Selection of the Right Motor Oil for the Corvair and other Engines – 2025 Edition

By Richard Widman

This is a major revision or re-write of the paper, based on technologies that have been developed since I wrote the first version in April of 2008.

A lot of things have happened in the lubricant industry, especially in the las 5 years. Enough to change the recommendations for our classic cars. I will try to explain these developments as well as a little history.

I'm sure there will be additional questions that will arise or points that I haven't explained to the satisfaction of some readers. Please send your questions or suggestions to rlwidman@hotmail.com *and I will answer them in the next draft.*

Introduction

My object in this paper is to explain in common language how to protect your engine through the selection of the correct oil. In this explanation I will be summarizing various SAE Technical Papers with the information pertinent to this discussion. I will not tell you which brand to buy, but what to look for on the label (*and what I am using*). I will not repeat word for word what is in the pages of the American Petroleum Institute, but put it in the best layman's terms I can think of. Some people will say that there are not enough graphs and charts; while others will say it is overkill. I have eliminated the section that showed the reactions and effects of different additive balances on different base oils. I hope to strike a balance.

Many questions have been raised about the wear on flat tappet valve trains and other parts of these engines by the reduction of ZDDP in the API SM & SN oils and the desire to add commercial additives to increase those levels. Here we will investigate the advantages and disadvantages of different oils and aftermarket additives.

Many people say they have been using the same oil for 20 years, why change now. The answer is simple. Between 2000 and 2020, the emphasis on oil development has been almost entirely driven by goals to reduce friction and increase gas mileage in the ever-developing automotive engines. The oils produced in that period were very good at protecting these newer engines, but ignored the needs of flat tappet engines. *But the development of the 2020 category of oils for the API category SP (ILSAC GF-6) was to protect the engines from low speed preignition.* ***That development is key to what I will address here, and key to the reason for a change in recommendations.*** The new (2025) API SQ (ILSAC GF-7) oils continue improve engine protection.

New Recommendations

For those who are anxious to see the new recommendations without reading the details or history, here it is. But please read further before asking questions or critiquing based on experiences, myths, or other opinions.

Any motor oil with an API rating of SP or SQ will provide more wear protection than any diesel formulation, and most specialty oils.

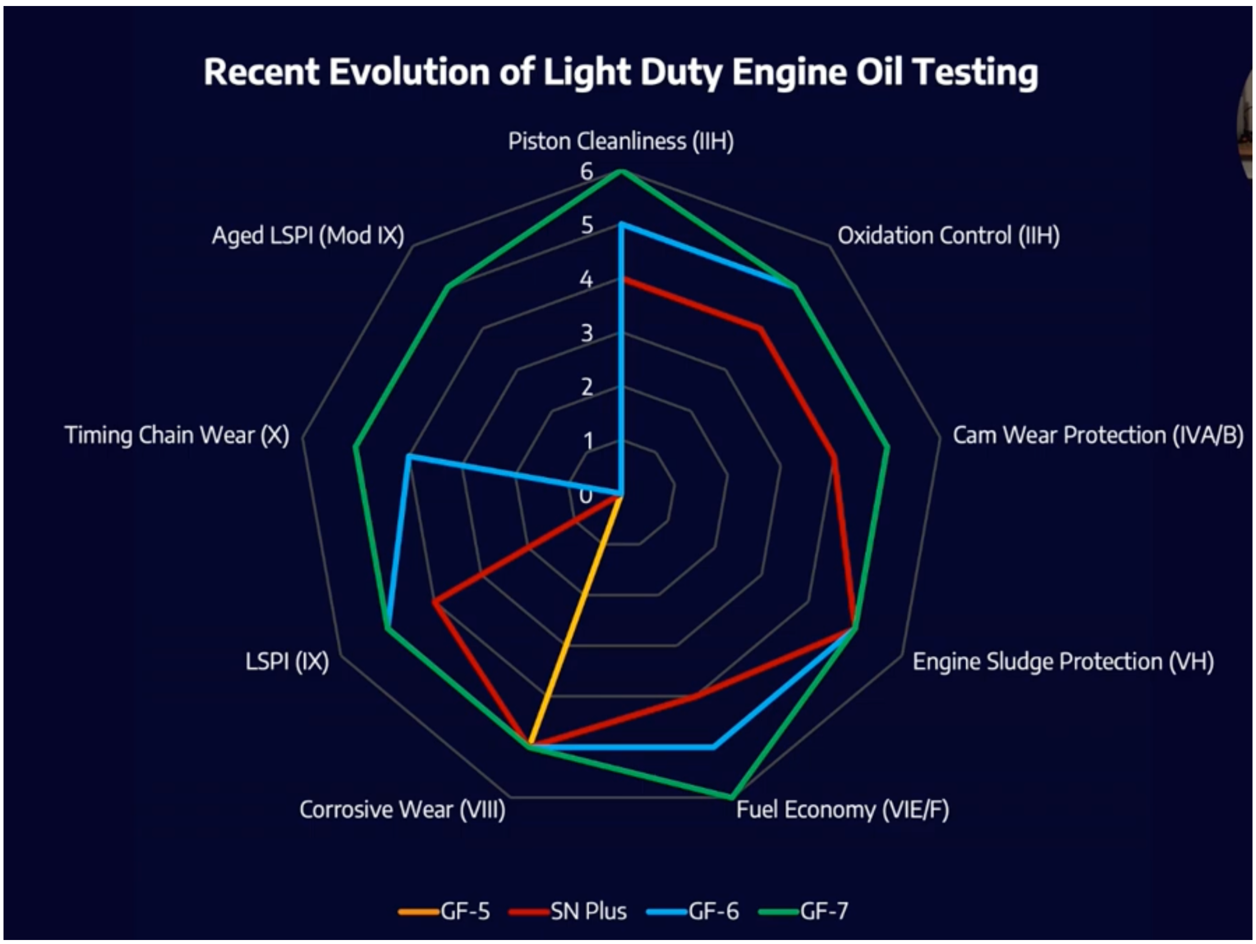
Yes, you read that right. With the developments of the SP category of engine oils, where part of the Calcium was replaced by Magnesium to eliminate LSPI in TGDI engines, the current levels of ZDDP provided much better wear protection than SM, SN, CI-4, CK-4, or other oils in Flat tappet engines.

Why?

The main detergent/dispersion agents used in motor oils are Calcium and Magnesium. It has been known for decades that too much magnesium destroyed engines, so most formulations used high amounts of calcium, sometimes exclusively. CK-4 oils reduced the calcium and blended magnesium to compensate. When manufacturers needed to reduce LSPI in gasoline engines, they tried the same and found that it not only reduced the deposits that caused LSPI, but let the ZDDP do its job much better. When tested in Flat Tappet engines, the SP oils reduced wear when compared to the diesel formulations we have depended on.

In addition, most of the SP (and now SQ) oils are using a significant amount of Boron and Moly. I've loved the Boron additives since I started working with them in 2000 with industrial gear oils. And Borate additives have shown greater protection in air cooled engines. So, **any API oil rated SP or higher will provide better protection in flat tappet engines.**

Here is a graph that shows the progress of the SQ oils over previous categories. Most notably for our cars is the improved cam wear protection and piston cleanliness. The new aged oil tests are also important, as they show prolonged protection. You should save a little gas along the way.



As for viscosity, I will go into much detail further in this paper, but for those choosing skip that part, my basic recommendation remains what GM published since 1960: SAE 10W-30 is the best option for almost everywhere. With the development of better multigrade oils since then, a 5W-40 would be appropriate for very hot areas (Las Vegas comes to mind). Read further for details.

There is one more development that I will introduce here

Technology has not stood still. In 2019 when I was working with power companies trying to solve their problems with varnish on large turbine bearings, vibrations, high temperatures, and short oil life, I started working with a company in Houston that had developed a product where you can add a small amount of it to a turbine or screw compressor oil that is dark from the varnish deposits and solubilize all those deposits, releasing the solid contaminants to flow into the filters, effectively cleaning the bearings and shafts completely while they operate; reducing temperatures and vibrations, extending the life of the oil indefinitely, leaving internals like new.

I believe this chemistry, or a variation of it is being used in the *Valvoline Restore and Protect* line of motor oils. Their publications, along with reports from reputable people on line, reports from some friends who are using it in their cars and customers cars, has led me to use it in my Corvair.

While I've only got 13,000 miles on my Corvair since I re-built the engine, it has been 16 years, with a lot of pauses, storage, and shipping, and there was varnish on the underside of the engine cover when I changed the (*65-year-old*) fan bearing last month, so I decided to try this product, in the 5W-30 version. I only had about 500 miles on the Rotella 10W-30, but it had developed lifter noise that lasted several minutes after most starts. Within two days with the Valvoline product, I no longer had any lifter noise. I now have about 800 miles on the new oil, and it sounds quieter.

They say that, in time, it will clean up the rings and ring lands to promote better sealing of the rings if it is needed, but I have no way of testing that, although someone told me recently that it has seriously reduced the oil consumption in his 57 Chevy in only 2 months.

I believe that with this knowledge, the ***next*** category of engine oils will require the ability to clean up and maintain cleaner engines, instead of just maintaining a certain level of cleanliness and this technology, or a version of it, will become common in all certified oils.

So, at this point, although I'm sure many specialty oils are fine, and maybe racing oils are better for people who do a lot of racing or have particularly aggressive cams/springs, my primary recommendation is ***Valvoline Protect and Restore 5W-30***. (read further to see why 5W-30 can substitute for 10W-30). It is interesting to note that this product already passed the SQ standards before they were published.

Typical Properties:	SAE 5W-30
KV100 (cSt)	10.8
KV40 (cSt)	64
Viscosity Index	161
Density @ 15 °C kg/m³	0.852
CCS (cP @ °C)	<6200@ -30
Pour Point (°C)	</= -36
Zinc (ppm)	850
Phosphorous (ppm)	770
Noack (% loss)	<15.0

History

In the 1960's when the Corvair engines were produced, there was basically only one commercially available type of base oil and very little in the way of classification of oil quality. Through the years the American Petroleum Institute (API) in cooperation with the engine manufacturers, oil companies, and car/truck makers have established norms for base oil classification and additive types, levels and effectiveness.

When the current API classification system was developed it classified the oils of 1960 as "SB" for gasoline and "CC" for Diesel engine oils. The higher quality oils of the time, recommended by the Corvair Maintenance Manual, were classified "API Service MS" or "API Service DG".

