think my Ferrari Maranello would need a 20 grade oil. In truth I could actually have used a 10 grade oil. A 0W-10 would be good but it simply does not exist for normal use. Red Line does make 2W, 5W and 10W oils (this acts as a 0W-10 multi-grade oil) but they are for racing only. One Formula 1 team has actually used these very oils off the shelf from Red Line.

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Synthetic Class

60 Grade:

- Agip Synthetic PC 20W-50 (a thick 50 wt oil)
- Redline straight 60 wt racing oil (racing only, acts as a SAE 20W-60 oil)*
- Penn Ultra Synthetic 10W-60
- Shell Helix Ultra Racing Oil 10W-60

50 Grade:

- Castrol Syntec 5W-50
- Penn Platinum Synthetic 5W-50
- Red Line 5W-50*

40 Grade:

- Amsoil 0W-40
- Castrol European Formula 0W-30 (a thicker 30 grade oil, almost a 40 grade oil)*
- Mobil One 0W-40
- Penn Ultra Synthetic 5W-40
- Renewable Lubricants Inc. 5W-40*

30 Grade:

- Mobil One 0W-30
- Penn (Any) Synthetic 5W-30
- Red Line 5W-20 (a thick 20 grade oil)*
- Renewable Lubricants Inc. 0W-30*

20 Grade:

- Mobil One 0W-20
- Pennzoil Platinum Synthetic 0W-20
- Renewable Lubricants Inc. 0W-20*
- Valvoline SynPower 5W-20

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Race Oils for Street Use

(Use these when continued sump temperatures over 240°F are expected.)

60 Grade:

- Redline straight 60 wt racing oil (racing only, not for the street, acts as a SAE 20W-60 oil)
- Shell Helix Ultra Racing Oil 10W-60
- Valvoline SynPower 20W-50

50 Grade:

- Castrol Syntec 5W-50
- Shell Helix Ultra 15W-50

40 Grade:

- Red Line 5W-40
- Penn Ultra Synthetic 5W-40
- Shell Helix Ultra 5W-40

30 Grade:

- Red Line 10W-30

20 Grade:

- Amsoil 5W-20
- Red Line 5W-20

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Synthetic Blends

60 Grade:

- Castrol Syntec Blend 20W-50

50 Grade:

- Valvoline 20W-50

40 Grade:

- Agip 4-Synt 10W-40
- Valvoline Durablend 10W-40*

30 Grade:

- Castrol Syntec Blend 5W-30
- Motorcraft Blend 5W-30
- Valvoline Durablend 5W-30*

20 Grade:

- Motorcraft 5W-20*
- Valvoline Durablend 5W-20

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Non-Synthetic

50 Grade:

- None recommended – all relatively too thick at start up.

40 Grade:

- Penn regular Multi-grade 10W-40*
- Valvoline All Climate 10W-40

30 Grade:

- Penn regular Multi-grade 5W-30*
- Valvoline All Climate 5W-30

20 Grade:

- Penn regular Multi-grade 5W-20
- Mobil Clean 5000 5W-20*

If while on the road you are forced to add oil there are rules. Let us say for example that our engine has synthetic Mobil One 0W-30. Use the same type and brand if you can. If you are using Mobil 1 then it is acceptable to mix different grades but use a close grade when possible. It is not a good idea to mix say 1/2 your oil tank with 0W-30 and 1/2 with 15W-50 Mobil 1. If there is no Mobil 1 available then use the mineral based Mobil oils next.

The last choice is to mix a synthetic of another brand. They should not react adversely if mixed but it may dilute additives. This is not a good combination. Use this combination if you must but only until an oil change can safely be performed some time soon.

I personally used 0W-20 Mobil 1 in the 575 Maranello and for the first oil change I drained the Murcielago's (OEM) 5W-40 Agip and replaced it with 0W-30 Mobil 1. The engine became much quieter. A valve tappet noise disappeared. I then used the 5W-20 Red Line in the Lamborghini. Used oil analysis showed that this oil worked well for my non racetrack application. The same oil went into my Maybach 57. My Enzo Ferrari calls for the Shell Helix Ultra racing 10W-60 but I have used the Castrol Syntec European Formula 0W-30. This is

different than the easy to find plain 0W-30 Syntec. It MUST say European Formula across the front of the label. I buy it at AutoZone stores but it is often mixed with the plain stuff. I am now using Renewable Lubricants Inc. (RLI) 0W-30 in the Enzo and 0W-20 RLI in the new Maybach 57s AMG.

You have to try by experimentation what operating oil grade your engine requires. In all cases however, you want the oil that gets least honey-like at startup and thins to the appropriate thickness for normal operation. Always recheck the oil label as they change a lot.

## Chapter 7: What is the terminology from SAE and API?

Many think that the “W” in 10W-30 means “winter”.

