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Issue 858

Passenger car motor oil challenges

By Blaine Ballentine, Lubrication Engineer

Government mandates are forcing passenger car manufactures to produce more fuel efficient products. Based on their purchasing and driving habits, consumers do not care about fuel efficiency. They prefer larger vehicles and powerful engines.

These opposing conditions have pushed the trend toward turbocharged direct injection gasoline engines running on thinner oils. The oil specifications are changing to meet the requirements of new engines.

The API is finalizing the requirements of a new specification, likely to be named API SP, that is expected to be released in August 2018. GM has jumped the gun with an upgrade to their dexos 1 specification that will probably be mandatory by the time this article is published. We will have a recommendation for the new dexos, but not yet.

We are going to drag our feet because it is not clear that dexos 2016 will align with the upcoming API passenger car oil specifications. There is no way to check because the API tests have not yet been finalized. We do not want to risk making a change that will have to be changed again shortly after the first change. We intend to upgrade to the API spec, when it becomes available, with a formation that will also meet dexos requirements.

Here are some of the details behind the upcoming specifications.

New Oil Specs Needed

The trend is toward smaller engines with direct injection and turbochargers. It is estimated that half of all new car sales will include direct injection by 2020.

It makes sense, given the constraints. A turbocharged direct injection 4-cylinder can make as much power as a port fuel injected V-6. Direct injection allows the engine to go ultra-lean with aggressive timing under light load without creating excessive heat. You get a car that accelerates as fast, yet gets better fuel economy.

However, making more power with smaller engines means running them harder and hotter. Then throw in additional fuel dilution which causes the thin-as-water oil to break down faster, creating deposits, sludge, and varnish. Also direct injection increases soot, which gives dispersants more to contend with and interferes with what little anti-wear additive is still permitted. Waste oil generation and maintenance costs are also concerns, so drain interval recommendations are not getting any shorter. All of the above puts additional strain on the engine oil and is the reason a new performance category is needed.

Increasing Performance

Let's build a hot rod engine. The first

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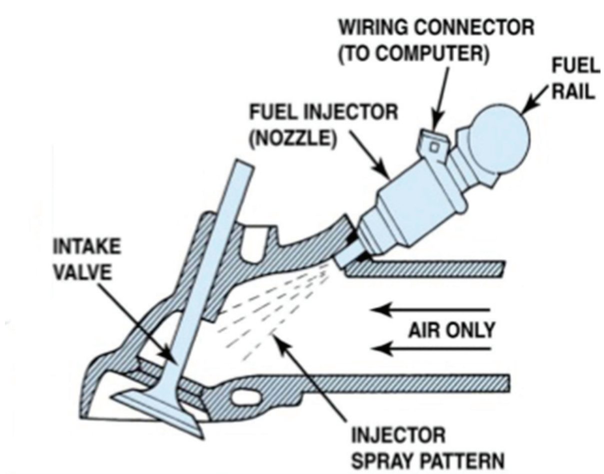
thing we want to do is increase compression. That increases temperature and makes the fuel burn faster for more power (grunt, grunt, grunt).

Now we cannot take the compression ratio too high or the fuel might ignite before the spark plug fires. Pre-ignition can cause ping, knock, or detonation. Ping is just annoying. Knock can be damaging over time. You only get to hear detonation once or twice. It is a big bang that occurs during the compression stroke with enough force to break pistons or rings.

The source of the problem is heat. Higher compression means more heat. Diesel engines do not even have spark plugs because compression builds enough heat to ignite diesel fuel, so we are limited in our hot rod's compression ratio with easier-to-ignite gasoline.

The source of pre-ignition is usually a hot spot, such as heat-holding carbon deposits or the tip of the spark plug. So, we are going to use a reasonable compression ratio, burn high octane gasoline, and use a cooler spark plug.



