Motor Oil Issues

The science of oils is called tribology – it's real and it's really important to today's oil manufacturers. Photo courtesy of Champion Brands.

One of the challenges of building engines for a living is making sure that every engine you build has good oil pressure and suffers no lubrication-related issues once it goes out the door. Good oil pressure requires main and rod bearing clearances that are within your target specs for the application, a good oil pump (tight internal clearances with no excessive play between the gears and pump housing), and the "right" motor oil (a viscosity that matches the bearing clearances and application, as well as the right additive package for the application). You can do everything right building the engine, but if your customer uses an oil that isn't right for the engine or application, it can create a real headache for you.

If you're building an old-school race motor with relatively loose bearing clearances (.003″ or more) and a high volume oil pump, you're probably going to use a 15W-40 or 20W-50 racing oil, or maybe a straight SAE 40 or 50 racing oil. A heavier viscosity oil will help cushion the bearing loads while maintaining good oil film strength and oil pressure when the motor is hot. Cold oil flow usually isn't a concern because it's a race motor that will likely only be used during warm weather. A racing oil or street performance oil should also contain higher levels (1,200 ppm or more) of zinc and phosphorus (ZDDP) to provide extra anti-wear protection, especially if your old-school engine has a flat tappet cam.

On the other hand, if you are building a late-model Ford modular 4.6L engine or a Chevy LS V8 for a stock or street performance application, you're probably going to build the motor with tighter bearing clearances (.0015 to .002″) and stick with an OEM recommended oil viscosity such as a 5W-20 or 5W-30 that meets current API "SN" or ILSAC "GF-5" standards (or GM's "dexos" specifications in the case of the Chevy LS). These oils have reduced levels of zinc and phosphorus (ZDDP) anti-wear additive (no more than 800 ppm) because late-model engines with roller cams or overhead cams do not require as much anti-wear additive. Higher levels of ZDDP can shorten the service life of a catalytic converter over time, so that's why ZDDP levels have been reduced in motor oils.

Wear Issues

Reducing ZDDP in motor oils created some serious cam lobe and lifter wear issues in older engines with flat tappet cams – especially those with hi-lift performance cams and stiffer valve springs. One fix was to run diesel motor oil in these engines to prevent cam wear. The higher level of ZDDP in diesel oils provided the same anti-wear protection as the older gasoline motor oils.

Aftermarket ZDDP oil additives were introduced to add extra anti-wear protection, but the best solution was the introduction of specially formulated street performance oils and racing oils with extra ZDDP for flat tappet cam motors. The additive packages in these oils provide the best protection and performance for flat tappet cam performance engines.

It's important to recognize the difference between oils formulated for street applications versus those formulated for racing applications. Street oils generally contain more detergent than racing oils because street engines usually have much longer oil drain intervals. Racing oils typically contain less detergent and more anti-wear additive because they have to withstand higher loads, more fuel dilution and are changed fairly frequently.

Camshaft manufacturers have also addressed the cam wear issue by improving their camshaft heat treatments, surface treatments and materials. Some cam manufacturers have switched to higher-grade iron and tool steel alloys to make their cams more wear resistant. Consequently, premature cam wear and failure should not be an issue as long as you are using a high-quality cam and an oil that contains adequate levels of anti-wear additive.

Also important to preventing premature wear and component failures is using plenty of oil and assembly lube as the engine is being put together. Assembly lube is best because it clings to surfaces and won't drain off like oil.

A break-in oil that contains extra anti-wear additive should also be used when the engine is first fired up and during the initial cam break-in and ring-seating process. The break-in oil can then be drained and the crankcase refilled with the type of oil it will use for everyday driving or racing.

Also important to preventing engine damage is priming the engine's oil system prior to its first start so the bearings and valvetrain have some lubrication. And if there's little or no oil pressure after the engine is first started, shut it off immediately. Don't keep it running. Shut it off so you can investigate why it isn't getting normal oil pressure (bad oil pump or sloppy oil pump clearances? Loose or obstructed oil pickup? Bad oil pressure sending unit? Low or no oil in the oil pan? Loose bearing clearances? Leaky oil gallery plug? Obstructed oil filter or oil gallery?).