Two series of viscosity grades are defined in Table (1): (a) those containing the letter W and (b) those without. Single viscosity grade oils with the letter W are defined by maximum low temperature cranking and pumping viscosities and a minimum kinematic viscosity at 100°C.

Single grade oils without the letter W are based on a set of minimum and maximum kinematic viscosities at 100°C and a minimum high shear rate viscosity at 150°C.

The shear rate will depend on the test method. Multi-grade grade oils are defined by both of these criteria….

*SAE J300 page 2*

The W is just a designation of one type of testing vs another.

What is the viscosity of the various grade oils? The definitions are as follows:

| Oil Viscosity | Range |
|---|---|
| 20 | 5.6 – 9.2 |
| 30 | 9.3 – 12.4 |
| 40 | 12.5 – 16.2 |
| 50 | 16.3 – 21.8 |
| 60 | 21.9 – 26.1 |

(From SAE J300 – viscosities at 212°F)

| Oil Viscosity | Range |
|---|---|
| 20 | 2.6 |
| 30 | 2.9 |
| 40 | 2.9 – 3.7 |
| 50 | 3.7 |
| 60 | 3.7 |

(By a modified analysis – Minimum viscosity at 302°F)

Note again that the difference between the 20 grade and 60 grade oils at 302 F is only about 1 (one). Whereas the difference in viscosity at 104°F is 120 units. The 20 grade has a viscosity of

40 and the 60 grade a viscosity of 160. The difference at startup (75°F) is even higher, probably 250 or 300. At ice cold temperatures the difference is in the thousands.

The American Petroleum Institute, API, and Society of Automotive Engineers, SAE, have rated engine oil performance over the years. We have seen the ratings go from SA, SB, SC, SD, SE, SF, SG, SH, SJ, SL with SM to follow. SI and SK were eliminated as they are used by other businesses. There are over 3 dozen tests that oil now must pass in order to make the next higher rating. The tests are defined by the American Society for Testing and Materials, ASTM. Some tests have progressed to a zero tolerance level. For example there can be no sticking of any piston rings any more. I will compare the SL rated oil to the previous SJ oil in a few categories. For simplicity I will skip the units of measurement:

| Category | SJ | SL |
|---|---|---|
| Maximum cam plus lifter wear | 30 | 20 |
| Sludge buildup | 9 | 7.8 |
| Varnish rating (higher is better) | 5 | 8.9 |
| High temperature deposits | 60 | 45 |
| High temperature volatility | 70 | 10 |

(Engine oil performance)

Other categories include: Resistance to rust, resistance to foaming, resistance to oil consumption, homogeneity and miscibility, flow reduction with varying amounts of absorbed moisture, gelation index and others.

As one can see just going from the previous SJ to the SL rating is a significant improvement. I cannot wait to get the upcoming SM oil into my cars. This is the current rating as of April 2010.

4. Because engine pumping, cranking and starting are all important at low temperatures the selection of an oil for winter operation should consider both the viscosity required for oil flow as well as cranking and starting, at the lowest expected ambient temperature.

Pumping viscosity is a measure of an oils ability to flow…during the initial stages of operation.

Test in ASTM D 4684. ….samples are tested after a slow cool cycle. This cycle has predicted as failures several SAE 10W-30 and 10W-40 oils which are known to have suffered pumping failures in the field after short-term (2 days or less) cooling. These field failures are believed to be the result of the oil forming gel structures that result in excessive yield stress and viscosity of the engine oil…

A.2.1…After preliminary warming, the sample is subjected to a controlled temperature/time cycle over 5 1/2 to 7 days. The cycle reproduces …instability or reversion which has occurred during storage of oils in moderately cold cyclic conditions. Recent work shows relevance to engine oil pumpability failure. Oils exhibiting pour reversion have solids resulting from wax gel formation, at temperatures significantly higher than their ASTM D 97 pour points.

*Extracted, from ASTM D 4485-03 Standard Specification for Performance of Engine Oils, copyright ASTM International,*

*100 Barr Harbor Drive, Wets Conshohocken, PA 19428, USA.*

*SAE j300 1999*

My point is that tests are not just laboratory concoctions. They design tests to match real life conditions.

I used 5W-20 Pennzoil mineral based multi-grade oil in my Expedition as it has many of the low temperature characteristics of higher grade synthetic oils. My ’04 manual states that the SUV is delivered with a Ford semi-synthetic oil and although regular oil can be used they recommend a semi or full synthetic oil. For the differential gear oil they used 75W-140 in my ‘98 Expedition but now recommend 75W-90. If I was towing 8,000 lbs. then I would need the semi or full synthetic 5W-20. But for my usual around town driving a plain, mineral based oil is plenty good.