The “MS” oils were similar to what is known today as “API SC” up until 1968 when improvements were made. These were later classified as “SD” for gasoline engines. The “DG” oils were similar to what is known today as “API CA” for diesel engines. At some point in time the oil companies came out with an additive containing additional anti-wear ingredients. Some oil companies began to sell oils with these products included and called them “supplement 1” oils or HD oils.

GM was a pioneer in raising the phosphorous level of oils from 200 ppm to 800 ppm for certain high horsepower engines with flat tappets in the 50’s and 60’s. I imagine that their additive was designed to raise the level from 200 ppm to 800 ppm, but I was too young at that time to investigate that.

Thanks to a reader of this paper who sent me a can of oil from the late 60’s, I have now had a sample of MM-MS-DG quality oil analyzed. After the brand name they have the word “plus” on the label, which might indicate it was their premium product. The results show that the Zinc was 517 ppm and there was 482 ppm of phosphorous (slightly more than half the level of today’s SP oils). It also had 807 ppm of Calcium as a detergent and 124 ppm of barium as a demulsifier (which is contrary to current oil production, since it would cause the moisture in the oil to settle out and cause sludge and rust in low places instead of evaporate in hot places. As this mixed with lead from the gasoline, it left a big mess in the oil pan.

The base oils used in those oils were fractionally distilled petroleum products using solvents to extract what they could of impurities and wax (paraffin). Today these base oils are called “API group I”. There were different extraction processes used to filter out or extract the paraffin from the oil, resulting in different wax contents in different oils. There was no classification of these base oils, and some had much higher molecular saturation than others, resulting in less evaporation and deposits, while others had high aromatic content and therefore higher acid formation, evaporation and oxidation. Some had too much wax and obtained a reputation of filling the engine with waxy compounds. In general, the Pennsylvania base stocks had less aromatics and produced better products, although in the earlier years, before paraffin separation, they left waxy deposits. Today those oils are divided in two sub-categories within the group I category based on their aromatic content. Today, most motor oils sold in the US are group II, group III, or mixtures, using variations of hydrocracking techniques originally developed by Chevron in 1984.

Additive Levels

The basic additive package for motor oils designed to reduce wear (anti-wear) is a combination of zinc and phosphorous that is commonly called ZDDP. This is combined with Calcium or Magnesium for cleanliness and anti-acid. This part of the package is referred to as “Detergent/Dispersant”. These additives are polar. That means that one end of each molecule tries to adhere to the metallic surfaces of the engine to keep it clean or keep it from wearing during periods of contact while the other end is saturated with oil.

It is important to note that the API does not qualify oils based on additive levels, but on performance. Performance is determined by base oil and additives. Different base oils need different levels of additives for optimum performance. It is the combination of additives and base oil that gives performance and protection. As shown above, the API Service MS of the late 60’s (known as “SC” or “SD” today) oils had only 800 ppm of detergent and approximately 510 ppm (parts per million) of zinc combined with 480 ppm of phosphorous. At that time, little was known about the rate of evaporation of different phosphorous compounds and their effect on the length of time that the oil could provide adequate boundary lubrication.

Lubrication

To fully understand the effects of the oil in the engine it is necessary to understand the basics of the four types of lubrication:

1. **Hydrodynamic lubrication**: A cushion of liquid oil surrounds the lubricated item and holds it away from the rest of the parts. When the **proper oil viscosity** is used in a properly built engine at **operating velocities**, the crankshaft is in hydrodynamic lubrication. It has no contact with the bearings. The only physical contact is during startup before velocity is attained or under lugging from improper gear range. If the oil is too thin, it can be displaced and allow contact. If it is too thick it takes longer to get to the bearings and valve train as well as build pressure (the cushion) in the bearings creating additional wear. If the oil shears excessively (loses viscosity) this cushion is broken. Oil pressure is normally measured in the passage to the bearings. **Low pressure means a weak cushion; excessive pressure means too much restriction for adequate flow to all parts.**
2. **Elasto-hydrodynamic lubrication**: During brief moments in the operation of the engine, certain parts, such as the cam pushing on the rockers, create so much pressure that the oil is momentarily converted to a solid. During these brief moments the oil is passed through the bearing or lubricated surface as a solid, deforming the surface.
3. **Boundary lubrication**: When the oil is displaced completely, cleaned by the oil control rings or sliding action of the valve train, as well as crankshaft bearings during startup until the oil gets to the bearings, the lubrication is provided by the anti-wear additives. These polar compounds are attached to the metal surfaces, although they can be stripped off by continued use in this mode (starved for oil) or fuel in the oil.
4. **Mixed lubrication**: This is a combination of hydrodynamic and boundary lubrication. It occurs between boundary lubrication and hydrodynamic lubrication in the cylinders on startup and shutdown of the engine, in certain parts of the valve train, and other areas where there is minimal full film hydrodynamic lubrication.

Viscosity

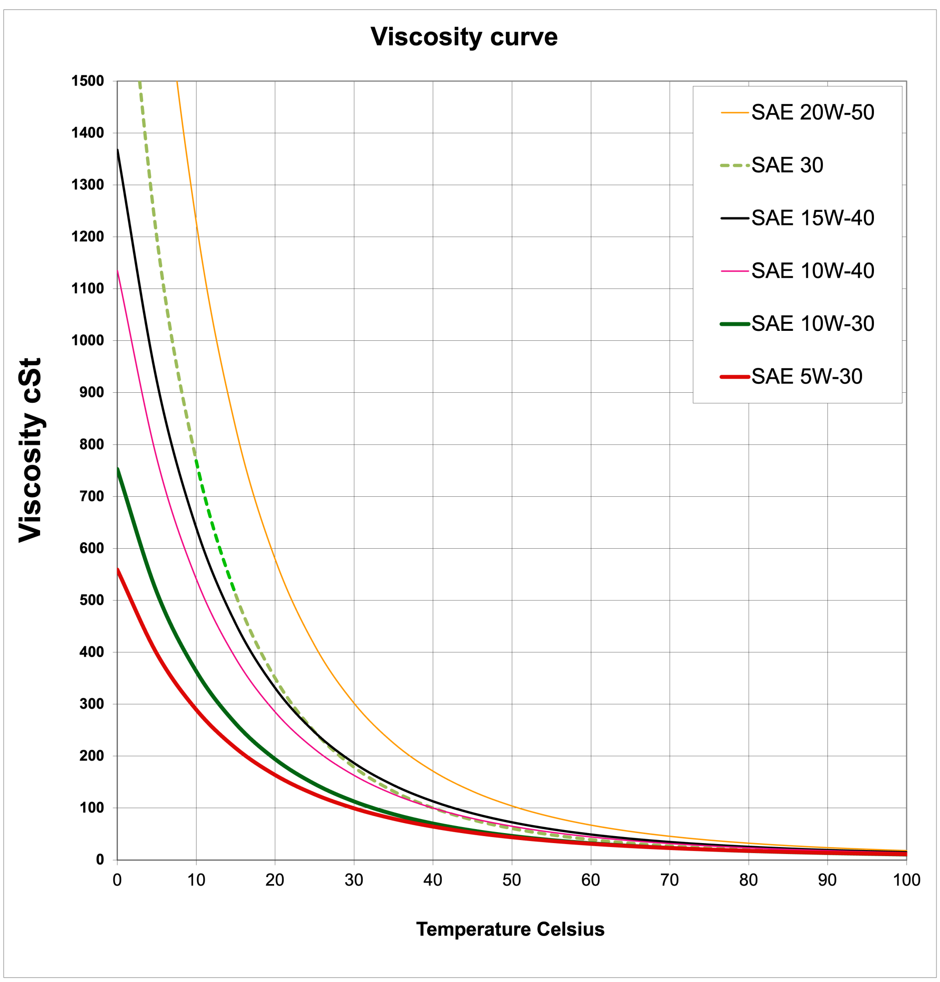
Viscosity is defined as the *resistance of a fluid to flow*. The more resistance the liquid creates, the higher the viscosity. The higher the viscosity, the higher the fuel consumption, engine temperature, and load on the engine. The most important aspect of an oil is its viscosity. To create the **correct** hydrodynamic cushion for maximum protection for any given velocity, surface area and diameter/tolerance, you need a specific viscosity. In the design of an engine this ideal viscosity is calculated, tested, and then recommended. As mentioned above, an oil too thin will not provide enough hydrodynamic lubrication, and an oil too thick will not flow properly. Eventually, as an engine wears, it may be necessary to compensate by **slightly** increasing this viscosity. “High mileage oils” do this by being in the upper portion of the range for a specific viscosity.

The following table shows the different SAE viscosities that meet engine design characteristics. See the SAE J300 table for additional data.

