BLACKSTONE LABORATORIES

The Oil Report
July 2017
Oil the News That's Fit to Print!

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A *Brand* New Perspective

Digging Into the Timeless Question, "Which Oil is Better?"

by Travis Heffelfinger

I was talking to a customer recently, going over the results from his latest oil report, and the conversation went a little something like this:

Him: "So, I'm using Rotella in this engine… is that the best choice?"
Me: "It certainly seems to be doing a good job. You'd probably get good results with whatever oil you used, but this is working fine."
Him: "Would I be better off if I switched to Mobil 1?"
Me: "Well, you could, but I wouldn't expect much change in engine wear. We find that the type of oil typically doesn't matter when it comes to wear metals."
Him: "What about Amsoil? I've heard that's the best oil out there."
Me: "That's a good brand as well. We just don't tend to see much difference in wear metals between different oil types, so whichever one you want to use is fine."
Him: "Okay, but what about that new Pennzoil Ultra stuff? I've heard that's a much better product. Is that better than Amsoil, or not?"
Me: [sigh…]

Three very different oils, three very different prices. But does the more expensive oil really work any better?

This discussion went on for a while. And I know I'm not the only analyst who's had a similar conversation.

By far, the most common question we get is, "Which oil should I use?" And that's understandable. You're just trying to do what's right for your engine, and each oil promises to be the absolute best. After all, there's got to be some reason why you can pick up a cheap, store-brand oil for about $2.50 a quart, while other types of oil go for $10 per quart or more. There have to be some differences, right?

Well, of course there are. Different brands have different levels of additives, start from different base stocks, and undergo different manufacturing processes, making some types of oil a lot more expensive than others. But the real question is, do those differences have a meaningful effect on how your engine is wearing?

Fig. 1 - Universal Averages Subaru EJ 2.5L Turbo, after ~3,900 miles of oil use

Element	Universal Average
Aluminum	4
Chromium	1
Iron	9
Copper	8
Lead	2
Molybdenum	76
Boron	49
Sodium	29
Calcium	1840
Magnesium	456
Phosphorus	847
Zinc	1009

We've got the data. What does it say?

If you're a long-time reader of this newsletter, you probably realize that this is not the first time we've tackled this topic. In fact, just a few years ago, one of our analysts did an in-depth analysis by comparing the wear levels in her beloved MINI Cooper over the course of two oil runs using very different brands of oil, and her results confirmed what we generally believe to be true – if an engine is running well, it should produce pretty similar levels of wear metals, regardless of the specific brand of oil that's in use.

To really put this question to rest, though, we realized we needed to work with a bigger population of engines. When comparing two individual oil tests, there are simply too many variables in terms of maintenance, usage, and other real-world factors to be able to say for certain if any slight differences are due to the oil type.

Instead, we want to look at the average wear rates from a lot of different engines of the same type. This eliminates the statistical "noise" from individual samples, and gives us a more accurate picture of normal wear. For example, shown at left (Fig. 1) are the universal averages for the Subaru EJ 2.5L Turbo engine, used in the Impreza WRX STi and Forester XT. We have more than 5,000 samples from this engine in the database, at an average oil run of ~3,900 miles.

Fig. 2 - Subaru EJ 2.5L Averages, Separated by Oil Type

	Universal Averages	Shell Rotella T6 5W/40	Mobil 1 5W/30	Subaru 5W/30	Amsoil 5W/30	Castrol Syntec 5W/30	Amsoil Signature Series 5W/30	Valvoline 5W/30	Royal Purple 5W/30	Pennzoil Platinum 5W/30	Castrol Syntec 0W/30
Count	5234	1321	483	184	143	96	93	83	79	77	75
Miles	~3900	4044	4169	4085	4209	3742	3719	3355	3825	3938	4519
Al	4	3	4	4	4	4	4	3	4	3	4
Cr	1	1	1	1	0	1	0	1	1	1	1
Fe	9	8	11	10	9	9	8	8	10	9	11
Cu	8	7	9	12	8	8	11	9	10	11	8
Pb	2	2	2	2	2	2	0	2	6	2	6
Mo	76	66	82	109	93	80	144	20	70	54	15
B	49	29	53	35	150	54	155	10	28	16	5
Na	29	13	14	10	7	23	10	230	130	7	9
Ca	1840	915	1729	2167	3130	1958	3418	1985	2098	2490	2026
Mg	456	1160	340	48	34	498	29	30	498	51	466
P	847	1031	666	685	701	686	717	698	748	696	863
Zn	1009	1257	780	835	809	830	807	832	870	816	1044

The top five elements (aluminum through lead) are wear metals from the engine, while the other elements shown are additives in the oil. In a normal report, we don't separate averages by oil type, so that was step one. We then created new averages for each type of oil that had been used more than a few times in samples we'd seen. The chart below (Figure 2) shows the top ten oil types used in this kind of engine. The "Count" is the number of samples of each oil type, and "Miles" is the average oil change interval for that engine/oil combination.