Please note that it makes no difference what oil you are using. The 0W-20 Mobil 1 that is SL rated meets the same criteria as that SL rated 10W-30 synthetic or mineral based Pennzoil. That SJ or in particular that SH oil some people are looking for (from their older automotive owners manual) is no where near as good as any SL oil of today. Always use the most currently available, highest rated motor oil, even in the oldest, most worn engine. You may require a thicker grade but just make sure it is SL or SM rated.

The SH rating was used in oils starting 1993. The SJ rating started in 1997 while the SL became effective in 2001 oils. According to ASTM D 4485, SL rated oils are superior to previous oils and from:
X2.3.1 and 2: SL oil is for use in current and all earlier passenger cars, sport utility vehicles, vans, and light trucks. This SL rated oil can be used in engines requiring SJ and All Earlier Categories.

Concern: People are worried about the SM oils not having as much ZDDP as the SL and older oils. The reason ZDDP has been used for years is not because of its superior performance but rather its low cost and dual function as an antioxidant. It also has anticorrosive properties.

There are other additives. Some newer oils do not have any ZDDP, and they are excellent products. Just the same, I prefer oils with ZDP for now. The research shows that 0.03 is all that is needed and has the same function as higher levels. The only reason to have more is because your engine is consuming the ZDDP secondary to borderline lubrication from oil alone.

And lastly, too much can be corrosive itself and has shown in some tests to actually increase wear.

**See these sites for more info.:**

- American Society for Testing and Materials – www.astm.org
- Society of Automotive Engineers – www.sae.org
- American Petroleum Institute – www.api.org

## Chapter 8: Odds and ends

I have some stories that I collected. First, my architect drives a big SUV. He was running with Mobil 1 brand 15W-50. He changed it to Pennzoil Multi-grade (mineral oil based, non-synthetic, cheap) 5W-20 at my suggestion. His gas mileage went from 10 to 13 MPG around town. What really impressed him the most was the "robust" increase in "get up and go." He changed from a thick synthetic to a thin mineral oil. His venue is stop and go city traffic in Florida, mostly short trips. The oil just never got that hot to require a 50 grade oil. Short trips means that the oil temperature never gets up to the normal operating range. It was too thick on short trips and too thick when it did get up to temperature.

The lower temperatures he saw with the thinner oil occurred because of reduced friction and internal drag and higher oil flow.

One of the members of the Ferrari Chat web site went from a 40 to a 30 grade oil in his Ferrari 355 for racing in Texas. He noticed a drop in temperature but no change in oil pressure. This may seem odd but really makes perfect sense. Since the 30 grade oil is thinner he got better flow and therefore better cooling. The oil was at a lower temperature so it was not as thin as it would have been at the previous higher temperature. Cooler engines last longer. Fact: The higher the temperature, the greater the wear, all other things being equal.

People say that their old car manual says to use a 10W-40 so they would never think of using a 0W-40. Again, both are the same viscosity at normal engine operating temperature. The 0W-40 just does not thicken as much after you turn off your engine. There are now several cases when manuals for older cars have been updated to reflect this. My 550 Ferrari Maranello manual said to use 5W-40 yet the 575 manual says to use the 0W-40. The engines are the same except the 575 has more BHP. It has better acceleration and more top speed. The engines have the same tolerances.

All manufacturers I have seen are specifying 0W-XX or 5W-XX oils now. Honda, Ferrari, Ford, Mercedes, Porsche, and others specify a 0 or 5W-XX oil to mention a few. These are appropriate for all engines of all ages of all levels of wear. This second number is the only thing that may change with an older, lose or worn engine. This can only be determined by experimentation. If you are using XW-50, go to a 0W-40. If your pressures are still too high go to a 0W-30 and so on.

When I took delivery of my 575 Maranello I drove for 500 miles then changed the oil to 0W-30 Mobil 1. There were no changes in operating pressure or temperature. Starting the engine seemed faster though. I called up FNA and was told that all new Ferrari Maranellos are delivered with 5W-30 Shell Helix Ultra. That is when I decided to try the 0W-20 Mobil 1. I could have gone to a 10 grade oil as my pressures were still excessive while driving around town. I do not drive on the track.

What about the break in period? For one thing you could just follow the car's manual and gradually break your engine in. Some cars like Ferrari and Lamborghini run engines and the cars for a period of time before you even take delivery. They often run up to full power. Some

representatives at least from Ferrari hinted that the traditional break in period was not really needed, at least in their cars.

Most people who buy high powered cars that I have experienced will just get in there cars and step on the gas fully. They do not wait for the oil to warm up. Personally I would not mind running full BHP for short bursts during the break in period but I always fully warm up the engine first. Water / coolant warms up on just a few minutes but oils takes up to 30 minutes to get up to just the normal operating temperature of around 200°F.