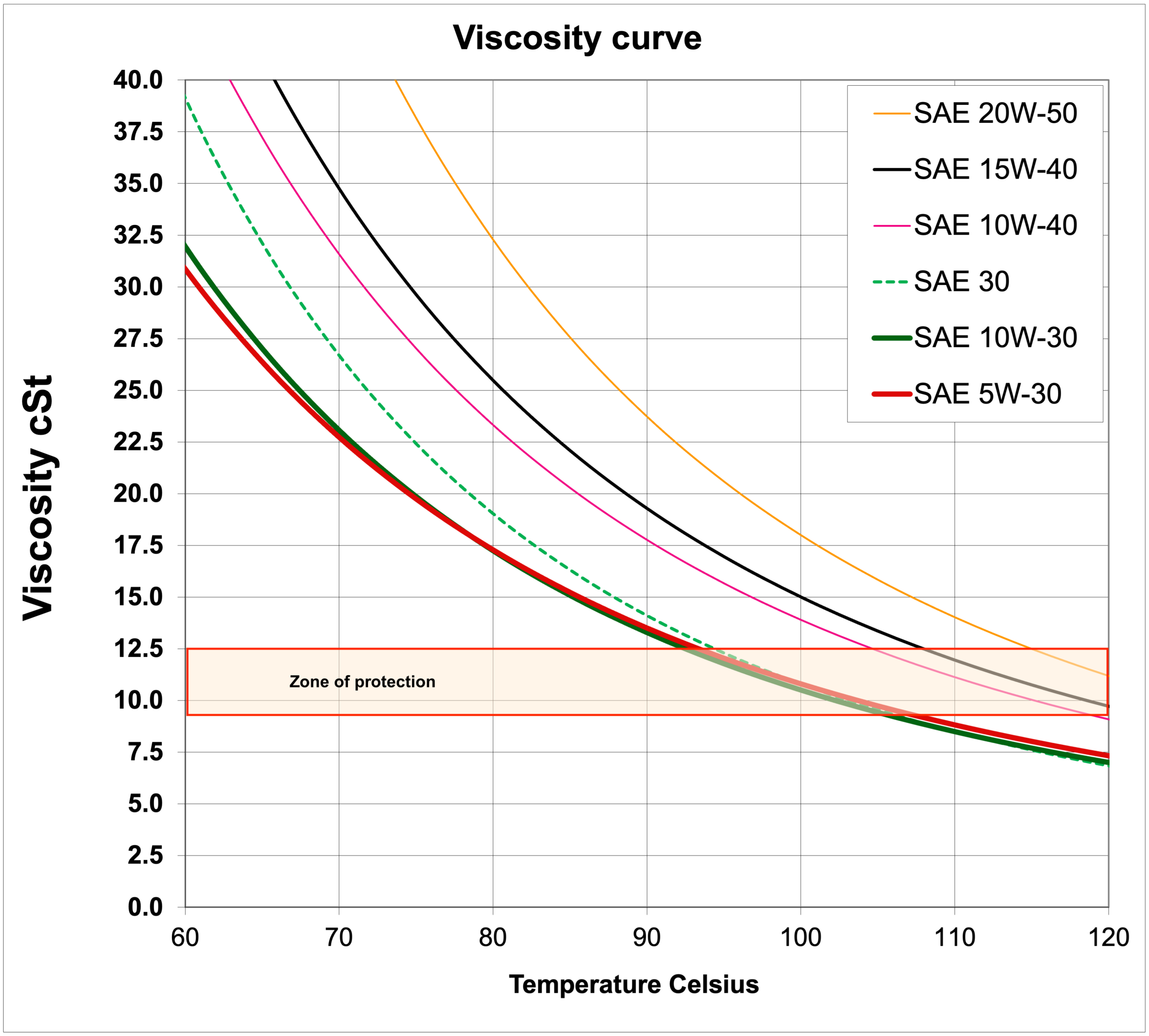
Oil viscosity at operating temperature (100° C) required by engine design	SAE viscosities to choose from
5.6 cSt – 9.6 cSt	0W-20, 5W-20, 20
9.3 cSt – 12.5 cSt	0W-30, 5W-30, 10W-30, 30
12.5 cSt – 16.3 cSt	0W-40, 5W-40, 10W-40, 15W-40, 40
16.3 cSt – 21.9 cSt	0W-50, 5W-50, 10W-50, 15W-50, 20W-50, 25W-50, 50

As an example, the 1960 Corvair Service Manual recommends SAE 10W-30 or SAE 30 for most operating conditions anticipated. (the early printings did not show 10W-30). Chevrolet *apparently* designed this engine to run on oil that is between 9.3 cSt and 12.5 cSt in the bearings. This means that as long as our oil is in that viscosity range, we are minimizing the wear in the engine. When the oil viscosity is *above or below* that range the engine will have additional wear. Here you can see the overall range of viscosities for six commonly used engine oils.

If the lowest anticipated temperature during the interval in which the oil will remain in the crankcase is:	The following SAE viscosity oils are recommended:	Multi-Viscosity oils recommended:
32° F	SAE 30	SAE 10W-30
—10° F	SAE 10	— —
Below —10° F		SAE 5W—20



Here is the same chart, looking in detail at the viscosities at the high end of the operating temperature range. You will see that around 80ºC (176ºF), the 5W-30 is more viscous than the 10W-30, giving more protection at both ends of the scale. There will be slight variations between different brands.



You can see from this chart that until the engine reaches operating temperature there is very poor lubrication and frequently the oil is going through the bypass valve directly to the bearings without passing the filter (in other cars it goes through the dirty filter and out the bypass valve). During this period, you should refrain from putting the engine under high load or high rpm.

As the engine approaches operating temperature, we begin to get close to the range of optimum protection, as shown in the following graph. (These are typical values. To graph your own oils, click here.) This next graph shows the zone of protection when an engine is designed for a 10W-30. You could call it the "Goldilocks zone", as it is not too thin and not too thick.

We see here that a typical:

- SAE 5W-30 engine oil is in the design viscosity between 92° C and 107° C
- SAE 10W-30 engine oil is in the design viscosity between 93° C and 107° C
- SAE 30 is in the design viscosity between 97° C and 106° C

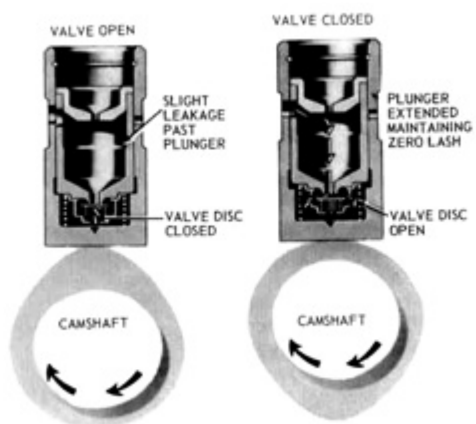
- SAE 10W-40 is in the design viscosity between 98° C and 118° C
- SAE 20W-50 oil is in the designed viscosity range between 118° C and 130° C.

Note that this means an engine with 20W-50 oil is outside of its ideal range of protection from the time it is started until the bearings reach 118° C, causing excessive wear.

Monograde oils: The first concept to understand when contemplating the difference between single grade (SAE 30) and multigrade (SAE 10W-30) motor oils is that:

- Single grade SAE 30 is just that. It will thicken up in the cold and thin out in the heat with a fairly steep slope. It is thicker than an xW-30 oil in the cold and thinner at higher temperatures. It is only at the proper viscosity from 97º to 106º C. If we start the engine at 70ºF, it is more than twice the required viscosity.
- A multigrade 10W-30 depends on its base oil for its strength.
    - A 10W-30 Group I mineral oil is basically a SAE 15 that has polymers that expand and cause resistance when heated to flow more slowly, acting as a SAE 30 in hot areas of the engine and cold flow additives that make it flow better at sub-freezing temperatures.
    - A 10W-30 Group II oil is similar to the Group I oil except that it is much stronger molecularly and therefore uses fewer polymers. It also has fewer aromatic molecules and more saturated molecules for better film strength.
    - A true 10W-30 synthetic oil is basically a SAE 30 oil that has been created structurally to act as a SAE 10 when it is cold. It does not need polymers.
    - The cheaper "full synthetic" oils are usually API Group III products, and still need polymers to improve their viscosity range, but less than a Group II product, and will have more saturated molecules (less aromatics).
- Most single grade oils have not been updated in formulation since SF. They are assumed to be used in lawn mowers and other small equipment. Many use 100% calcium for their detergent/dispersant, negating the much of benefit of the ZDDP (from what we now know).

Also, it is important to note that the thinner the oil, the faster it will pressurize the lifters. All oils will drain out of the lifters from the pressure on them when the engine is off. If too much drains out, it may be time to add an engine cleaner for a thousand miles or so, and then better oil (*see my primary recommendation at the beginning*). Moving to a thicker oil to reduce the drainage should be considered a temporary step since it can cause other problems and takes longer to re-fill them.

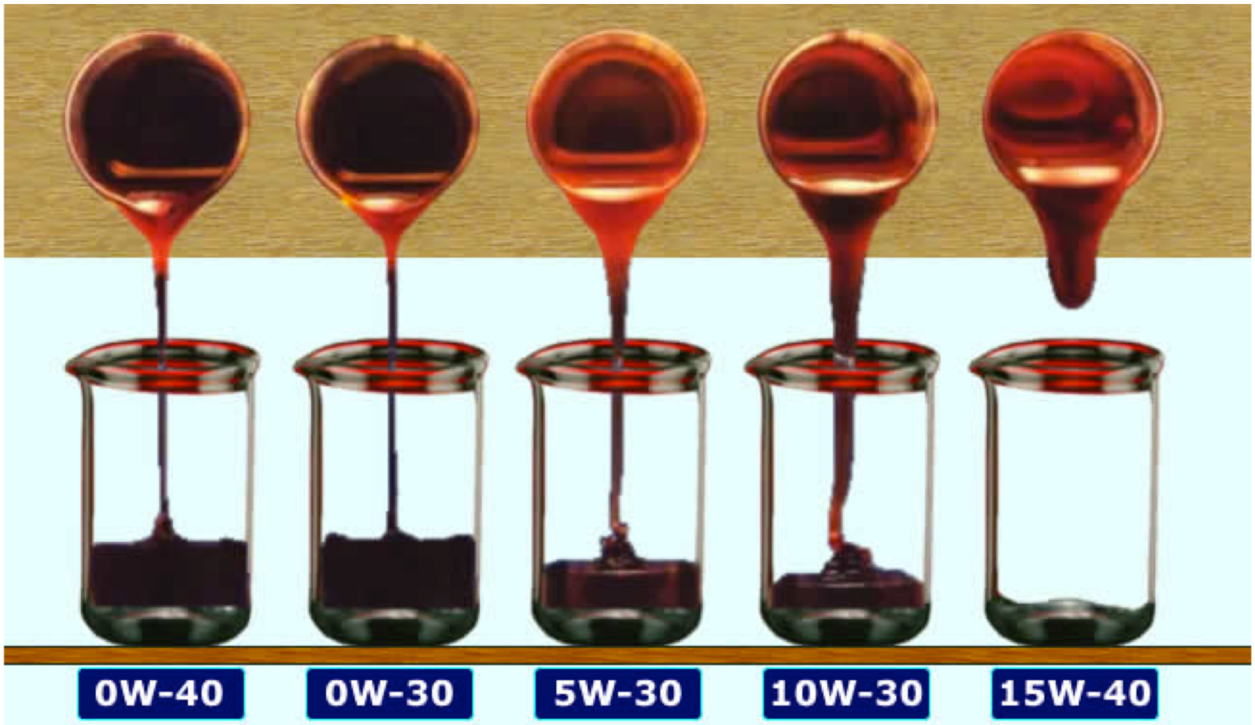


Many people consider lifter noise normal. While a few seconds could be considered normal, any more than that is damaging the engine, especially on a Corvair engine that uses pushrods between the rockers and the lifters. The noise that you hear is the banging of metal, whether internal to the lifter or directly against the ends of the pushrods. That hammering is transmitted from the cam to the valve stem through each of the connected parts. Every little "bang" adds up, causing more fatigue, wear and distortion of the ends of each piece. Even a sliding tappet has increased wear when it receives a hit in the middle of its slide.

