Photo by Karen Winton on Freelmages.

Engine Oil

Decoding the alphabet soup

By Glenn Quagmire

It used to be oh, so easy. Grab a few quarts of 10W-30 and fillerup. Check to make sure the can or bottle had the correct API service designation and you were good to go.

Those days are long gone.

Today the choice of engine oil is not a simple exercise, even within a single marque like BMW. Different engine families have different requirements, and those requirements are spelled out in great detail in BMW service literature. It is worth noting that there are industry standards and classifications for automotive engine oil, and there are BMW's standards as stated above.

It is helpful to understand all of the various standards, categories, and classifications as well as understanding where they overlap and where they do not. So here's what you need to know (and, perhaps, some information you don't need to know, but might want to know...). Do note that this article will focus primarily on oils for gasoline engines. Oil for diesel BMWs can be covered separately.

Dino? Synthetic? Semi?

Today's engine oils are marketed under a variety of descriptions. Conventional. Synthetic. Semi-synthetic. High Mileage. And a few more as well. So just exactly what makes an oil synthetic, semi-synthetic, or "other?"

We turn to our good friends at the American Petroleum Institute for their always-clear and detailed explanations. In this case, API divides oil types into five groups, referred to as base oil groups, describing their chemical basis before additives are blended in. Groups one through three are conventional motor oils. Groups four and five are made up of various types of synthetics. Here's how it works.

Group 1 oils come from petroleum crude oil. The refining process for these oils is a basic solvent refining process, and these oils have modest performance characteristics.

Group 2 oils are more highly refined oils from petroleum crude oil, refined by using a process called hydrocracking. They have better anti-oxidation properties than Group 1 oils, lower levels of sulfur, and higher levels of saturates.

Group 3 oils are also based on petroleum crude oils, produced by hydrocracking. Like Group 2 oils, they have low levels of sulfur, higher levels of saturates, and a higher viscosity index. Viscosity index is a measure of the oil's ability to maintain its viscosity and lubricity over a wide range of operating temperatures, and can be enhanced through the addition of task-specific additives in the blending process. Higher is better.

Oils falling into Groups 1-3 are all considered "conventional" or "mineral" oil, although Group 3 oils are sometimes referred to as Synthetic Technology oils.

Group 4 oils are synthetic oils. This means they are developed from base fluids other than petroleum crude oils. These base fluids are most often based on polyalphaolefins, or PAOs, although they may also include synthetic esters and alkylated aromatics. They are developed using a process called synthesizing.

What makes synthetic oils special is the size of the molecules that comprise them. Conventional oils (Group 1-3 oils...) have molecules of varying sizes. Synthetics have molecules that are very consistent in size and shape. The result is reduced friction when they collide. That's why they're "slipperier." These oils have improved shear strength and a more broad temperature operating range, making them especially well-suited for use in cold climates as well as in high operating temperature conditions.

Finally, there are Group 5 oils which are all oils not covered in Groups 1-4. They may include a variety of base oils, and include semi-synthetics, or synthetic blends. These may include the so-called High Mileage oils, designed for cars that have accumulated, typically, 75,000 miles or more. These oils commonly have additives that cause modest swelling of gaskets, seals, and o-rings, allowing them to seal better in well-used engines.

There. Got all that?

Now, let's dig into more familiar territory – the API service designations. You may be aware that the current service designation from API is SN, a standard first introduced in 2010. Oil meeting this standard provides better oil performance than oil meeting previous standards. Improved features include better high temperature deposit protection for valves and pistons, better sludge control, and enhanced seal compatibility.

In addition, the API now identifies some SN oils as "Resource Conserving" oils, designated SN RC. These oils have been shown to provide a number of important features, including improved fuel economy with better compatibility with emission control systems, better lubrication for turbochargers, and better lubrication in engines run on ethanol fuels up to E85.

And just to make things even more interesting, API also provides a "Plus" designation for SN oils that offer protection against low-speed pre-ignition in forced induction gasoline powered vehicles.

Now, with all of that background, what is it we need to know about the proper oils to use in BMW engines?