Older engines may in fact benefit from thinner oil use. Over time permanent deposits of carbon and sludge build up in the engine oil ways. It is like a clogging of arteries in humans. We are now all on blood thinners. This is an area I specifically studied while a general surgeon resident at Chapel Hill.

Thinner oils, and specifically synthetic products are better. Some people say their engines were "designed" to run on mineral based lubricates. I have not seen anything to support this theory. The synthetic of the same viscosity as the mineral oil you are now using will be an improvement. If you go from a mineral to an even thinner synthetic you may be better off still. The pressures go up in many older engines because of this "clogging" of the arteries. Most think this is good but it is really a lessening of flow and therefore accelerates engine wear even further.

For those engines with excessive varnish and carbon buildup the engine oil additives of the detergent type may be of benefit. On the other hand you could just use a thin synthetic oil and change it every 200 miles for a while and end up with an even cleaner engine. With everything working properly you may actually need a thicker oil if that engine is overly worn. The thicker oil would be a disaster however, if the arteries were narrowed from deposits.

Remember, the only difference between a 0W-40 and a 10W-40 is that the 0W-40 thickens less after you turn off your engine. It is still too thick in the morning at startup but not as thick as the 10W-40. Yet, they are still too thick to use until they both warm up to operating temperature at which point they have the save viscosity, around 13 to 14. Remember that the 0W-30, 10W-30 and straight 30 grade oils all have a viscosity of around 10 at normal engine operating temperatures. They all thicken when you turn off your engine. The 10W-30 will thicken the most.

There is one more thing. A 20 grade oil is not half as thick as a 40 grade oil. The real scale is more like the oils having an absolute thickness of 108 and 114. Now it can be seen that the 40 grade oil is only around 10 percent thicker than the 20 grade oil. The difference is not that much at operation but at startup the difference is significant. Pressure / flow dynamics go along with this 10 percent figure. A 30 grade oil should be thought of as having an absolute viscosity of 110 and a 50 grade oil has an absolute viscosity of 120. I am talking about the viscosity at operating temperatures.

I thought everyone knew that 90 percent of engine wear occurs during the startup period because oil is just too thick. Some think it is good to have a thicker oil for startup since the parts shrink when cold and would otherwise "rattle." Sure, your piston diameter will shrink on cooling but so

will the diameter of your bore. The net result is about the same clearance hot and cold. This is not true for your valves. They lengthen when extremely hot. In the Murcielago they use shims instead of self-adjusting valve tappets. You need to put a millimeter of clearance there so that after expansion the valve will not be held partly open when it is supposed to be closed.

If it were true that thicker oils were needed at startup then the manufacturers would not be requesting oils that thicken less on cooling. They would just specify that one should use a straight 30 or 40 grade oil. Instead, over time, they have been specifying thinner and thinner oils.

The manufacturers know what parts shrink or expand and the clearance changes that result. You do not have to worry about this. If it was that easy to design engines we would all be making them.

I would like to go back to the worry that oil falls off the parts when a car is stored or sees long periods of inactivity. For the first oil change in my 575 Maranello I drained the Shell and put in 0W-30 Mobil 1. This was at a few hundred miles on the odometer. I drove the car home from work, put it on the lift and drained the transaxle and engine oils. I also opened and drained the oil cooler and took off every line that is in the oil system. I wanted to get every speck of the Shell oil out of there. For optimal results you are not supposed to mix synthetic oils of different brands.

The system takes 12 quarts with a “normal” oil change but took 15 quarts for this change. It all took about an hour. I then started the engine to check for leaks. The multitude of mechanical engine noises that followed nearly broke my eardrums for about 10 long seconds. Then it was suddenly very quiet. You could hear a pin drop. There was certainly the most possible amount of surface oil on all the internal parts as the engine was only off for an hour. But it was not until the oil circuit primed, filled, then sent flow into all the parts that any lubrication was occurring. Hence all oil filters that are manufacturer certified have back flow limiters to keep the oil filter full even with the engine off.

Here is an interesting tidbit of information. A 75W-90 gear oil has the same viscosity as a 10W-40 engine oil at 212° and 302°F. Once again, those numbers on that oil can are misleading and certainly add to the confusion I see among automotive enthusiasts. At 75°F gear oils are much thicker than motor oils. There are no start up issues so pour point depressants are not added that minimize the thickening with cooling in gear oils.

## Chapter 9: Let's start over

We have seen that 0W-30, 5W-30, 10W-30 and straight 30 grade oils all have the exact same viscosity at 212° and 302°F. What about startup viscosities? Do 0W-20, 0W-30 , and 0W-40 all have the same viscosity at a 75°F startup. The answer is no. The SAE J300 standard allows for this discrepancy. Here are some examples:

| Oil Type | Thickness |
|---|---|
| 0W-20 | 40 |
| 0W-30 | 50 |
| 0W-40 | 60 |

(Viscosity at 75° startup)

The numbers are not exact but they show clearly that the "0" represents different startup viscosities. This is unlike the 0W-30, 5W-30, 10W-30 and straight 30 grade oils that all have the exact same viscosity in a hot engine = 10 cS.