Assuming the valves are properly adjusted, there should be no “play” in the system and therefore nothing to hammer. Outside of the “normal” slight drain of the oil that will fill back up quickly on startup with the correct viscosity oil, the causes of lifter noise are:

1. Actual mechanical damage in the camshaft lobe or the lifter itself. This is physical damage that retards the free movement. This may be caused by fatigue or continuous pounding, as well as corrosion from sitting several months or years with old oil.
2. Broken parts within the lifter. This can be caused by fatigue or cavitation and implosion of air bubbles in the oil. Air bubbles are caused by oil levels too high or too low, poor seal of the oil pickup tube to the block, or poor-quality oil.
   - An API SJ oil is allowed to produce 200 ml of foam in a 5-minute test, and after a 1-minute rest it must settle down to 50 ml.
   - Newer oils are allowed to produce only 100 ml of foam in that test, and after the 1-minute rest it must settle down to 10 ml.
3. Varnish in the lifters, blocking the passages or the seal of the valves or ports. These deposits form in different parts of the engine, frequently in the rocker area from heat after shut-down of the engine or overheating. Turbo equipped cars are more prone to varnish and carbon buildup since the drivers frequently shut off the engine without letting the turbo cool off first. The excessive heat then carbonizes the oil in the turbo bearing, sometimes causing it to seize if the engine is restarted before it completely cools. Low quality oil or excessively high metallic anti-wear additives (ZDDP, Moly, etc.) in the oil increase the deposits. See below for the need to balance cleanliness with anti-wear.
4. Wax, sludge, or varnish deposits causing internal parts to stick. This is typical of an engine that sits for long periods (months to years) without use. The oil oxidizes where it is, forming varnish deposits. Running an engine too cold or many short trips without a longer/hotter trip weekly or so will also lead to sludge.
5. A foreign substance (gasket material, nuts, bolts, oil bottle seals, carbon, etc.) blocking an oil passage, restricting flow to the lifter.
6. Low oil pressure from a defective oil pump (or gasket too thick), low oil level or foaming. The bypass valve in (or from) the oil pump might also be stuck open from carbon particles or foreign matter.
7. High oil flow resistance. On a cold start the oil is much more viscous than at other times, creating a lot of resistance to flow through the pickup screen and passageways. The oil has a hard time passing through the cellulose oil filter, frequently causing the bypass valve to open (this is when a synthetic oil filter would be better). Then it has to travel to the oil cooler where it may also have to use the bypass valve. Finally, it travels through the galley to where it can fall by gravity to the lifters. The thicker the oil, the slower it travels. Note how the different oils flow in this picture ***when they are cold***. The 0W-40 and 0W-30 have practically all poured out of their test tubes and into the recipients. The

5W-30 is about half finished, the 10W-30 slightly behind, and the 15W-40 is still trying to get out of its test tube. A straight SAE 30 is slower to flow than the 15W-40.



If you are using an oil that flows properly at startup temperatures, a cleaning treatment with one of the engine cleaning products mentioned should correct any problems of carbon, sludge and varnish. Or you can switch to an oil that cleans as it works, as I have. If that does not work, you can try raising the viscosity to try to seal the gap caused by cavitation within the lifter, but in reality, you need a new lifter or need to find the problem with the oil flow and pressure. Allowing the noise to continue will cause more damage in the long run.

There are many anecdotal stories of lifter noise going away by raising viscosity. Sometimes it is due to better sealing of the damaged surfaces. Sometimes this is really because the new viscosity is also a new brand, or simply *new*. Sometimes this new brand has more detergency. Sometimes even within the same viscosity grade the lifter noise can go away by changing brands when one brand is at the top end of the range (a 10W-30 around 12 cSt) and the other is in the lower end of the range (closer to 10 cSt for a 10W-30) for that viscosity.

Base oil

There are several different base oils available to formulate motor oils. The base oils used in the 1960's were what we call today API Group I, although some fall in the high aromatic sub-classification and some in the low aromatic sub-classification (This difference is important when we discuss additives). Today, Group I oils (considered mineral oils, or "dino" oils) continue to be marketed, but in the US it is more common to find API Group II (still considered to be mineral oils), some API Group II+, more API Group III (considered "synthetic" after Mobil lost an argument against Castrol), and mixtures of API Group IV and V (traditional synthetics). The original synthetics were pure Group IV base stocks, and due to lack of solvency did not mix well with the residuals of Group I and Group II oils and shrunk oil seals, creating the concept (Myth) that you cannot change to synthetics after using mineral oils.

- Group I oils are solvent refined and normally low in natural viscosity index, although some oil fields produce better grades than others. They have 20 to 30% aromatics, high nitrogen and sulfur.

- Group II oils are hydroprocessed oils (or solvent refined and then hydrotreated). Normally 92% to 99% of the molecules are saturated in the bombardment of hydrogen, creating a clean, stable base oil and eliminating almost all aromatics, sulfur, and nitrogen.
- Group II+ oils are hydroprocessed to a quality somewhere between Group II and Group III.
- Group III oils are severely hydroprocessed, creating base oils that under some conditions give equal performance to traditional synthetic oils. Gas-to-liquids base oils are sometimes referred to as Group III+, although that category is not official.
- Group IV oils are PAO (Polyalphaolefin) synthetics. These are excellent lubricants but have very low solvency when used by themselves, not mixing well with other oils, additives or contaminants, and causing hardening of seals and gaskets. Fully formulated PAO based oils use esters or other ingredients to increase their solvency, and the final oil must pass the same solvency tests as other oils.
- Group V oils are everything else synthetic. In general, the esters and diesters of various formulations are used to mix in small percentages with PAO oils to give then the necessary solvency and help them maintain a clean engine, softening the seals to avoid leakage. The category also includes other types of oils used for specialty products or to thicken group I, II, III or IV oils.

Shear Strength

One of the arguments often given to avoid the shearing of oils is to reduce it by using single grade oils. It is interesting that in several studies that have been done over the years, single grade oils have had up to a 30% increase in consumption over their multigrade counterparts. This is assumed to be going past the oil control rings when the piston is going down and trying to scrape it off of the cylinder walls.

The viscosities shown above are nominal when the oil is new. Once in use, the oil suffers two different shear conditions as well as thickening conditions:

1. **Permanent shear**: A cheap oil that depends on polymers for its multigrade properties begins to lose viscosity between 1000 and 1500 miles of use, falling out of its viscosity range. As it continues to be used beyond 2000 miles it typically thickens from oxidation and by 5000 or 6000 miles it may be out of range on the top end again. If it does not get overheated and over aerated, instead of oxidizing and thickening it may continue to lose viscosity.

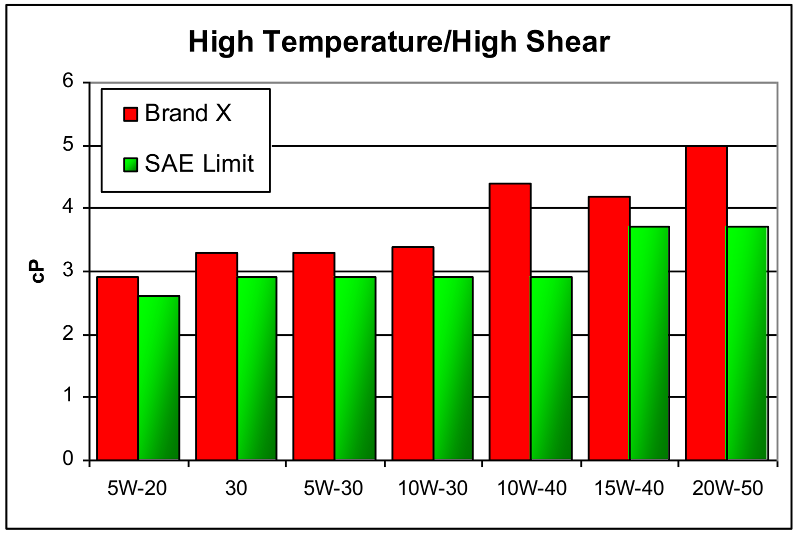
   In engines that depend on gears for timing (rather than timing belts and chains) there is often a tendency to shear at a very high rate. This is not as big a problem in Corvairs because the timing gears are larger in diameter, slowing their contact and milling action.

   In addition to its use as an anti-wear agent, ZDDP is used in the oils to reduce oxidation. Reduced levels will lead to excess thickening and the formation of acids.

2. **Temporary shear**: When an oil is under high pressure, as it is under the cams, the bearings and the rings, the polymers can collapse. In the rings the oil can often get as hot as 150°C in many engines. To check the quality of the oil a test is run called the HT/ST (High Temperature/High Shear). This is where we see one of the differences in the quality of the base oil. Oil that thins out under these conditions will return to its nominal viscosity, but while it is under pressure it offers less protection.

   In this graph we can see that the shear limit of the SAE 30, 5W-30, 10W-30, and 10W-40 are identical (SAE J300). They are all allowed to shear down to the same viscosity.

A low quality 10W-40 can officially behave like a 5W-30 in the bearings, rings, valve train and other areas of stress in the engine. If this 10W-40 is a mineral oil, the polymers will temporarily shear, leaving the protection at the thickness of the 5W-30.



In this example, the Brand X 10W-40 is synthetic. It therefore behaves like a SAE 40 under stress.

Evaporation

All oils are tested for evaporation for 1 hour in an oven at 250° C in a test called NOAK. An SJ oil is allowed to have 20% evaporation. An SQ oil is allowed only 15%. Many synthetic oils are around 5% to 8%. The higher the number, the thicker the oil gets in service and the more you will have to add. This test and the limits will be changed in the next category to better represent the actual oil consumption.

Additives

We tend to think of "additives" as simple products like salt or pepper. In reality they are extremely complex. Some of the additive packages used contain moly, boron, or other substances and non-polar compounds. Both moly and boron, for example are good anti-oxidants. High loads of moly can be good for anti-wear, but also add to total ash content, fouling valves, and forming deposits. Total sulfated ash content needs to be restricted by limiting the amount organic-metallic additives to limit deposits.

It should also be noted that ZDDP is activated by heat and pressure. Until an engine warms up the layer left from the day before is wiped off and not replaced. This is another reason not to race an engine until it is hot and to maintain a working thermostat in your cooling system.

The formulation of motor oils is like the formulation of a soup, a cake, or anything else that uses a lot of ingredients that interact with each other. The premise going into the API studies was that all of those additive packages would perform well in different base oils.