Port Fuel Injection

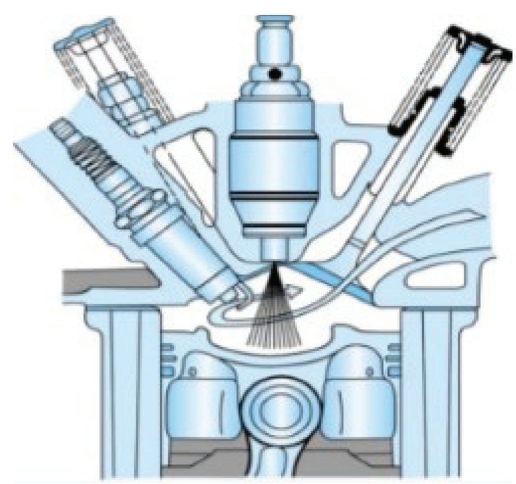
The cooler spark plug sparks with the same intensity as a hotter spark plug, but it is literally cooler. It can be as simple as a shorter plug that does not extend as deeply into the cylinder, and therefore does not retain as much heat, but there are other methods of making a cooler plug. We just do not want a hot spark plug tip to glow from heat and pre-ignite the fuel.

Higher octane gasoline is a no brainer. Octane is a measure of gasoline's resistance to pre-ignition. The higher our compression, the higher octane rating we need.

The other things we want to do to prevent pre-ignition involve tuning. We are going to run our air-to-fuel ratio a little richer than necessary, which helps keep the combustion chambers cool, and we are going to retard the timing a little bit. We could make more power by maintaining a little leaner air-to-fuel ratio and advancing the timing as far as we dare, but rich and retarded is safer.

Now consider what the new car manufacturer is up against. Their goal is more power while using less fuel and lowering emissions. They have to run lean with very precise ignition timing. However, they still found a way to raise compression.

Port fuel injection sprays the fuel into the air in front of the intake valve. It allows enough


Direct Injection

time in the turbulent air that most of the gasoline evaporates before it enters the cylinder,

which is good. Unfortunately, it also allows time for it to pick up heat. By spraying cool gasoline directly into the cylinder, engine manufacturers

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can lower the pre-combustion temperatures to avoid pre-ignition. The cooling effect is great enough it has allowed engine manufacturers to significantly raise compression and make more power. It is one of the reasons we are seeing the move toward direct injection.

Pre-Ignition

We launched into our discussion of hot rod engines to better understand what is perhaps the biggest challenge facing manufacturers. Some of the turbocharged direct injection engines experience detonation during low-speed high-load operation. In some cases, there has been sufficient force to break pistons or rings.

Nobody seems to know the source of the pre-ignition, and perhaps there is more than one. We know heat is a factor. Again, there is excessive heat or a hot spot, or something that lights the fuel before the spark plug, but there does not seem to be a single source to which we can point. However, we know oil is one of the factors.

In fact, one of the theories is that a droplet of hot oil from the crevice above the top ring is thrown into the fuel spray and starts combustion.

The industry has developed engine testing to measure an oil's contribution to pre-ignition. A turbocharged direct injection 4-cylinder engine is run at high load and low rpm. The number of pre-ignition events is measured with the test oil, and compared with the number of pre-ignitions measured using a reference oil. Base oil, viscosity, and additives (especially detergent) are all factors affecting performance in the test. The bottom line is that oil formulation influences pre-ignition, and is measurable with repeatable results.

Intake Valve Deposits

Gas-O-Klenz removes intake valve deposits. Powerful dispersants in the Gas-O-Klenz clean deposits as the gasoline is sprayed onto the intake valve. But when the injector is moved from in front of the intake valve to the cylinder, the fuel bypasses the intake valve. Gas-O-Klenz provides a host of other benefits, but obviously fuel additives cannot clean intake valve deposits in direct injection engines.

Intake valve deposits come primarily from poor quality gasoline in port injected engines, but intake valve deposits are an issue in some direct injection gasoline engines. They come from

oil mist recirculated through the PVC (Positive Crankcase Ventilation) system, back flow from the cylinder, EGR (Exhaust Gas Recirculation), and oil weeping from the turbo seals or valve guides.

As oil degrades from heat, it becomes sticky and eventually hardens to varnish. When this process takes place on the surface of a valve, particulate from the sources mentioned above is thrown onto the sticky degrading oil and hardens into nasty deposits. If the deposits build up on the intake valves and the ports to the point that they interfere with the engine's operation, they have to be removed mechanically; i.e. remove the head and blast it with a mild abrasive. Needless to say,

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is an expensive repair.

Engine oil may be a factor in intake valve deposits in direct injection engines. However, it seems to be more of a mechanical issue and some engine manufacturers have a lot more problems with intake valve deposits than others.