Emission Issues

Motor oils for late-model, converter-equipped engines that are driven on the street should be converter-friendly, so that means no more than 800 ppm of ZDDP. If an oil is not certified to API "SN" or ILSAC "GF-5" standards, it probably contains a higher level of ZDDP and should not be used in such an application.

This includes most “racing” oils, which are formulated for racing or off-road use, not street use and extended oil drain intervals. It also includes most current “CJ-4” diesel oils that still contain up to 1,200 ppm ZDDP.

Diesel oils are formulated primarily for diesel engines, but some also meet current API “SN” standards for gasoline engines as well. A loophole in the API rules allows diesel oils with higher levels of ZDDP to also be certified for gasoline applications if the oil is formulated primarily for diesel use. This allows some fleets that have a mix of diesel and gasoline engines to use the same oil in both.

An oil that contains a higher dose of ZDDP won’t harm a converter initially. But over tens of thousands of miles of driving, the extra zinc and phosphorus may slowly poison the catalyst and eventually cause the converter to fail. The more oil the engine uses, the faster the contamination occurs in the converter. Once converter efficiency drops below a certain threshold, it will trip the OBD II catalyst efficiency monitor, set a fault code (P0420) and turn on the Check Engine light. The engine will still run fine and performance will likely be unaffected (unless there is an exhaust restriction), but the vehicle won’t pass an emissions test until the converter problem has been fixed.

Something else that must be taken into account with late-model, overhead cam engines is cold oil flow following a cold start. Overhead cams are a long ways from the crankcase, so it takes awhile for oil to flow up through the engine to the cam journals and followers. If the oil is too thick for cold temperatures, it increases the risk of seizing or damaging an overhead cam. Fill a stock Ford 4.6L with 20W-50 oil and crank it over on a cold morning and you might seize a cam. That’s one of the reasons why OEMs have gone to relatively thin 5W-20 motor oils in most late-model, OHC engines. Another reason is to improve fuel economy.

Fuel economy has been the main driving force in the move to thinner and thinner multi-viscosity motor oils. Lower viscosity oils reduce friction and drag, and they require less pumping effort by the oil pump. However, they also require tighter bearing clearances so the engine can maintain adequate idle oil pressure when the oil is hot.

How close should the clearances be? The old rule of thumb of allowing .001˝ of bearing clearance for each inch of crankshaft journal diameter is probably on the “loose” side for some of today’s engines and thinner viscosity oils. A crankshaft with 2-inch journals and .002˝ of bearing clearance may be fine for a 10W-30, 10W-40 or even a 5W-30 oil, but it may be a bit loose for a 5W-20 or a 0W-20. On Chevy LS engines, the range of “acceptable” factory bearing clearances is .0007 to .00212˝, with .0015˝ being a good mid-range clearance to aim for. On Ford 4.6L engines, the factory specs allow .001 to .002˝ of bearing clearance, with .0015˝ being the mid-point. These clearances are for today’s 5W-20 and thinner oils. Using a relatively heavy oil like a 20W-50 or straight SAE 30 or 40 in one of these engines is asking for trouble.

In 2014, GM began specifying 0W-20 for its 5.3 and 6.2L engines. The problem is that some of these engines have had hot idle oil pressure problems when the assembly tolerances in the bearings and/or oil pump have been on the loose side of the acceptable range. If the engine is put together with a sloppy oil pump and relatively loose bearings (over .002 inches), a 5W-20 or 0W-20 oil may not maintain adequate oil pressure, especially at hot idle. And if you build the motor with an extra .001˝ of bearing clearance (as is often done with high performance engines to accommodate rod and main bore distortion at high RPM), oil pressure issues may be a problem unless you run a thicker oil.