Since the additives are polar, they fight for surface area. The addition of extra ZDDP usually results in reduced cleanliness, higher engine temperatures and more deposits, particularly in the piston rings. Some studies have shown that going past 1400 ppm of phosphorus will increase wear over the long term, and going above 2000 ppm will begin to break down iron and result in camshaft spalling. There is certainly good reason to stay under 1800 ppm of phosphorous and safer with less than 1600 ppm. And with the recent tests of SP/SQ formulations, we now know that as long as we keep the Calcium low, The SP and SQ quantities of ZDDP are more than sufficient.

Be careful of marketing statements made to sell obsolete products. Here are comments from an interview that was printed a few years ago:

> *Technical Support for Shell Marketing …………. says the less-expensive Shell "Rimula Premium fleet oil is adequate for a temporary machine.*
>
> *When choosing engine oil, it also is important to consider an engine's planned life. Companies keeping machines for life should consider investing in the highest-grade oil. But oil that only meets the minimum standards is fine for engines that are going to be resold before they are rebuilt, at least for the original owner."*

Additive levels

So, if we go back and compare the 517 ppm of zinc and 482 ppm of phosphorous of the late 1960's with the 800 ppm of a fully formulated SQ we will find that we meet the 800 ppm that the GM additive was apparently designed to do for their higher horsepower flat tappet engines. But at the same time, the SQ oil has reduced Calcium, so the ZDDP works better, especially with the synergy of Boron.

While some specialty oils are not registered with the American Petroleum Institute (API), any good, normal, oil will be. This means it will have at least the API donut with the rating around the outer part and viscosity in the center. The primary category they aim the oil for will be on the left side of the "/" (slash), while the secondary categories will be on the right. They do not have to list anything on the right, and often it is shown that way to not confuse the customer.

Oils for gasoline engine cars, especially those with catalytic converters in the exhaust will also show the ILSAC starburst that says "For Gasoline Engines". This symbol will guaranty that the oil is suitable for a gasoline engine and its catalytic converter (as long as the viscosity is correct).

Understanding the label on the oil is not easy. Normal Gasoline Engine oils with the starburst can be rated SQ, SP, or SN and must have between 600 ppm and 800 ppm of phosphorous. Others could be rated SL and have up to 1000 ppm of phosphorous.

Other Additives

There are many chemicals and synthetic oil formulations used as additives that are multipurpose. The specific combination of these in any formulations will react differently to produce the results wanted. Mixing the wrong proportions will change the results.

Friction Modifiers: Every oil is designed for a specific purpose. In general, gasoline motor oils are designed to be as slick as possible and to reduce friction as much as possible. These are generally esters (group V synthetic) and fatty acids whose molecules also attach to the metallic surfaces to reduce friction during sliding action. If the contact is heavy, they are pulled off, allowing friction and wear unless there are enough anti-wear additives to take over.

- The friction modifiers in motor oils are designed to reduce the friction between the point where hydrodynamic lubrication is lost and boundary lubrication starts, reducing the friction in the mixed lubrication range.
- If you use motor oil in a wet-clutch or wet-brake application (motorcycle, automatic transmission, tractor, transmission or differential of heavy equipment, etc.) the clutches and brakes will slip due to the effect of these esters or fatty acids, creating heat and poor performance.

- Automatic transmission oils have different friction modifiers that are slippery as long as there is a high-speed differential between the discs, but change as the discs come together to grab quickly and not slip. Each type of friction material in the discs, and each angle and depth of groove in the surface is compatible with a specific friction modifier/oil combination. Using the wrong oil for a given material will make brusque or mushy shifts, depending on the combination.
- CVT fluids depend on the correct combination of sophisticated friction modifiers to make most things slippery but maintain the correct friction on the belts.

Corrosion inhibitors: These are additives used to reduce the effects of moisture and the acids formed during the combustion process. Motor oil provides this protection through a combination of the anti-acid capability of the Calcium or Magnesium in the detergent and the coating of ZDDP, similar to the galvanization of steel, but to a very minimal level. The ability of an oil to inhibit corrosion is shown on the spec sheets as BN or TBN (Base Number or Total Base Number). When an oil reaches the point where this reserve meets the Acid Number (TAN), an oil should be changed. (Some say change oil when the TBN is 50% of the original value, but that might be 6 in some oils and 3 in others – not a very good parameter.) Gasoline leaking past the rings from leaks or poor combustion seriously reduces the BN.

Oxidation inhibitors: Oxygen and heat work to break down the petroleum molecules to acids and gums, turning the oil into sludge and varnish. Oxidation inhibitors used in oils are typically products like amino phosphates and other organic compounds. These are depleted with time, making it necessary to change the oil (although there are some high-end oil filters that replace these).

Foam inhibitors: These additives reduce the surface tension and also act like alka-seltzer in the oil, joining and breaking up the bubbles that are formed by the turbulence of returning oil into the oil pan. If bubbles are allowed to circulate, they will cause cavitation of any parts under pressure and failure of the lifters. *Foam is particularly prevalent when engines are overfilled* or *underfilled.* High levels of oil are beaten into foam by the crankshaft. Low levels of oil circulate faster than they can release the air.

Pour point inhibitors: All mineral oils need pour point depressants to allow them to flow at low temperatures by keeping any wax or other molecules from joining together blocking the flow. *Synthetics do not thicken like mineral oils and generally do not use pour point depressants*.

Seal swell control: Esters and other group V synthetics are used in small quantities to control the drying or swelling of the seals and gaskets in the engine. Each one causes specific effects in specific seals. The goal is to *slightly soften and swell the seals over the life of the engine* to compensate for their natural drying, contraction and wear. Engine deposits that block the flow of oil to the seals can cause shaft wear from dried seals and dirt grinding on them. Cars that are not driven much may suffer from a lack of fresh oil being circulated over the seals, causing seal leaks. These leaks can often be corrected with the addition of more seal swell additive.

Reading the label

Unfortunately, it is not easy to read the label and make a decision. Marketing people make the big decisions and determine what the label will say in most cases. As an example of the power of marketing, I know of one brand that packaged oils in black bottles. They switched to red bottles and multiplied their bottled oil sales 5 times! The engine won't run any better when the oil has been stored in a red bottle, but the engine does not make the purchase decision. Now the trend seems to be going to silver and gold to imply quality.

Many brands use racing to showcase their brands. I believe this is good for the sport and helps develop better oils, but we have to be careful when using racing oils; since they don't need cleanliness because the engines will be disassembled in relatively few miles; we don't run our engines at 10,000 to 18,000 rpm; and because they put the race cars on labels of some of their poor-quality oils to raise the price and sales.

The determination of the base oil used is difficult. Some brands will proudly display a registered name for their high-quality base oil, so that is a start. Chevron's "ISOSYN®", American Petroleum's "MAX-SYN®", Pennzoil's "Purebase®" (even if the ad campaign was flawed), ConocoPhillips' "Pure Performance®", Shell Oil's "Star®" are all examples of what you should see mentioned somewhere on their labels. Another thing to look for is the term "Severely refined", although I'm sure someone will stretch that one out too. In theory "highly refined" gives you group II, but since it has no legal definition, it really has no meaning anymore.

Energy conserving oils

The energy conserving classification in API approved oils checks oils against a known oil to see whether it is more slippery (less friction). This reduction of friction is through reduced viscosity and increased friction modifying additives.

Bottom line recommendations:

1. Remember that the correct viscosity is your primary consideration. ***Increasing*** it beyond what it should be will cause **more wear and heat**. Reducing it below what is needed will cause additional bearing wear. *Read your manual* and use the "preferred" viscosity or the lowest viscosity that covers your temperature range.
2. We should recognize that the 10W-30 in the Corvair manual is probably a general recommendation for the weather ranges in the US. That is a huge range. If you are constantly driving in high temperature areas, your oil temperature is probably higher than "normal" so an oil such as a 10W-40 would give you the same start-up protection, and would be in its proper viscosity range between 98° C and 118° C instead of 93° C to 107° C. Making that a 5W-40 would give you better startup protection at the same time. *But don't use 5W-40 or 10W-40 oils that are not 100% synthetic or good semi-synthetic* (note the shear of polymers above).
3. ZDDP, when burned, leaves deposits on pistons, heads, ring grooves, valves, etc. Tests show that oils with 1% sulfated ash leave 58% less deposits in the engine than oils with 1.45% sulfated ash. Every ounce of additive that you put in increases the ash content.
4. The same study showed that oils with 1% sulfated ash gave 36% lower oil consumption than oils with 1.45% sulfated ash.
5. Some have said diesel oils had too much detergent to work properly in flat-tappet engines, but in reality, it was just too much calcium. Current overall levels of detergent remain the same.
6. Shear strength of the base oil is more important than a few parts per million of ZDDP. Synthetics will give the best protection, with Group II oils next. Try not to fall for the group I oils. This is not always easy to identify, although in the USA, group II is now more of a norm than an exception.
7. If you want the maximum valve train protection, look for an oil that is certified SQ for gasoline engines.