BMW engineers have gone to great lengths to determine the optimal engine oil characteristics for their various engine families. Those recommendations are all based on extended oil change intervals. Hence the BMW standards are all designated LL, for Long Life oils. The BMW standards add a few more "vegetables" to our alphabet soup of oil chemistry, but they are well worth digesting.

As you'll see from the accompanying chart, BMW has established six categories of oil characteristics and their application to various models going back as far as early 2000's model years. And you can glean specifics by studying the chart. But here's the Cliff's Notes version for U.S. models.

- In general, for model years up to 2013, non M-series gasoline engines can use LL01 oil.
- M20 engines 2013 and newer can use LL14FE+ oil.
- LL17FE+ oil supersedes LL14FE+ and is backwards compatible to LL14FE+. It is not backwards compatible to LL01.
- All 2018 and newer models except M models must use LL17FE+.

BMW Specification	LL-01	LL-01FE	LL-04	LL-12 FE	LL-14 FE+	LL-17 FE+
Application	Minimum level for Gasoline from MY 2002 Minimum level for non-DPF Diesels from MY 2003 OK for older engines Not allowed for M-engines in general, only for new S55- and S63-M-engines	All Gasoline engines from MY 2005 OK for older Gasoline engines with Valvetronic Not allowed for Diesel Engines Not allowed for M-engines in general, only for new S55- and S63-M-engines	Mandatory for DPF Diesels OK for non-DPF Diesels OK for gasoline from MY 2002 in Europe only Not allowed for M-engines in general, only for new S55- and S63-M-engines	Standard BMW Diesels from MY 2013 onwards. (Not backward compatible) Not allowed for high power Diesels. Check manual for details. (Rule of thumb: Multiple turbos) Ok for gasoline from MY 2002 in Europe only Not allowed for M-engines in general, only for new S55- and S63-M-engines	ONLY for EU and USA! Allowed for Gasoline from MY 2013 with N20 and "Baukasten" engines NOT allowed for other engines Not allowed for M-engines in general, only for new S55- and S63-M-engines	Backward compatible with LL-14 FE+ ONLY for EU and USA! Mandatory for engines with Gasoline Particulate Filters (GPFs) OK for Gasoline from MY 2013 with N20 and "Baukasten" engines NOT allowed for other engines Not allowed for M-engines in general, only for new S55- and S63-M-engines
ACEA basis	A3/B4^{-15}	A5/B5^{-16}	C3^{-15} excl. P limit	C2^{-15}	C5^{-15} excl. S. Ash limit	C5^{-15}
SAE Viscosity grade	0/5W-30/40	xW-30	0/5W-30/40	xW-30	xW-20	xW-20
HT/HS viscosity (CEC L-036-90), mPas, min.	3.5	3.0	3.5	2.9	2.6	2.6
Kin. Viscosity at 100°C, mm^2/s	SAE J300	≥10.0	SAE J300	≥8.8	≥7.8 & <9.3	≥7.8 & <9.3
Noack (ASTM D5800), %	ACEA	ACEA	ACEA	ACEA	ACEA	ACEA
TBN (ASTM D2896), mg KOH/g, min.	10.0	10.0	6.0	6.0	9.5	6.0
Sulfated ash (ASTM D874), %m/m	≥1.0 & ≤1.6	≤1.6	0.8	≤0.8	≤1.3	≤0.8
Pour Point (ASTM D97) °C, max.	-42 for 0W-xx, TBD for 5W-xx	-42 for 0W-xx, TBD for 5W-xx	-42 for 0W-xx, TBD for 5W-xx	-42 for 0W-xx, TBD for 5W-xx	-42	-42

You'll see details and exceptions in the chart, but the above information should provide much of what you need to know.

What's this about SAPS?

SAPS stands for Sulfated Ash, Phosphorus, and Sulfur. These materials serve as anti-friction modifiers and provide wear protection for internal engine components. However they are sometimes associated with increased levels of carbon deposits. So refiners and blenders must achieve a careful balance of SAPS for optimal performance.

For instance, LL01 oils have high SAPS content, making them a good choice for older BMWs. Oil blends for newer BMWs have lower SAPS content.

What problems occur with the wrong oil?