As you look at each element, there are a few things to note. First of all, you can see that the levels of additives can vary quite a bit from oil to oil. Calcium is much higher than average in the Amsoil products, but much lower than average in the Rotella T6. Rotella makes up for that with the higher magnesium, since both calcium and magnesium are detergent/dispersant additives. We also find sodium in Valvoline and Royal Purple, but only trace levels of sodium in the other types of oil. You can see similar variations in the other additives, like boron and molybdenum.

For wear metals, though, there's not nearly as much variation. Iron is between 8 and 11 ppm all across the page, and copper is between 7 and 12 ppm for each set of averages. Other metals had even less variation, and no single oil type had the lowest level of all metals.

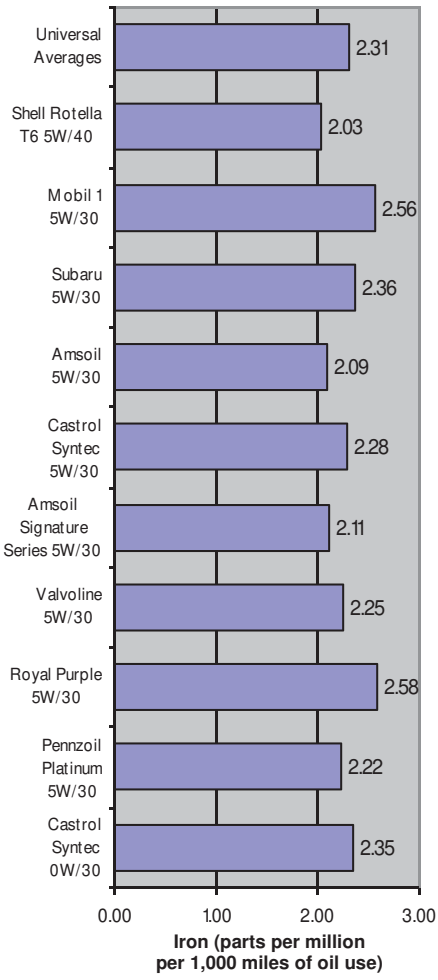
So what does this tell us? Well, on the face of it, it doesn't really look like the levels of additives have an awful lot to do with engine wear. Brands with more calcium and zinc don't have significantly better wear readings than the brands with relatively lower additive levels. The Rotella T6 does seem to have a slight edge, since all metals are reading at the low end of the spectrum, while the Subaru 5W/30 has some of the highest levels, but the margin is pretty thin.

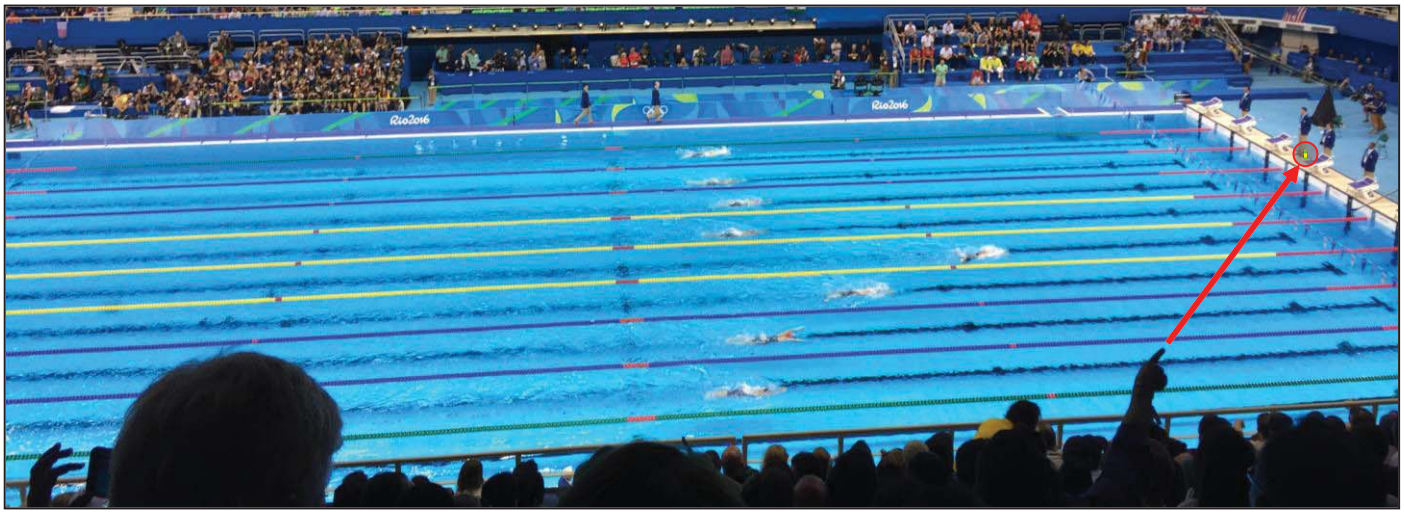
Breaking it down even further, we can look at the level of iron produced by engines running each type of oil on a per-mile basis. Iron is from steel parts, so it's the dominant metal in most engines, and it tends to track with oil use more than the other metals do, so it makes sense to look at the wear-rate, or the amount of iron per mile.

