BLACKSTONE LABORATORIES

The Oil Report

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Oil the News that's Fit to Print!

Do I Need to Worry?

By Amanda Callahan

Last month we got an email from John, who had some questions about his report. His F250 was showing traces of coolant in the oil, and lead – from bearings – was elevated. He had the engine out of the truck pending repairs and wanted to know: how much lead is too much? Did he need to replace the bearings?

"Do I need to worry?" is a common question, and one there's not one easy answer for. We've had people pull the bearings out of a Corvette when lead was only a few ppm above average and we said in the report, "You don't need to do anything about this yet." (For the record, that guy called us and said his bearings looked fine and was kind of honked off about it.) We've had people with metals that are high all along, but not changing, and it never turns into a problem. And we've had people not pursue what appeared to be a problem, and regret it in the end (this is especially problematic when the engine is in an airplane). So how do we decide what's a problem and what's not? It would be great if there was a magic number, but there's not. We assess each engine individually, mainly focusing on these things:

1. How your sample compares to your trends
2. How your sample compares to average
3. The balance of metals to each other
4. Whether you're using additives

Trends

If you have them, trends are the most helpful thing we look at in determining your engine's health. It takes three samples to get

Figure 1: BMW 4.0L S65

ELEMENTS IN PARTS PER MILLION				UNIVERSAL AVERAGES
MI/HR on Oil	6,000	5,000	7,000	
MI/HR on Unit	49,000	43,000	37,000	
Sample Date	4/23/2017	2/6/2016	1/24/2015	
Make Up Oil Added	0.75 qts		0.75 qts	
ALUMINUM	5	5	7	4
CHROMIUM	0	0	0	0
IRON	7	7	9	7
COPPER	3	3	7	2
LEAD	16	14	17	8
TIN	1	0	0	1
MOLYBDENUM	174	179	126	111
NICKEL	0	1	0	0
MANGANESE	0	1	1	1
SILVER	1	0	0	0
TITANIUM	42	46	27	16
POTASSIUM	3	0	1	2
BORON	18	23	24	51
SILICON	4	2	3	4
SODIUM	12	4	4	7
CALCIUM	2668	2991	2228	2535
MAGNESIUM	31	62	175	77
PHOSPHORUS	727	790	718	845
ZINC	812	931	770	980
BARIUM	0	0	0	0

High metals aren't necessarily problematic, if they're steady.

a good trend going (though we can often tell if something is amiss earlier than that). All engines are different, as are their drivers, how they're used, and where they are in the country. As such, it's very helpful to sample a few oil changes in a row, at least at first, and have a baseline established for your specific engine.

Consistency counts. If your engine is wearing a lot but it's doing so steadily, it's possible that the metal isn't a problem. Problems tend to get worse over time – not remain stagnant. Figure 1 is a good example where lead (a bearing metal) doesn't appear to be a problem. That engine has more lead than average, but it's consistent. Since the owner wasn't having any problems, our recommendation was to just watch lead as time goes on.

Figure 2: BMW 4.0L S65

							UNIVERSAL AVERAGES
MI/HR on Oil	5,891	5,348	3,295	4,594	4,594	3,201	
MI/HR on Unit	64,141	58,250	52,902	49,607	49,607	45,013	
Sample Date	6/15/2018	6/16/2017	7/1/2016	6/21/2015	6/21/2015	6/14/2014	
Make Up Oil Added	2 L	1 qt	1 qt	1 qt	1 qt	0 qts	
ELEMENTS IN PARTS PER MILLION							
ALUMINUM	2	6	4	4	4	5	4
CHROMIUM	0	0	0	0	0	0	0
IRON	7	5	4	5	5	4	7
COPPER	5	4	3	5	4	5	2
LEAD	**12**	8	4	7	7	3	8
TIN	0	0	0	1	0	1	1
MOLYBDENUM	217	190	206	211	210	172	111
NICKEL	1	0	1	1	0	0	0
MANGANESE	1	0	0	0	0	0	1
SILVER	0	0	0	0	0	0	0
TITANIUM	43	45	48	56	56	36	16
POTASSIUM	0	0	1	4	6	1	2
BORON	33	32	36	35	35	35	51
SILICON	4	5	4	4	4	5	4
SODIUM	2	3	3	3	3	3	7
CALCIUM	3123	2652	2951	3075	3051	2634	2535
MAGNESIUM	22	11	11	20	20	51	77
PHOSPHORUS	927	792	844	883	865	763	845
ZINC	1116	923	1022	1115	1098	884	980
BARIUM	0	0	0	0	0	0	0

A deviation in trends (even if metals aren't excessive) is worth watching.