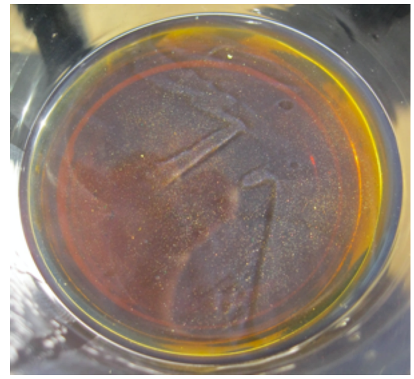
8. **Because of the advancements in technology, look for the API starburst** for flat-tappet engines. That is what tells you that it the reduced calcium levels to allow the ZDDP to work better.
9. Do not use home-brew rinse procedures. I know people who swear by a diesel rinse during the oil change, others use gasoline or kerosene, and some actually swear by a five-minute cleaning cycle with laundry detergent in the engine before rinsing with diesel. This destroys the engine. These products do more damage than good.
    - In a Corvair, during this cleaning cycle, you would be running 25% left over oil and 75 % diesel or whatever.
    - Once you have put in the new oil, you would be running 75% new oil and 25% cleaning solution, reducing the quality and viscosity of the new oil.
10. If you have an engine that needs internal cleaning of the lifters, valve train, ring grooves, etc. Use a product designed to clean it in 1000 or more miles. These products use group V synthetics to deep clean slowly. Don't use the 20-minute flush junk. It can loosen too much at once and clog passages yet not get to the ring lands to clean them. Sometimes it is nothing more than kerosene. Ideally these products should be run in a Group I or Group II oil, and the following oil change should be the same for a short (3000 mile) rinse cycle. Follow the instructions on the product.
11. When moving up to a high-quality synthetic oil that actually uses group V (high in solvency) oils in the blend, you *may* also notice some smoking as when increasing detergency. This will go away in a few thousand miles, and your rings will seat better.
12. Forget the myth that you can't switch over to synthetics in an older engine. Any formulation on the market today is totally compatible, and the better formulations will not only give you better shear protection and cold weather protection, but will clean up the sludge around the seals, allowing them to be softened and expanded to their normal size by the oil.
13. Forget the myth that synthetics cause leaks. The formulations of decades ago were pure PAO (group IV) that had poor solvency and tended to shrink seals. All of today's formulations have esters or other ingredients that make them totally compatible with the seals, and *the better ones will actually reduce leaking* ***after a couple thousand miles***.
14. Forget the myth about the wax and sludge formations from paraffinic oils, or from a specific brand. Those are old wives' tales. Today the filtration systems for the group I oils remove enough paraffin to eliminate that, and the hydrocracking of the group II oils convert the paraffin to good oil. I still wouldn't buy a group I oil, but that is because of the 20 to 30% impurities and rapid decomposition.
15. Forget the myth that multigrade oils have higher consumption or "oil burning". The reverse is true. Tests show multigrade oils have up to 30% less consumption than single grades in the same engine.
16. There is nothing wrong with changing brands or viscosities. They are all compatible. But I recommend finding a brand that you are confident with and sticking with it to receive the full benefits of that formulation.
17. When changing brands, remember that some of the previous brand remains in the engine. While this is true of all engines, it is especially true of Corvairs, where approximately 1½ quart remains. You will not get the full benefits of the new

formulation until the 3rd oil change. If every oil change is a different brand, you will never get the full protection.

18. Be careful of the term "Semi-Synthetic". There is no standard on its use. It is legal everywhere I know to put 1% of a synthetic oil in the cheapest mineral oil and call it semi-synthetic. I know of one brand that calls their products semi-synthetic because of the synthetic polymers used for viscosity control. Some brands use base oils so poor that they need a percentage of synthetic just to get up to the minimum performance standards.
19. **Never change oil when it is cold**. The oil should be as hot as you want to risk your hand. Change it at the end of a decent drive, when it is hot, thin, and the contaminants are in suspension.
20. Never leave the cap off, or oil pan off for longer than absolutely necessary, as dirt and dust will stick onto all of the available parts. This dirt will contaminate your new oil. You can only see particles over 40 microns, but the ones between 5 and 15 microns are the most damaging, since most of those over 15 microns will eventually get stuck in the filter. (The average filter retains 50% of the particles that are 20 microns and over on each pass.)
21. If you are not going to use the car for 2 months or more, *change the oil first*. Change it, run the engine a minute to circulate the oil, and turn it off. Engines stored with used oil will suffer from corrosion of the bearings from the reduced anti-corrosion additives and small contaminants trapped in the bearings. The new oil will clean and protect until you are ready to use the car.
22. When changing oil, always change the oil filter. If you pre-fill your filter, do it with extreme caution. Any oil that goes into the center will reach the engine unfiltered (and there is no cleanliness requirement for new oils).
23. Never use a funnel to pour the oil in unless it is absolutely clean of all possible dust and dirt. Most shop rags will leave a lot of dirt.
24. If the oil was particularly dirty, thick, contaminated with gasoline, or suspect in any way, change it a second time within 100 miles or so to eliminate the contaminants that were in the 25% that was not drained out.
25. After rebuilding an engine, *always return to the original viscosity recommended by the factory*. If done right you will have the original clearances. The use of a high viscosity oil, especially during break-in, may cause engine seizure on startup and will cause a high wear rate. This is the moment when the clearances are the tightest they will ever be.
26. **Don't believe** the myth that you can break in a rebuilt engine with synthetic oils. *The argument that new cars come with synthetics so you can break in a rebuilt engine is totally false.* None of us has the same work conditions, torque wrench calibrations or parts that the factory has. Use high quality mineral oil until the consumption stops; then switch to synthetic if you want maximum protection. *Note*: The use of Chrome or Moly rings in your rebuild will extend the break-in period. *Don't switch over to synthetics until oil consumption has (basically) stopped.*
27. After rebuilding an engine, your first oil and filter change should be after a few hours and again be before 1000 miles, preferably by 500 or less. During this time, you are creating a more-round bearing chamber to avoid aeration, seating the rings, and cleaning

out the dust and other products you added while rebuilding (unless you have a "clean room" to assemble your engine).

28. After rebuilding an engine, **break it in slowly**, without a lot of stress and use of the power it has. You will have contaminants in the oil. You will have more foaming (and therefore less hydrodynamic film strength) from imperfect bearing fit to crank (the amount depending on fabrication of parts and calibration of the torque wrench). You will have more metal particles in suspension in the oil from the break-in (the filter only takes out particles over about 20 to 25 microns.) Once you are on your second oil change you can occasionally push the power, and once it stops oil consumption it is ready for anything. The oil in this picture is from a new car, with 2000 miles on it. There are thousands of shiny particles floating in it, even though it had an EOM oil filter.



29. In many cases, an oil change every 12 months or 5,000 miles is plenty of security, in fuel-injected engines, but most carbureted engines should have the oil changed by 3000 miles, especially for group II oils. Synthetics last longer. The only reasons to change more often are:
    - The poor quality of Jiffy Lube (and Fram) filters
    - Driving in high dust/dirt conditions
    - Poor carburetor calibrations and/or ignition timing
    - Short trips that do not allow the engine to warm up
    - Towing trailers the entire time
    - Very cold operations where the choke is frequently closed and any leaking fuel does not get a chance to burn off (cuts viscosity and TBN).
    - Pure city driving mostly in 1st and 2nd gear.

    I used group II/IV semi-synthetic SN oils in my older (>400,000 miles) 4x4's and changed them every 5000 miles, mostly dirt roads or city driving (except my Grand Cherokee where I used a 5W-30 SN PAO/Ester synthetic). After my Corvair rebuild I used a group II CI-4 10W-30 and changed it once a year (after was broken-in). I have determined that these are safe limits based on used oil analysis (more than 5000 samples). But I have now switched to *Valvoline Restore & Protect synthetic 5W-30 (currently labeled SP)*.

30. The optimum oil change interval should be determined by analysis of the used oil, but this is really not practical for the average driver, particularly because a single sample shows very little. Regular sampling gives you excellent information, but you have to know how to use it. The results given by the labs are too generic to be of much use unless something is really wrong. For the average driver the cost is more than the benefit. The lab results that compare your sample to the average, or "norm" are only a starting point. You need to compare them against the best, check your driving conditions against those of the "best", and set your goals.

Used oil analysis is extremely useful to companies with a large number of vehicles or equipment and many drivers and mechanics. When I have a hundred or so samples of oils from the same engines, I'm able to see the protection or wear from different base oils, oil formulations, additives, contaminants, mileage, driving habits, and tuning. It really is amazing to see the differences in wear metals. My 2.7 L Toyota 4 cylinder showed 1 ppm of iron wear in 5000 miles while another 2.7 L Toyota showed 991 ppm of iron in 2000 miles. These differences are used to manage maintenance procedures, oils, filters and other things to optimize maintenance costs and reduce repairs

For those interested in knowing more about oil analysis there is plenty written on the web. I have more than 50 pages about it on my site, but it is in Spanish.

31. If you have your oil analyzed, don't draw too many conclusions until the 3rd oil change. An oil with little detergency will have left sludge and wear particles embedded in various crevices of the engine that will take 10,000 miles or more to clean up with a good oil.
32. **Take care of your air filter**, do not undersize it to put chrome ones on or anything else that causes the vacuum created by the engine to draw dirt in from other areas of the engine compartment unfiltered. No oil can compensate for dirt ingestion (although the better the HTHS, the higher protection in critical parts). And **do not use** high pressure air to clean your filter.
33. **Forget motorcycle oils**: Motorcycle oils typically have *different friction modifiers* to make them compatible with the belts and clutches in the transmissions (see friction modifiers above). This makes them less energy efficient *(more friction)* and in theory will increase your gasoline consumption slightly. Similar wet-clutch products are normally used in transmissions of farm tractors where some are considered "optional" for engine use, although not the primary recommendation. The lack of this friction modifier that would otherwise reduce the surface contact and dependence on the ZDDP *increases the chance that the ZDDP will be stripped from the sliding surface and cause more wear.*

Meets or Exceeds API SF/SG/SJ
Meets or Exceeds JASO MA

Test	SAE 10W-40
Vis @ 100°C (cSt)	15.2
Vis @ 40°C (cSt)	104.1
Viscosity Index	155
Spec Gravity @ 60°F	0.8794
Density (lbs/gal)	7.32
Total Base No.	8
Flash COC (°C)	216
Pour Point (°C) max	-33
CCS cP (°C)	6200(-25^{0}C)
MRV TP-1 cP (°C)	38000(-30C)
Noack % off @ 250°C	<15.0
Sulfated Ash, wt.%	0.70
Zinc/Phosphorus, wt.%	0.120/0.109
Calcium, wt.%	0.230

Reading the spec sheets for several of these oils shows reduced detergency and not necessarily high ZDDP. Often, they are also only available in higher viscosities. Here we see an example of one such oil (Valvoline) that only meets API SJ, only has 1200 ppm of zinc, 1090 ppm of phosphorous and only 2300 ppm of detergent (Calcium). Reviewing the SDS we can see that 70 to 80% of it is, however a group II product, so it should have less shear than a group I, but more shear than a synthetic. I have never analyzed the wear permitted by these products. This comment is based on what is printed on various spec sheets and design specs.

Components	CAS-No.	Concentration
DISTILLATES (PETROLEUM), HYDROTREATED HEAVY PARAFFINIC	64742-54-7	>=70-<80%
PETROLEUM DISTILLATE	NJTS# 800986-5245P	>=10-<15%

My 2012 involvement in the study and marketing of the newest motorcycle oils reinforced my recommendation against motorcycle oils in our cars. Oils for modern car engines (API SQ) and high-performance motorcycles where the clutch and transmission are separate have low friction coefficients, generally between 0.80 and 1.00 (some below and some above). The main motorcycle oil category (MA) was recently split into MA1 (old standards) and MA2 (new standards). The three friction tests show the MA1 with friction coefficients between 1.25 and 1.85, while the newer oils (MA2) have friction coefficients between 1.70 and 2.50. We are not looking for higher friction in our valve trains or anywhere else in the engines. These oils are designed to protect the engine while avoiding slippage of wet-clutches. For more information, refer to http://www.jalos.or.jp/onfile/pdf/4T_EV1105.pdf

My Morris Mini Pickup has an automatic transmission in the oil pan that uses the motor oil for its oil. I use MA2 motorcycle oil in it.