If you're reading this publication, you know that BMW engines enjoy sophisticated design features and advanced materials. So ordinary oils just won't do. The use of non-compliant oils can lead to a host of problems, not the least of which are carbon deposits within the rotating assembly and on induction system components. We're all familiar with problems of deposits on the backs of intake valves on all types of GDI engines. BMW engines are no exceptions.

But problems can be even more serious and invasive. Inferior oils can break down and lose lubricity, causing internal damage to engine bearings, piston rings, and turbochargers. We know that there are many reports of excessive oil consumption with specific engine families. With such consumption comes the risk of vehicles being driven with critically low levels of oil in the sump, providing the opportunity for catastrophic engine damage. And this is exacerbated by extended oil change

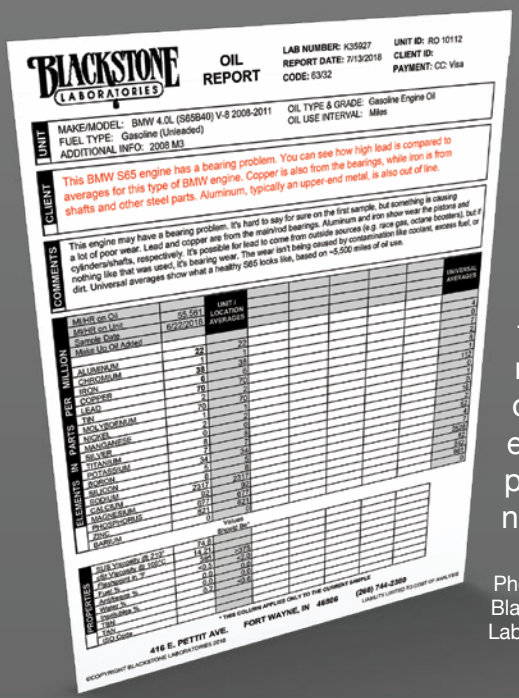
What's my oil telling me?

Oil analysis can reveal a great deal about an engine's condition and operating environment. It's a valuable diagnostic tool that can reveal how, and how much, internal engine components are wearing. It can also identify if inappropriate fuel and oil have been used.

Oil analysis is done by highly-qualify labs, at very reasonable prices, and can provide reports and observations in a matter of just a couple of days. As you'll see from the sample report here, analysis was performed on an oil sample from an M3 with 4 liter S65 powerplant. The presence of lead, copper, iron, and aluminum point to possible excessive wear on the engine bearings. This, of course, could be confirmed with oil pressure readings hot and cold.

Particularly helpful are comments/observations from the lab, which not only provides statistical data, but also presents conclusions about possible causes and developments. It is also apparent from this report that the lab providing this report has an extensive database of normal measurements, presumably based on data accumulated from many analyses performed on similar engine architecture.

An initial oil analysis can provide useful information to the repair technician which can then be shared with the vehicle owner. Subsequent follow-up oil analyses can reveal patterns of engine wear and component degradation that can suggest that more frequent maintenance or internal engine repairs may be needed. •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OIL REPORT

LAB NUMBER: K35927
REPORT DATE: 7/13/2018
CODE: 63/32

UNIT ID: RO 10112
CLIENT ID:
PAYMENT: CC: Visa

UNIT
MAKE/MODEL: BMW 4.0L (S65B40) V-8 2008-2011
FUEL TYPE: Gasoline (Unleaded)
ADDITIONAL INFO: 2008 M3

OIL TYPE & GRADE: Gasoline Engine Oil
OIL USE INTERVAL: Miles

CLIENT
This BMW S65 engine has a bearing problem. You can see how high lead is compared to averages for this type of BMW engine. Copper is also from the bearings, while iron is from shafts and other steel parts. Aluminum, typically an upper-end metal, is also out of line.

COMMENTS
This engine may have a bearing problem. It's hard to say for sure on the first sample, but something is causing a lot of poor wear. Lead and copper are from the main/rod bearings. Aluminum and iron show wear the pistons and cylinders/shafts, respectively. It's possible for lead to come from outside sources (e.g. race gas, octane boosters), but if nothing like that was used, it's bearing wear. The wear isn't being caused by contamination like coolant, excess fuel, or dirt. Universal averages show what a healthy S65 looks like, based on ~5,500 miles of oil use.