But on the other hand, look at Figure 2. Lead read at just 12 ppm in this sample – that's well within the average range, but we marked it because lead had always been much lower than this. If this had been his first report, we might have thought lead was okay. But since we know that lead is usually low, we told him the bearings are wearing more than they were and to watch for abnormalities like low oil pressure.

Universal averages

Of course, when you start sampling, you don't have trends to rely on. So our second line of defense, when we're looking at your numbers, is universal averages.

We have averages established for most of the engines out there, though we're always adding to our database as new types of engines (and transmissions and generators and other machinery) are being made all the time. When you do your first sample, we'll compare your metals to averages for your specific engine.

It's helpful for us to know what kind of engine you have. Look at Figure 3, for example. This is a comparison between the Toyota 1.8L 1ZZ-FE (used in Corollas and Vibes), and the Oldsmobile 455 (used in older mo-

Figure 3: Toyota 1.8L and Oldsmobile 455

	TOYOTA 1.8L 1ZZ-FE	OLDS 455
MI/HR on Oil		
MI/HR on Unit		
Sample Date		
Make Up Oil Added		
ELEMENTS IN PARTS PER MILLION		
ALUMINUM	3	6
CHROMIUM	0	2
IRON	9	37
COPPER	2	24
LEAD	1	38
TIN	1	2
MOLYBDENUM	73	74
NICKEL	0	1
MANGANESE	1	2
SILVER	0	0
TITANIUM	2	0
POTASSIUM	2	8
BORON	39	45
SILICON	16	13
SODIUM	54	72
CALCIUM	1955	2161
MAGNESIUM	230	323
PHOSPHORUS	706	1133
ZINC	820	1361
BARIUM	0	1

Different engines have different wear patterns.

torhomes and the Cutlass and Trans Am).

Toyotas don't wear much, whereas the Olds 455 makes a lot of metal. If we don't know what kind of engine you have, we might end up comparing your numbers to the wrong set of averages, or just a generic engine file. We can still tell if something is way out of line, but the more subtle differences between your engine and averages are harder to see.

Along those same lines, some vehicles come with many different engine options, so just telling us the year, make, and model of your vehicle isn't always enough. The 2006 Silverado, for example, could have the 4.3L V6, the 4.8L V8, the 5.3L V8, the 6.0L V8, the 8.1L V8 gas engine, or the 6.6L diesel engine in it. We have different averages for each of those engine types. Take a look at Figure 4. The metals are similar in those engines, but they're different enough to matter when we're determining if something is too high or not.

Figure 4: 2006 Chevy Silverado

UNIVERSAL AVERAGES	4.3L V6	4.8L V8	5.3L V8	6.0L V8	8.1L V8	6.6L V8
ALUMINUM	3	3	3	3	4	3
CHROMIUM	1	1	1	1	1	0
IRON	14	16	18	20	21	15
COPPER	4	19	22	25	17	10
LEAD	6	6	6	5	10	2
TIN	1	1	1	1	1	1
MOLYBDENUM	67	67	74	64	77	42
NICKEL	1	1	1	1	1	0
MANGANESE	1	24	6	39	4	0
SILVER	0	0	0	0	0	0
TITANIUM	1	1	1	1	0	0
POTASSIUM	6	3	4	3	2	5
BORON	40	36	44	38	51	117
SILICON	17	10	11	10	13	9
SODIUM	51	55	54	45	34	5
CALCIUM	1908	2002	1950	1980	2032	1841
MAGNESIUM	189	155	222	175	228	480
PHOSPHORUS	711	701	695	714	742	1063
ZINC	845	827	817	847	898	1235
BARIUM	0	0	0	0	0	0

The 2006 Chevy Silverado came with six engine options and they each have different wear patterns.

Generally speaking, we'll mark a metal in bold when it's twice average or more. But not always - there are also times when we don't mark elevated metals, if we know something else is going on. We test a fleet of armored Sprinter vans that operate in New York City, for example. The vehicles are loaded up with armor and spend their entire lives idling and driving in unforgiving traffic conditions. It's no surprise that the engines wear more than average. (See Figure 5.)

Balance of metals

We also look at the balance of metals relative to each other. In Figure 6, lead is not reading twice average but we marked it anyway. According to averages, lead and iron should be at about a 1:1 ratio. In this sample, the lead: iron ratio is more like 4:1. This balance tells us the bearings are wearing more than the rest of the engine, and that can be a sign of trouble too.