34. **Forget single grade oils:** Single grade oils, with the exception of some specialty products, are obsolete. Since no major manufacturer recommends them, they, at best are CF or SF in additive levels, and more often made with Group I oils.

    Here is the data sheet for current *Chevron Ursa Super Plus SAE 30 and SAE 40* single grade oils. You can see that the levels of zinc and phosphorous are even lower than the current SQ oils. Their Ursa Super Plus 10W-30 is 6% more viscous at 100ºC and 16% less viscous at 40ºC, with 9% more phosphorous.

SAE Grade	30	40
Product Number	*271203*	*271204*
SDS Number	*23578*	*23578*
API Gravity	29.4	28.7
Viscosity, Kinematic cSt at 40°C cSt at 100°C	 96 11.5	 141 14.7
Viscosity Index	107	104
Flash Point, °C(°F)	232(450)	254(489)
Pour Point, °C(°F)	-27(-17)	-24(-11)
Sulfated Ash, wt %	0.95	0.98
Base Number, ASTM D2896	6.3	6.3
Phosphorus, wt %	0.069	0.069
Zinc, wt %	0.072	0.072

35. **Be careful with specialty oils:** Often recommended on some classic oil sites is Halfords Classic Oil. That, and similar oils, are the last thing you want to consider. This is what their web page says:

```
API SE CC
Protects and preserves old engines
High viscosity helps to reduce oil loss & leakage
Multi-grade Oil for use in Summer and Winter
Oil adapts to outside temperature
```

36. **Forget aftermarket additives:** As explained earlier in this paper, when you buy a good oil, it has the proper compromise between cleanliness and anti-wear. With the right test equipment and conditions, you *might* find a combination of ingredients that *might* reduce wear, but it will be at the expense of sludge and carbon. It will do you little good to reduce wear and rebuild the engine because it is fouled with carbon or the oil stops circulating because of the sludge.

    Aftermarket additives that claim to stick to the metal areas and therefore continue lubricating when there is no oil probably end up burning onto the surfaces, resulting in polished cylinders and lack of seal and oil control, with excess carbon build-up. They do not tell you what happens to them in the combustion process; and the upper cylinder and rings are exposed to very high temperatures.

Good rings clean off the remaining lubricant from the cylinder walls to avoid its burning and filling the hashes of the walls or getting burned in the combustion chamber.

We know that according to SAE studies and others, 1400 ppm of phosphorous is sufficient, 1600 to 1800 ppm is possibly dangerous to cams, lifters, and other parts, and 2000 ppm is considered dangerous and probable damage.

According to the ZDDPlus web site, you add their product to a modern SM or later oil that has 600 ppm of phosphorous. Actually, 600 is the lower limit, 800 is the higher limit, with most oils around 760 ppm.

And they go on to say that one 4-ounce bottle, added to 4 quarts of these oils will give you 2100 ppm of phosphorous. It would actually be 2100 to 2300, which we know is dangerous.

If we look back at history, considering about 200 ppm of phosphorous in the oils of the late 50's, moving almost to 500 by the late 60's, we can see that it would have been a benefit in those years, but not the whole bottle. As one bottle, with 4 ounces of this additive would give you 1700 ppm of phosphorous for the earlier oil and about 2000 ppm for the oils of the late 60's.

Certainly, there are other factors, such as temperature and pressure, that will accelerate the problems, but based on this, I see no reason to risk overdosing on phosphorous.

37. Some people will say air cooled cars need thicker viscosity because it transfers heat better than thinner oil. But the reverse is true. Here I will quote Amsoil: *"Since thicker oil doesn't transfer heat as well as thinner oil, operating temperatures will increase, possibly leading to accelerated chemical break down (called "oxidation") and harmful sludge and deposits."*

38. Brand recommendations: I am hesitant to recommend brand names to look for because

    - *Formulas change frequently*
    - Because people tend to read or remember only part of what they should look for.
    - Due to inventories in different stores and distribution centers, different regions of the various countries where this will be read have different products with the same label at any given time.
    - Whatever I list today will probably be outdated tomorrow.
    - Product spec sheets should rule: I have never used or analyzed Amsoil products, but I like the fact that their web site gives every possible product aspect. There are other brands that also show the complete or almost complete data. I *dislike* the business practice of Shell because it is almost impossible to find any real product data on their web site. It is 99.9% advertising.
    - If I say Shell or Mobil makes a satisfactory product, some will take that as a negative comment and others will go out and buy anything with the Shell or Mobil label, no matter the rating. *You should get and read the spec sheet*, but at the very least *you must read the label*.

Additional comments

With the exception of a couple of products, I've had to go to the SDS (previously called MSDS) information to figure out the base oil. As long as you get a SQ and keep the viscosity range to 20 or 25 points (10W-30) and don't stretch your oil change intervals, a group I won't kill the engine. If you are racing or driving hard, want to extend intervals between oil changes, or plan on keeping the car for many years, it is better to look for the better base oil.

Obviously, price and availability are considerations. Look through the oils on the shelf, read the labels and look up the specs and SDS information if you want the details. Then stick with that brand to get the best results over the long run.

I read a website recently that said it was extremely easy to choose a motor oil. *"Just read the label."* I think you can see from this information that this is far from reality if you really want to take care of your engine beyond what the manufacturer guarantees or if you have an engine with flat tappet valve trains.

If your goal is to find an oil that will take you to the end of your warranty period without problems, you can read the label and chose something that meets the minimum the manufacturer recommends. But chances are **that *if you own a classic car or are reading this far, your goal is maximum protection.***

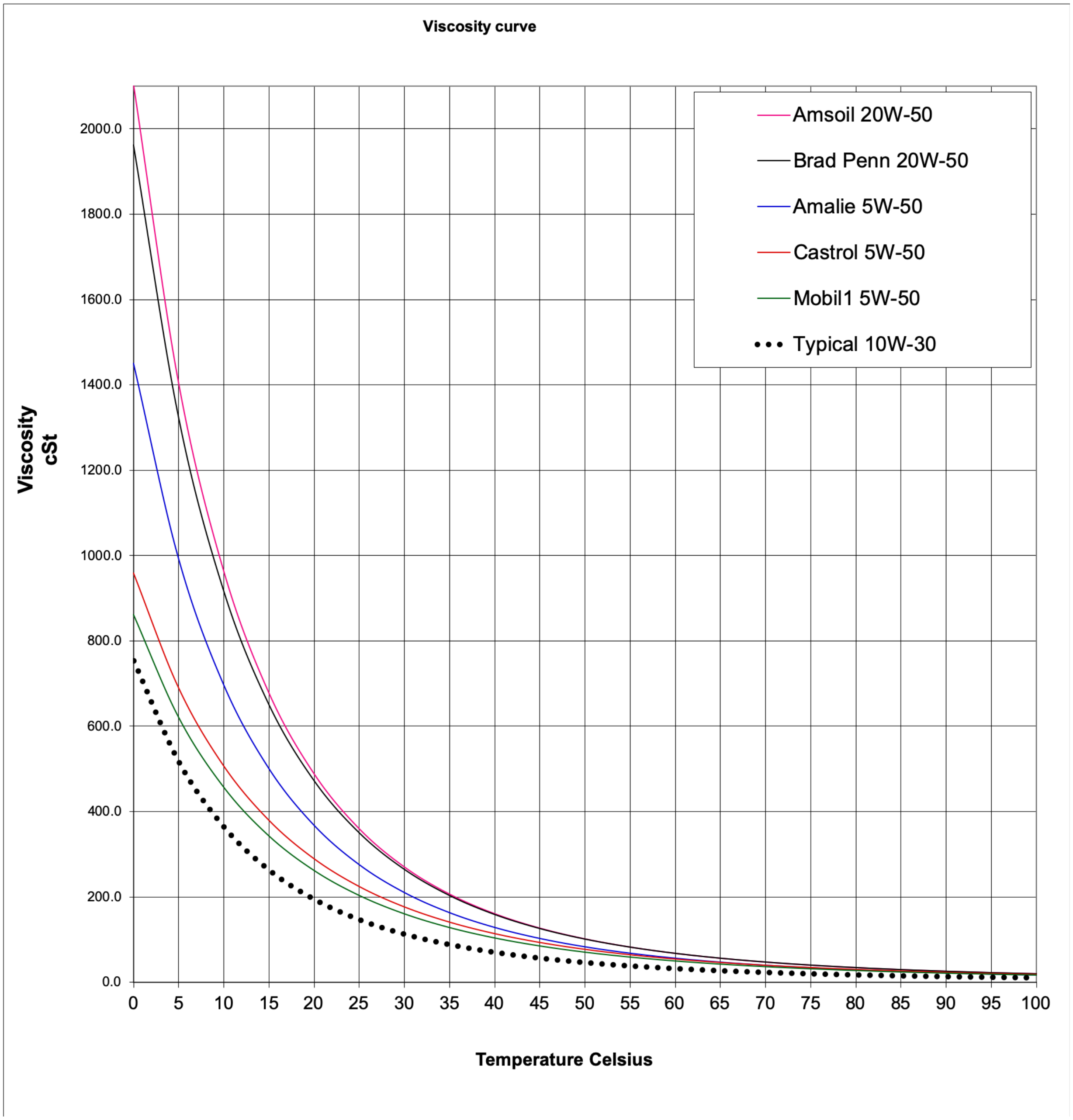
SAE xW-50 oils

Although I don't believe they are appropriate for Corvairs, I have been asked to comment on xW-50 oils. In general, 20W-50 oils in a Corvair would require a very worn engine and extremely hot climate to avoid premature wear and damage to the valve train *(note an exception below).* I would not recommend any *mineral oil* that covers a spread any bigger than that since they will shear down under stress.

Here is a brief look at six xX-50 oils: three 5W-50 synthetic, one 20W-50 synthetic, one part-synthetic 20W-50 and one mineral 20W-50. It is hard to find information on xW-50 oils. I found some oils licensed with the API that were not on the manufacturer's web sites. The old Castrol Syntec group III synthetic is no longer listed. It sheared down to 3.7 under pressure, making it thinner than the average 40 weight when you really need it.