A heavier oil viscosity that solves an oil pressure problem may create another issue if an engine has Variable Valve Timing (VVT). The cam phasers that advance and retard the cam(s) in an engine with VVT usually rely on oil pressure to actuate the phaser. If the oil is too thick and flows too slowly, it can slow down the action of the cam phaser(s). A camshaft position sensor monitors cam timing changes and how quickly the cam responds to commands from the PCM. If it sees a sluggish response or no response, the PCM will set a cam timing fault code. That's why it's important to use the viscosity of oil recommended by the engine manufacturer if an engine is equipped with VVT.

More Changes Coming

In recent years, new oil viscosities have been introduced by various oil companies for specific vehicle applications, such as new 5W-50 racing oils, and 10W-60 and 20W-60 Euro oils for certain BMW and Audi applications. But these are the tip of the iceberg when it comes to new oil formulations.

New gasoline and diesel oil specifications are coming that will introduce next generation oils for a variety of new engine applications. A new "GF-6" and API "SP" oil classification should be in place by late 2017 or early 2018 for new ultra-low viscosity oils such as 0W-16 and 0W-8. Japanese auto makers Honda, Mitsubishi, Nissan and Toyota are currently leading the push towards these ultra-thin oils in an effort to improve fuel economy even more over today's 0W-20 and 5W-20 motor oils.

The ultra-thin oils will likely require even tighter main and rod bearing clearances (less than .001˝ are likely) as well as improved bearing materials and/or anti-scuff/anti-wear coatings. Many of these engines will have idle stop/start systems to provide additional fuel savings, which means the bearings may have a harder time retaining oil film during frequent stop/start cycles. Some of these engines may be equipped with pressure oilers similar to those used on race car engines today to maintain oil pressure when the engine isn't running.

The new ultra-thin oils will probably NOT be backwards compatible with today's engines, and will be for 2018 and up next generation engines. Although it will be a few years before we see any of these next generation engines or oils on the road, it's important to understand what the differences are so these engines can be rebuilt and lubricated with the correct oils.

Even with today's engines, the additive package in the oil should meet the performance requirements of the engine manufacturer. European OEMs are especially finicky about the kind of oils that are allowed in their engines. That's why various "EURO" oils have been introduced to meet the various requirements of the European automakers.

The next generation "GF-6" oils are designed for high temperature, small displacement, turbocharged gasoline direct injection engines. Smaller turbocharged engines are replacing larger V6 and V8 engines so the automakers can eventually meet the 2025 fuel economy standards that require a fleet average of 54.5 mpg. The new oils will actually be subdivided into two categories: "GF-6A" and "GF-6B." "GF-6A" will be backwards compatible in engines that currently use "GF-5" oil, but "GF-6B" oils will be for next generation fuel efficient engines designed for thinner viscosity oils such as 0W-16 and 0W-8. The “GF-6B” oils will not be backwards compatible for today’s engines. This could cause confusion among end users, so efforts will be made to distinguish which oils are backwards compatible and which oils are not.

One of the side effects of these new oil standards will be raising of the overall bar for oil quality. Some quick lube shops are notorious for using low quality bulk oil that does not meet all OEM performance specifications or even the proper viscosity rating. This type of cost cutting won’t cut it with the next generation fuel efficient engines that require higher quality oils and ultra low viscosities. Maybe that will be good for the engine rebuilding business down the road, but it won’t be good for consumers who will have their engines ruined by cheap quality oils.

Special thanks to the manufacturers and suppliers who contributed to this article. For more information, visit their Web sites.

AMSOIL – *www.amsoil.com;* ***Driven Racing Oil –*** *www.drivenracingoil.com;* ***Champion Brands –*** *www.championbrands.com;* ***Lubrizol –*** *www.lubrizol.com;* ***Mobil 1 –*** *mobiloil.com;* ***Motul –*** *motul.com;* ***Shell Oil Co. –*** *www.shell.com.*