Additives

Another factor to consider is the use of additives and/or leaded fuel. Lots of people use Restore, which has copper and lead in it, and although in that form those elements aren't harmful, they do make your numbers read high. Likewise, if you're using leaded fuel, racing fuel, or certain octane boosters, fuel blow-by will cause high lead readings. The highest lead reading we've seen in any BMW S65 engine was 1055 ppm. The rest of the metals looked great, though, and the customer had mentioned using an additive, so we were pretty sure the lead in his sample wasn't a sign of an impending bearing failure.

How much metal is too much?

So how much metal is too much? In truth that number is different for every engine. You already know that we take a lot of things into account in trying to answer that question. Usually we'll call you to get more information if we're not sure, and we'll suggest giving it an oil change or two to see how trends shake out. If something is seriously out of line we can usually tell, even if we don't know your engine type or how you use it.

We will say this, though: it's pretty rare for a major mechanical problem to happen unexpectedly overnight. Most engines will give at least some warning before things go south, and that's why you do analysis. Follow the trends to see what's normal for your engine, and when deviations occur, you're informed enough to make a good decision.

Figure 5: Mercedes-Benz 3.0L V6

			UNIVERSAL AVERAGES
MI/HR on Oil	9,842	14,511	
MI/HR on Unit	77,134	67,919	
Sample Date	4/16/2017	8/28/2016	
Make Up Oil Added	2 qts	3 qts	
ELEMENTS IN PARTS PER MILLION			
ALUMINUM	7	7	7
CHROMIUM	4	3	2
IRON	192	126	68
COPPER	3	2	3
LEAD	1	0	1
TIN	0	0	1
MOLYBDENUM	9	76	35
NICKEL	0	2	1
MANGANESE	2	1	1
SILVER	0	0	0
TITANIUM	0	0	1
POTASSIUM	4	2	7
BORON	63	106	67
SILICON	8	7	6
SODIUM	9	4	6
CALCIUM	2941	2924	1850
MAGNESIUM	17	22	162
PHOSPHORUS	937	946	844
ZINC	1126	1052	983
BARIUM	0	0	0

Some engines wear more than average due to operational conditions, and that's not a problem.

Figure 6: BMW 4.0L S65

		UNIVERSAL AVERAGES
MI/HR on Oil	6,000	
MI/HR on Unit	95,000	
Sample Date	6/17/2017	
Make Up Oil Added		
ELEMENTS IN PARTS PER MILLION		
ALUMINUM	2	4
CHROMIUM	0	0
IRON	3	7
COPPER	4	2
LEAD	**12**	8
TIN	0	1
MOLYBDENUM	6	111
NICKEL	0	0
MANGANESE	0	1
SILVER	0	0
TITANIUM	1	16
POTASSIUM	3	2
BORON	28	51
SILICON	5	4
SODIUM	4	7
CALCIUM	2380	2536
MAGNESIUM	21	77
PHOSPHORUS	756	845
ZINC	901	980
BARIUM	0	0

An improper balance of metals can suggest trouble.

Report of The Month

This new 2.0L 4-cylinder Kia engine didn't get an oil change for the first 30,000 miles.

What do you think? To see where the elements are from, click here.

ELEMENTS IN PARTS PER MILLION		UNIVERSAL AVERAGES
MI/HR on Oil	30,000	
MI/HR on Unit	30,000	
Sample Date	6/4/2018	
Make Up Oil Added	0 qts	
ALUMINUM	**110**	4
CHROMIUM	3	0
IRON	**299**	13
COPPER	**140**	2
LEAD	0	1
TIN	**15**	1
MOLYBDENUM	84	62
NICKEL	**6**	0
MANGANESE	8	0
SILVER	0	0
TITANIUM	8	2
POTASSIUM	9	2
BORON	4	39
SILICON	**60**	12
SODIUM	304	51
CALCIUM	1458	1847
MAGNESIUM	39	143
PHOSPHORUS	636	666
ZINC	717	761
BARIUM	1	0

PROPERTIES	
SUS Viscosity @ 210°F	56.6
cSt Viscosity @ 100°C	9.23
Flashpoint in °F	**350**
Fuel %	0.8
Antifreeze %	0.0
Water %	0.0
Insolubles %	0.5
TBN	
TAN	
ISO Code	

You know, all in all it's not a terrible report. An earlier oil change would have been good, of course, but mostly what you're looking at is the normal factory wear-in plus 30,000 miles of metal accumulation. There's probably also additional wear from the oil itself being abrasive from collecting so much metal. We suggested a few short oil changes to flush the system. The oil held up well over the long interval, though – the viscosity was still in the 5W/30 range and insolubles (oxidized solids caused by heat, use, and blow-by) read within limits.