I would like to comment on the following statements made by a knowledgeable automotive enthusiast:
"Pressure and flow are tied together with viscosity, but none have anything to do with lubrication. Lubrication is a property of the fluid, not the force. The oil pump would pump water just as well, but it would offer no real lubrication. If we double the pressure, we double the flow. If you decrease the viscosity to a lighter oil, you increase flow at a loss of pressure. High flow helps to carry away more heat. High pressure helps to keep metal parts like the bearings out of contact with each other (scuffing)."

Here is one example. Take an air conditioner closed bearing compressor for your home's A/C unit. Put a nipple on the bearing at one end of the shaft. Now pressurize the bearing. It will do nothing extra to reduce wear, nothing.

I give you the following example to help visualize what is happening with motor oil. This assumes the oil has no internal resistance. In actuality doubling the pressure will not double the flow but will be slightly less. And thicker oils have more resistance than thinner oils for all situations. But simplified we get the following:

| RPM | Pressure (PSI) | Flow |
|---|---|---|
| 1,000 | 20 | 1 |
| 2,000 | 40 | 2 |
| 4,000 | 80 | 4 |
| 8,000 | 160 | 8 |

(30 grade oil at operating temperature)

| RPM | Pressure (PSI) | Flow |
|---|---|---|
| 1,000 | 30 | 1.5 |
| 2,000 | 60 | 3 |
| 4,000 | 120 | 6 |
| 8,000 | 240 | 12 |

(30 grade oil at operating temperature)
*Higher output oil pump

If we stick with the same grade oil and increase the oil pump output we will increase the pressure and the oil flow too. If we double the oil pump output we will double the pressure and we will double the oil flow (in an ideal system). But we are always limited by the oil relief valve:

| RPM | Pressure (PSI) | Flow |
|---|---|---|
| 1,000 | 40 | 2 |
| 2,000 | 80 | 4 |
| 4,000 | 160 | 8 |
| 8,000 | 320 | 16 |

(30 grade at operating temperature)
*Higher still output oil pump

Let us compare a 40 grade oil at operating temperature:
The oil is thicker, has more internal resistance and therefore requires more pressure to get the same flow (baseline engine).

| RPM | Pressure (PSI) | Flow |
|---|---|---|
| 1,000 | 30 | 1 |
| 2,000 | 60 | 2 |
| 4,000 | 120 | 4 |
| 8,000 | 240 | 8 |

(40 grade oil at operating temperature)

| RPM | Pressure (PSI) | Flow |
|---|---|---|
| 1,000 | 45 | 1.5 |
| 2,000 | 90 | 3 |
| 4,000 | 180 | 6 |
| 8,000 | 360 | 12 |

(40 grade oil at operating temperature)
*Higher output oil pump

| RPM | Pressure (PSI) | Flow |
|---|---|---|
| 1,000 | 20 | 0.5 |
| 2,000 | 40 | 1 |
| 4,000 | 80 | 2 |
| 8,000 | 160 | 4 |

(40 grade at operating temperature)
*Original pressures

Increasing the pressure while using the same oil will increase the oil flow but increasing the pressure by increasing the oil thickness will result in less flow. It takes more pressure to move a thicker oil. When you go to a thicker oil the pressure goes up because of the increased resistance, and therefore reduction of flow. Because the pressure is higher sooner, the relief valve cuts in sooner. Flow will actually be less when the RPM is up and the flow is needed the most.

There is more to these graphs but I will continue with the next chapter.

Furthermore, in review, pressure does not equal lubrication. Let us look again at a single closed "lifetime lubricated" bearing. We could hook up a system to pressurize the bearing. This can actually be done. We could have the oil at ambient pressure. We could then double, triple, quadruple the pressure of the oil. The oil is non-compressible. Regardless of the pressure we would have the exact same lubrication that of the ambient pressure lubrication.

The physics of lubrication as I said earlier show a 1:1 relationship of flow to separation pressure. Lubrication itself is pressure independent. I will not go into the mathematical equations for this.

Even water can be used as a lubricant. This is partly because of its high surface tension. It is used in many medical devices and other systems that are under or exposed to water. It is just that water rusts metal parts making this unsuitable for automotive engines. It actually has a higher specific heat than oil. It can therefore carry away more heat than oil from bearing surfaces. In this respect water is a better lubricant than oil.

## Chapter 10: The Graduate

I am going to bring up the constant flow pump concept. First, it goes back to the principal that doubling the pressure of the same grade oil does not exactly double the flow but it is close. Also doubling the RPM for the same reason does not exactly double the flow but again it is close.