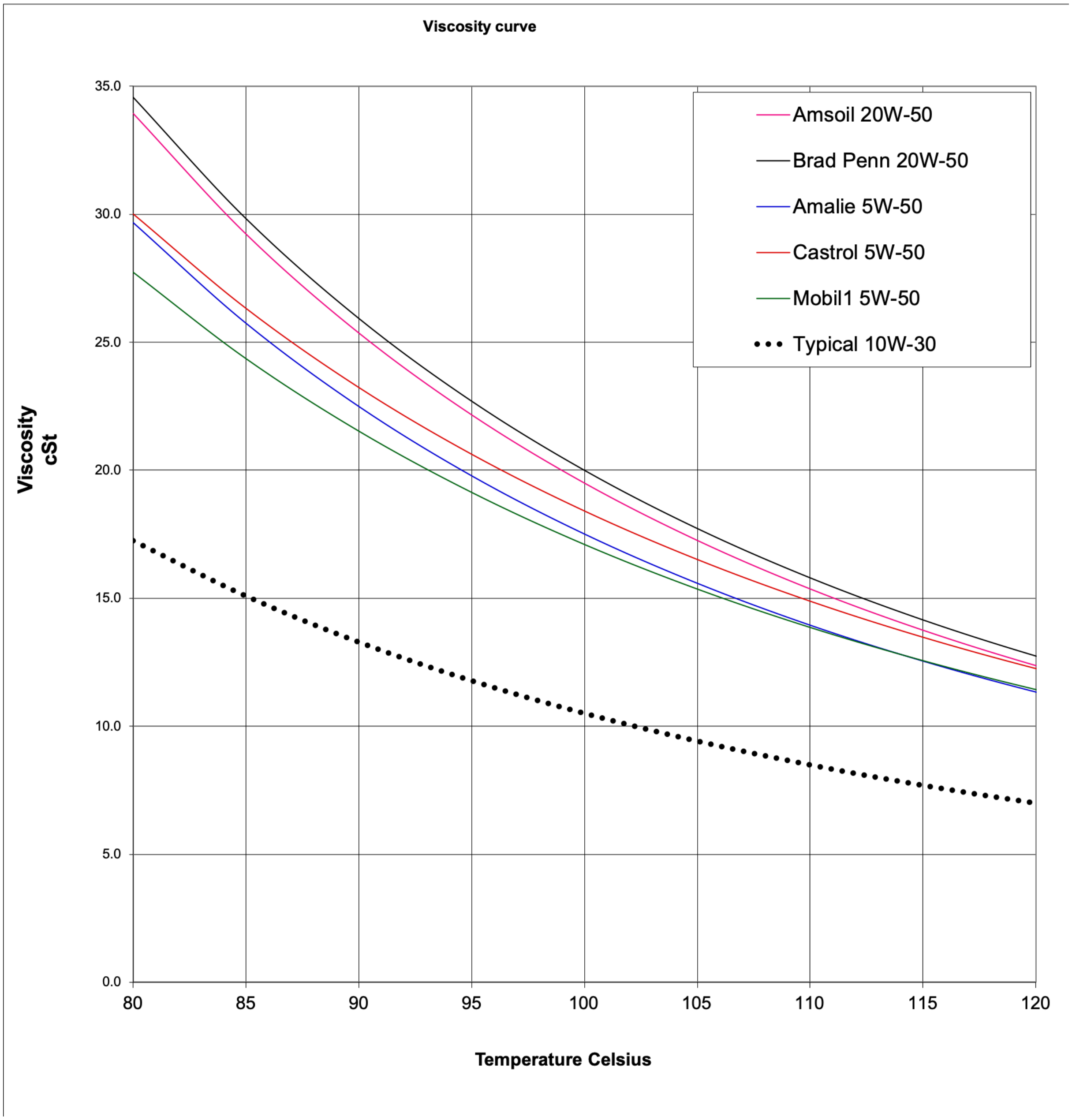
Oil	Viscosity	API	100° C	40° C	HTHS	Base Oil
Amalie Elixir Full Synthetic	5W-50	SM	17.5	129*	?	????
Castrol Edge Full Synthetic	5W-50	SN	18.4	114	4.1	"Base oil – highly refined"
Mobil 1:	5W-50	SN	17.1	104	4.4	Traditional Synthetic
AMSOIL Premium Protection Synthetic 20W-50 Motor Oil	20W-50	CI-4+	19.5	160.3	5.5	Traditional Synthetic
Brad Penn Partial Synthetic	20W-50	1400 Phos	20	159	6.2 (?)	Part Synthetic group III
Havoline	20W-50	SN	18.2	154	?	Mineral
Typical 10W-30			10.5	70	3.0	

*Viscosity at 40ºC recalculated based on VI to not repeat error on Amalie page



Note that in these graphs, I have added a dotted black line for the viscosity curve recommended by Chevrolet for the Corvair. Anything thicker is not fully flowing and protecting.

The next graph shows the viscosities of the same oils at operating temperatures.



Before considering a 5W-50 oil, you should look for its HTHS value. There is no point in a higher viscosity that shears down below the 5W-40 oils on the market, and we should remember that our Corvairs should be lubricated with 10W-30 under most circumstances. You do not want an HTHS higher than the engine design, as it will cause pitting or other wear in the bearings.

So, what is my bottom-line recommendation in xW-50 oils? *Only if you are racing,* since the oils do not circulate properly until they get up to full operating temperatures. The viscosity should get down to 12.5 cSt or below for full protection. Mobil 1 and Amalie 5W-50 oils reach that point at 115ºC, but we normally do not operate at that temperature.

This link should take you to the SQ oils that are 5W-30 or 10W-30 viscosity. There are 141 at the time of this writing, but since SQ was just approved, this number is increasing daily: https://engineoil.api.org/Directory/EolcsResults?accountId=-1&viscosities=10W-30%2C5W-30&serviceCategories=SQ

If you are looking for other viscosities you can find them on the API site listed above. But remember that if it does not have the starburst on the label, it *MAY* have excess calcium, limiting the protection.

And remember: when reading the label, you are looking at the highest classification to the left of the slash.

So, what does it boil down to? That is normally the question I get.

1. My first choice for the average Corvair is SQ, 10W-30, Group II, or 5W-30 synthetic

What would I use in very hot weather (100-120ºF ambient temps): preferably synthetic 5W-40, but 10W-40 would be satisfactory, but maybe not for a 12-month cycle, as it will probably be mineral, and will oxidize and possibly shear.

When would I use a 15W-40?

> Never, since SP and SQ oils are generally not available in this viscosity.

When would I use a 20W-50?

> For constant autocross in hot weather or really worn oil burner that you will be repairing soon.

Can I use a 5W-30?

> Yes: Particularly in colder climates, and especially with synthetics. For the reasons I mentioned earlier, a good synthetic SAE 30 can be labeled 5W-30 and 10W-30 (That does not mean all SAE 30's are 5W-30, but a 5W-30 is a 30 with better cold weather protection). With mineral oils, I'd say only if they are the best. The cheap stuff might shear down. As noted at the beginning, I am using 5W-30 synthetic in my Corvair in Florida.

I hope this has helped with your understanding of engine lubrication and oil selection to protect your Corvair or other engine. This is not an endorsement of any brand of oil, although I am very happy with my choice of *Valvoline Restore & Protect synthetic 5W-30*. In general, the brand is not as important as the certifications.

Keeping it simple, my rule of thumb for most of us is to look at all the 10W-30 oils (or 5W-30 if you want synthetic). Eliminate anything that does not have the ILSAC starburst on it. Then decide what your budget allows.

If you are interested in more information on viscosity determinations, please check out my paper on Oil Selection for Classic Minis.

You will find more on oils and analysis at:

https://www.widman.biz/English/

Corvair Oil Selection Guide

Choose a viscosity

5W-30 normal engines - all climates

10W-30 normal engines - all climates

5W-40 slightly worn or very hot climate

10W-40 for worn engines/very hot climate

Check the API Donut

Put all SP and SQ oils in one place.

Ignore the “C” category

SQ great to use

SP great to use

Verify that it has the ILSAC Starburst

Check your budget.

If you can afford or want synthetic, choose the SP or SQ Synthetic

If you want low price, choose between the SP and SQ remaining

Choose your brand of oil among those selected

About the Author:

It has been pointed out to me that with the expanded audience this is receiving these days, not everyone knows my history & experiences, so I will explain them;

I have been involved in maintenance for 65 years, although not in detail until 1970, when I started teaching auto mechanics and published my first book for the students in high school and adults at night.

Then I spent 25 years in the food industry, including the editing of equipment manuals and developing maintenance programs. Ten years of this was spent auditing production plants & procedures throughout the Caribbean and Latin America.

Finally, I set out to improve the maintenance and lubrication products in South America, where I dedicated 26 years to cause & effect analysis, utilization of used oil analysis to improve products and procedures, teaching in the universities, trade schools, and conferences, both national and international, and working with the mechanics to improve their understanding of tribology. During this time, I published 241 papers on lubrication and other maintenance issues (in Spanish). I also audited production plants and worked with engineers and maintenance people to increase production while reducing down time and repairs.

In 2004 I began working with my US based lubricant supplier to improve the formulations and reduce maintenance problems further and become a leader in the field, extending lubricant life 5-fold in some cases, while increasing journal bearing life more than 20-fold.

My motor oil recommendations are based on my experience with more than 5000 used oil analysis, my research, and the questions I have researched as I respond to emails from around the world.

I am not an engine builder. The first engine I rebuilt personally was my 1960 Corvair. The second was a 1992 Rover Mini SPI that I put in my 1975 Mini Pickup, and the third was my 1962 Renault Dauphine. I can't tell you how to get more power out of an engine, or the advantages of one brand of pistons vs another. I do know how to study the engine specs and how to lubricate and take care of it with the goal of extending its useful life. My goal throughout this period was to get my customers' heavy equipment and farm tractors past 24,000 hours without a rebuild, with pickups and cars past a minimum of 500,000 miles, which we accomplished on two of my small, gasoline delivery pickups before I retired.

Classic cars are my passion. I wrote this to help my friends in this community extend the life of their cars. I tried to cover as many of the questions and myths I ran across in 26 years of working in the field and researching solutions. I have run across many people set in their ways. Many still swear by single grade oils in spite of all the evidence. One insisted to me and the Chevron engineer who was with me that he could not put a "CD", "CF-4", or "CG-4" oil in a diesel engine where "CC" had been recommended when it was manufactured. He insisted that his education in Germany was superior to anything we could tell him.