ELEMENTS IN PARTS PER MILLION

		UNIT LOCATION AVERAGES	UNIVERSAL AVERAGES
MIHR on Oil	55.561		4
MIHR on Unit	6/22/2018		0
Sample Date			1
Make Up Oil Added			3
ALUMINUM	32	11	12
CHROMIUM	33	33	1
IRON	6	70	17
COPPER	70	70	27
LEAD	70	1	32
TIN	2	2	2
MOLYBDENUM	0	5	36
NICKEL	0	3	61
MANGANESE	1	34	55
SILVER	34	0	0
TITANIUM	0	0	0
POTASSIUM	6	6	0
BORON	231	231	0
SILICON	7	7	0
SODIUM	971	971	0
CALCIUM	971	971	0
MAGNESIUM	0	0	0
PHOSPHORUS		Values Exceed SAE	
ZINC			
BARIUM			

PROPERTIES

KUS Viscosity @ 210°	14.63	13.75	
cSt Viscosity @ 100°C	93.1	92.6	
Flash Point, F	0.0	0.0	
FUEL %	0.0	0.6	
Antifreeze %	0.0	0.0	
Water %		0.0	
Insolubles %			
TBN			
TAN			
Oil Color			

* THIS COLUMN APPLIES ONLY TO THE CURRENT SAMPLE

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intervals made possible through the use of synthetic oils with carefully-blended additive packages. The decreasing level of oil during extended oil change intervals may not be noticed by the driver. See “catastrophic engine damage” reference above...

We’re all likely familiar with heat-related problems in the N63 family of “hot-vee” engines. Because the twin turbochargers are located in the vee of the engine, exhaust heat is concentrated there, which cooks valve stem seals, with the resulting increased oil consumption you’d expect from such conditions. The factory reduced the recommended oil change interval from 15,000 miles to 10,000 miles, but many interpret this as a band-aid rather than a fix for the problem.

And then there’s the issue of Low Speed Pre-Ignition (LSPI). This is an evolving phenomenon and, without getting too deep into the quicksand, LSPI is a condition which manifests as premature combustion of the fuel/air mixture under low speed high load conditions. It is commonly found in forced induction GDI engines. While the causes are complex and not fully understand, it is believed that lubricating oil that is drawn into the combustion chamber likely contributes to this condition. This is just one more reason to choose engine oil carefully in order to avoid this condition.

Finally, non-compliant engine oil will not contain the additives and supplements necessary to prevent the formation or accumulation of acids and other nasty chemicals that can cause consequential damage to precision internal engine components.

But you knew that...

So how’s a technician to choose? And where to buy?

Well, let’s start off with, you’re not going to find compliant BMW oil at your local big-box store. You’ll need to choose oil from a specialty blender who certifies that their products comply with the various BMW LL standards. Such oils are available through various distributors, direct from refiners/blenders, or perhaps from your local dealer.

You should carefully choose oil for each customer’s vehicle based on the chart above. And while 0W-20 is a common choice for new BMWs, you should select the viscosity based on recommendations for the specific vehicle you’re servicing. These recommendations can be found in the owner’s handbook or in appropriate service literature. Bear in mind that your choice of viscosity can vary depending on your geography and its prevailing climate as spelled out in owner’s handbooks and elsewhere.

Also, consider that the correct specification is even more important than the correct weight, so be sure to choose oil that meets the appropriate specification. Documented approval by BMW further reinforces compliance with their standards.

You may encounter oil specifying compliance with other international standards. They may be those developed by ILSAC, the International Lubricants Standardization and Approval Committee, and you may also see reference to ACEA, the Association of Constructors of European Automakers.

The bottom line is, the choice of oil for BMWs is more critical than ever. Understanding the alphabet soup of it all will allow you to make more informed decisions, and will allow you to make the best recommendations to your customers and their prized BMWs. •

Some technical information for this article courtesy of Atlantic Import and Export Corp. (Atlanticim.com), the NAFTA marketing company for Rowe Motor Oil USA.