This shows the problem best:

(A)

| RPM | Pressure (PSI) | Flow |
|---|---|---|
| 1,000 | 20 | 1 |
| 2,000 | 40 | 2 |
| 4,000 | 80 | 4 |
| 8,000 | 160 | 8 |

(30 grade oil at operating temperature)

(B)

| RPM | Pressure (PSI) | Flow |
|---|---|---|
| 1,000 | 30 | 1.5 |
| 2,000 | 60 | 3 |
| 4,000 | 120 | 6 |
| 8,000 | 240 | 12 |

(30 grade oil at operating temperature)
*Higher output oil pump

If we stick with the same grade oil and increase the oil pump output we will increase the pressure and the oil flow too. If we double the oil pump output we will double the pressure and we will double the oil flow.

(C) For a 40 grade oil at operating temperature:
The oil is thicker, has more internal resistance and therefore requires more pressure to get the same flow. Compare this with (A):

| RPM | Pressure (PSI) | Flow |
|---|---|---|
| 1,000 | 30 | 1 |
| 2,000 | 60 | 2 |
| 4,000 | 120 | 4 |
| 8,000 | 240 | 8 |

(40 grade oil at operating temperature)

(D)

| RPM | Pressure (PSI) | Flow |
|---|---|---|
| 1,000 | 45 | 1.5 |
| 2,000 | 90 | 3 |
| 4,000 | 180 | 6 |
| 8,000 | 360 | 12 |

(40 grade oil at operating temperature)
*Higher output oil pump

The situations (A) and (C) are close to real life, assuming no loss in the system. This is what happens when you change the 30 grade oil to a 40 grade oil in your car:

(A) For a 30 grade oil at operating temperature:

| RPM | Pressure (PSI) | Flow |
|---|---|---|
| 1,000 | 20 | 1 |
| 2,000 | 40 | 2 |
| 4,000 | 80 | 4 |
| 8,000 | 160 | 8 |

(30 grade oil at operating temperature)

(C) For a 40 grade oil at operating temperature:
The oil is thicker, has more internal resistance and therefore requires more pressure to get the same flow.

| RPM | Pressure (PSI) | Flow |
|---|---|---|
| 1,000 | 30 | 1 |
| 2,000 | 60 | 2 |
| 4,000 | 120 | 4 |
| 8,000 | 240 | 8 |

(40 grade oil at operating temperature)

At 6,000 RPM the maximum rate of flow has been reached with the thinner oil (A). When you go to 7, 8 or 9,000 RPM you do not get any more flow. You only get a maximum rate of 5. The internal forces on the bearings increase but there is no additional flow of oil.

With the thicker oil you reach maximum flow at 3,000 RPM (C). Worse yet is that the maximum flow is now only 3. As we increase RPM to 4, 5, 6, 7, 8, 9,000 RPM we get no additional pressure and no additional flow, no increase in lubrication.

Next let us look at a 20 grade oil at operating temperature. We get the same flow out of our constant volume pump but the thinner oil requires less pressure to move through the system. This even goes along with the rule that we should use an oil that gives us 10 PSI per 1,000 RPM:

(D)

| RPM | Pressure (PSI) | Flow |
|---|---|---|
| 1,000 | 10 | 1 |
| 2,000 | 20 | 2 |
| 4,000 | 40 | 4 |
| 8,000 | 80 | 8 |

(20 grade oil at operating temperature)

The maximum flow rate has not been reached. If the engine went to 9,000 RPM then the flow would be 9 at 90 PSI, our maximum pressure at pop off. The engine now has 3 times the flow rate as with the 40 grade oil at full RPM. The nozzles at the bottom of each cylinder are spraying 3 times the amount of oil lubricating and cooling this section. Everything runs cooler and the separation forces in the bearings are 3 times higher.

For engines that redline at 5,000 RPM they usually pop off the oil pressure at 50 to 60 PSI. For engines that go to 8-9,000 RPM the pressures max out at 90-100 PSI. You can now see that you can only get the maximum flow rate if you follow the 10 PSI / 1,000 RPM rule.

The winner: 0W-20 grade oil for my Maranello. I said earlier that I could have used a 10 grade oil. I actually only ran with 185 F oil temperatures around town and the pressures were similar to the 40 grade oil example in (C) above. This is why I also said that in the racetrack condition, with hotter, thinner (0W-20) oil, I may actually get the optimal results as in (D) above.

Now let us go back to the Ferrari recommended parameters in my 575 Maranello manual. It calls for 75 PSI at 6,000 RPM. The pop off pressure has not been reached. As we now increase the RPM we still get an increase in flow rate. This is what we need and this is exactly what they are recommending. We get our maximum flow at the maximum system pressure, at about the maximum engine RPM of 7,700. There is no bypassing of the oil. All oil pumped goes through the system. There is no wasted BHP pumping oil past the bypass valve back to the oil tank. It is the perfect system.