Fuel Dilution

As mentioned earlier, port injection allows more time for the gasoline to evaporate, and absorb heat. Spraying directly into the cylinder cools things down a bit, but the fuel spray does not have time to completely evaporate.

Some of the liquid gasoline blasted directly into the cylinder can hit the cylinder wall, where it is dragged into the crankcase to dilute the engine oil. In extreme conditions of high load, fuel dilution can exceed 15%. According to Geoff Duff, Director of Applications Engineering at Honeywell, fuel dilution in direct injection engines is roughly twice that of port fuel injection engines.

Gasoline is volatile and should vapor off in the higher oil temperatures of the new engine designs, so viscosity loss should be temporary. However, the partially burned fuel and the byproducts it forms as it breaks down catalyze oil oxidation. In other words, fuel dilution makes oil break down faster.

Soot

Burning gasoline droplets instead of gasoline vapor also produces more soot. Watch out. Some manufacturers are already making plans for particulate filters for their direct injection gasoline engines in Europe, similar to the particulate filters on today's diesel engines.

Some of the soot finds its way into the crankcase to contaminate the engine oil. As soot particles agglomerate, they interfere with the function of anti-wear additives. By the way, phosphorus is still limited to 800 ppm, limiting the level of zinc phosphate anti-wear additives.

As globs of soot combine into larger globs of soot, wear increases on parts that experience metal-to-metal contact. A combination of soot build up and oil degradation are particularly hard on timing chains, and at least four manufacturers have issued recent recalls for timing chain problems.

Dispersants in the motor oil can prevent soot agglomeration, and careful selection of zinc phosphate and other anti-wear additives can provide protection throughout the drain. Oil is definitely part of the solution.

Practical Advice

Direct injection gasoline engines have been on the market for a few years now (yes, I know that the first one was built over 100 years ago), both turbocharged and naturally aspired. If you own one, here is some common sense advice to make it last.

Since we know pre-ignition can be an issue, if the owners manual recommends 91 octane gasoline, do not skimp with 87 or 89 octane. Octane measures gasoline's ability to resist engine knock, which is pre-ignition you can hear.

Treat your gasoline with Gas-O-Klenz. Combustion chamber deposits hold heat, and a hot spot can light the gasoline too early. Gas-O-Klenz fights combustion chamber deposits.

Another reason to use Gas-O-Klenz is it cleans fuel injectors. A dirty injector will squirt fuel instead of misting it. A squirt hitting the cylinder wall will increase fuel dilution, and big droplets of fuel create more soot than small droplets. Keeping injectors clean will keep fuel dilution, and soot as low as possible.

Use a high quality Cen-Pe-Co passenger car oil and change at reasonable intervals. Direct injection engines produce much more soot and roughly double the fuel dilution of port fuel injection engines. As soot builds up, it interferes with what little anti-wear additive is still permitted. Fuel dilution is scary in oil that is

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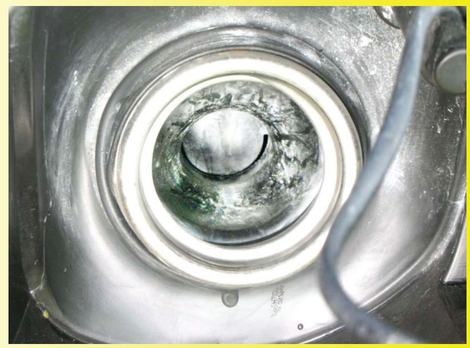
already as thin as water. The trend is to run drain intervals as long as possible to generate less waste oil, but shorter drain intervals mitigates each of these issues.

Changing oil flushes out the soot and fuel in the used oil and replenishes the dispersant and anti-wear additives that are depleted with use. Common sense does not seem to be as popular as it once was, but it can still go a long way toward making machinery last longer.

New Pint Bottle



We have begun shipping Cen-Pe-Co Gas-O-Klenz, DIeselMax, and Power Flo Klenz in new pint bottles. The new bottle has a smaller neck—small enough to get in and push back the flap covering some vehicle filler necks. The labels mark off 4, 8, and 12 ounces.

There are quite a few of the old pre-labeled bottles for Atomic Powered in inventory. When they are gone, they will also be replaced with the new bottle.

The old pint bottle is no longer manufactured.

Since we were forced into a change, we took advantage of the opportunity to upgrade to a bottle that makes it more convenient for our customers, many of whom have flaps covering their vehicles' gasoline filler necks.