Finally I will compare a single, 30 grade oil, at normal (212°F) and at racetrack (302°F) temperatures:

(A) 30 grade oil at 212°F

| RPM | Pressure (PSI) | Flow |
|---|---|---|
| 1,000 | 20 | 1 |
| 2,000 | 40 | 2 |
| 4,000 | 80 | 4 |
| 8,000 | 160 | 8 |

(30 grade oil at operating temperature)

(E) 30 grade oil at elevated 302°F operating temperature. The oil is thinner at 302 F. It requires less pressure to get the same flow:

| RPM | Pressure (PSI) | Flow |
|---|---|---|
| 1,000 | 10 | 1 |
| 2,000 | 20 | 2 |
| 4,000 | 40 | 4 |
| 8,000 | 80 | 8 |

(30 grade oil at 302°F operating temperature)

The hotter (302°F) 30 grade oil is thinner than the cooler (212°F) 30 grade oil. It has the same flow rate in the constant volume oil pump but at a lower pressure than the oil at normal operating temperature. This allows for a doubling of the flow rate at peak RPM. The thinning of oil at higher temperatures is a benefit. You get more flow, more cooling and more lubrication.

The 30 grade oil at 302°F has the exact same flow rate and pressures as the 20 grade oil at 212°F. See (D) above. Therefore, use the 20 grade for around town driving and the 30 grade on the hot track. You get maximum flow at each situation.

For YOUR engine, substitute the actual flow at 1,000 RPM. If your engine puts out 1.5 liters/min. at 1,000 RPM it would put out 3 liters/min. at 2,000 RPM and 6 liters/min. at 4,000 RPM and so on. The maximum flow in (A) would be 7.5 liters/min. In situations (D) and (E) you would get a maximum of 13.5 liters/min.

**Conclusions**:
The reason that multi-grade oils were developed in the first place was to address the problem of oil thickening after engine shutdown. Over the years we have been able to reduce the amount of thickening that occurs. Never-the-less there is no oil that does not thicken after you turn your engine off. This is why we have to warm up our engines before revving them up. Engine designers always pick the recommended oil based on a hot engine and hot oil. There is no issue with oil thinning as they are both matched when hot. The problem is oil thickening when the engine cools.

Cold engine showing very high pressures because of the thickened oil at startup:

For a 40 grade oil at 75°F at startup:
The oil is thicker, has more internal resistance and therefore requires more pressure to get the same flow.

| RPM | Pressure (PSI) | Flow |
|---|---|---|
| 1,000 | 60 | 1 |
| 2,000 | 120 | 2 |
| 4,000 | 240 | 4 |
| 8,000 | 480 | 8 |

(40 grade oil at 75° startup)

At 1,500 RPM you reach the maximum oil flow rate and if you run to 8,000 RPM it is the same rate. The flow cannot increase and it is insufficient. This is why we must wait until our oil temperature comes up to 212°F or higher. The maximum flow rate in this case will then double, up to 3. To get even more flow in our test engine you need to use a lower viscosity grade.

If you have absorbed and digested the information here you should be able to pick out the proper operating oil grade for your car, be it a 30, 40, 50 or even 20 grade oil. I have always used oils that were a grade thinner than recommended even though many use a grade thicker than recommended. I showed evidence that the starting grade should always be 0 or 5 (0W-XX or 5W-XX for thicker oils). If you want the best protection and highest output from your motor use a synthetic based oil. The actual brand is not as critical as the viscosity. The rating must be the SL or SM rating. Change your oil every 3 – 5,000 miles and at least every spring.

**THE END**

# Mid-Term Exam

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1) **At normal operating temperature, 212°F, a straight 30 grade oil has a viscosity of how many centiStokes?**

A. 3
B. 6
C. 10
D. 20
E. 30

## Answer: C

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2) **While racing at 95°F, mid-summer in Florida, which of these synthetic oils gives the best protection at 302°F oil temperature?**

A. 0W-40
B. 5W-40
C. 10W-40
D. Straight 40 grade
E. They are all exactly the same

## Answer: E

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3) **While starting up your car at 75°F, mid-winter in Florida, what is the approximate viscosity of a straight 10 (ten) grade motor oil?**

A. 3 cS
B. 6 cS
C. 10 cS
D. 20 cS
E. 30 cS or higher

## Answer: E

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4) **The biggest problem with mineral based motor oils with long tern use is:**

A. Thinning
B. Thickening
C. Loss of VI (viscosity index) improvers
D. Both A and C
E. None of the above is correct

## Answer: B

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5) **Which of the following mineral based motor oils are still too thick at a 75°F startup temperature?**

A. 20 grade
B. 10 grade
C. 5 grade
D. All of the above
E. None are too thick

## Answer: D

# Final Exam

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1) **While starting up your car at 75°F, mid-winter in Florida, which of these synthetic oils provides the least startup resistance, minimal battery and starter motor load?**

A. 0W-20
B. 0W-30
C. 0W-40
D. 0W-50
E. They are all exactly the same

## Answer: A

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2) **While vacationing in Orlando, it is 104°F mid-summer in Florida. The rental car company put a straight mineral based 30 grade oil in their car because they wanted the operating temperature viscosity to be at 10 cS. What will be the approximate viscosity of the oil when you start up your engine now?**

A. 10 cS
B. 20 cS
C. 30 cS
D. 100 cS
E. 400 cS

## Answer: D

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3) **While vacationing in Florida you are able to race your car at the Sebring track. At an oil temperature of 302°F what is the approximate difference in viscosity between a 20 and 40 grade oil. Pick the closest number.**

A. 1
B. 10
C. 20
D. 40
E. 400

## Answer: A

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4) **Assume there are no losses in the system and your oil pump is truly volume based. Also assume there is no cut off pressure valve and you are using a 40 grade motor oil. If at 1,000 RPM your pressure is 30 and your pump output is 1 (one), what will the pressure and output be at redline, 8,000 RPM?**

A. 240 PSI, flow = 8
B. 180 PSI, flow = 8
C. 240 PSI, flow = 4
D. 180 PSI, flow = 4
E. 120 PSI, flow = 8

## Answer: A

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5) **Water can be used as a lubricant.**

A. True
B. False

## Answer: A

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6) **If you increase the pressure in a bearing, all other things being constant, the force of separation between the parts increases.**

A. True
B. False

## Answer: B

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7) **The best grade oil for racing any Ferrari or Lamborghini is a 40 grade multi-grade synthetic oil like Mobil One 0W-40.**

A. True
B. False

## Answer: B

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8) **For my Maranello 575 the 0W-20 grade Mobil 1 oil was actually too thick for my driving conditions.**

A. True
B. False

**Answer: A**

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9) **The major problem with engine oil is that it thins with increasing temperature.**

A. True
B. False

**Answer: B**

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10) **Your 1993 sports car manual states to use an API / SAE SH rated 10W-40 mineral based motor oil. Your engine has only 4,550 miles on the odometer. On your next oil change it would be better to use a SM rated 0W-40 synthetic oil.**

A. True
B. False

**Answer: A**

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11) **According to SAE J300 a 0W-30 and a straight 30 grade oil must have a viscosity of between 9.3 and 12.4 centiStokes at operating temperature (212°F).**

A. True
B. False

**Answer: A**

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12) **In my list of recommended oils what did I list as the best mineral based motor oil in the 50 grade class?**

A. Pennzoil multi-grade 20W-50
B. Castrol GTX 20W-50
C. Red Line 15W-50
D. Valvoline Durablend 20W-50
E. No oil was recommended

**Answer: E**

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13) **You are running 5W-40 Shell Helix Ultra fully synthetic motor oil in your Mercedes Benz. You are in a K-Mart shopping center and checked your oil and it is 1 1/2 quarts low. You will need to add one can of oil now. Which of the following is the best choice.**

A. Mobil 1 – 0W-40
B. Pennzoil Synthetic 5W-40
C. Red Line Synthetic 5W-40
D. Castrol Syntec 0W-30
E. Shell mineral based 10W-40

## Answer: E

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14) **Motor oils that are labeled "for racing only" should not be used for everyday driving because:**

A. They do not have detergents
B. They may have harmful levels of some additives
C. They are generally unrated, there is no SJ, SL or SM approval
D. You would have to take your engine apart and clean it periodically
E. All of the above

## Answer: E

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15) **ASTM stands for:**

A. Automotive Standards and Test Methods
B. Automotive Society for Tooling and Machining
C. American Society for Testing and Materials
D. American Standards Trade and Manufacturing
E. Society for American Standard Testing Methods

## Answer: C

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16) **If your engine is running too hot at higher RPM one thing you can try to bring the temperature down is to use a thinner oil.**

A. True
B. False

## Answer: A

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17) **Oil with a startup thickness of 100 (at 75 F) that becomes the appropriate thickness of 10 when fully warmed up (212 F) is called a 10W-30 grade motor oil.**

A. True
B. False

## Answer: A

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18) **A main advantage that the synthetic has over the mineral based oil of the same grade is the ability to lubricate better at startup.**

A. True
B. False

## Answer: A

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19) **In ASTM D 4485 3.1.4: Engine oil is defined as "a liquid that reduces friction and wear between moving parts within an engine, and also serves as a coolant."**

A. True
B. False

## Answer: A

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20) **I am (single best answer):**

A. Surgeon
B. Biochemist
C. Halfass mechanic
D. Absurdly interested in motor oils
E. All of the above

## Answer: E

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