Shell Rotella T6 had the lowest iron wear rate, at 2.03 ppm per 1,000 miles, while Royal Purple 5W/30 had the highest wear rate, at 2.58 ppm per 1,000 miles. The difference is just over half a part per million per 1,000 miles, which is almost completely negligible.

In a typical engine, a half a part per million of the oil in the sump is such a small quantity that you wouldn't be able to see it without a microscope. To put that in perspective, an Olympic-sized swimming pool holds about 660,000 gallons of water. One half part per million of that volume would equal just over 5 cups of water – that's like mixing half of a 2-liter bottle of Sprite into the pool, and it makes about as much impact on your engine: if you know it's there, it might bother you, but realistically, you'll never notice the difference.

Fig 3. - Subaru 2.5L Turbo - Avg. Wear Rate by Oil Type





How much is half a part per million? We drew a 2-liter-sized bottle in this picture from the Rio Olympics, next to the Lane 3 judge. It's barely visible in this picture, even with the guy a few rows in front of you pointing right to it. You could pour half this bottle into the pool, and not even Michael Phelps would know it unless he actually saw you do it!

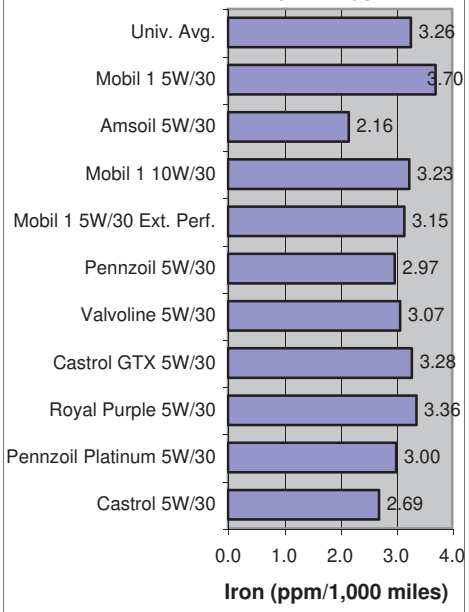
One part per million of the area of this page is about the size of the red dot inside this circle. →

We've done similar breakdowns for other popular engine/oil combinations as well, and most show similar levels of differences from oil type to oil type – which is to say, not much at all.

Fig. 4 - GM 5.3L Averages, Separated by Oil Type

	Universal Average	Mobil 1 5W/30	Amsoil 5W/30	Mobil 1 10W/30	Mobil 1 5W/30 Ext. Perf.	Pennzoil 5W/30	Valvoline 5W/30	Castrol GTX 5W/30	Royal Purple 5W/30	Pennzoil Platinum 5W/30	Castrol 5W/30
Count	2542	557	109	109	65	62	59	44	41	38	29
Miles	5657	5724	9862	6081	8260	4953	4686	3123	5789	6022	4490
Al	3	4	4	3	4	2	2	3	4	3	4
Cr	1	1	1	1	1	1	1	1	1	1	1
Fe	18	21	21	20	26	15	14	10	19	18	12
Cu	24	29	**36**	20	24	16	22	25	34	33	17
Pb	6	7	8	11	6	5	5	5	6	7	5
Mo	73	83	80	77	82	149	30	18	82	58	31
B	43	54	85	62	53	47	9	19	18	23	22
Na	53	14	23	11	11	27	193	155	120	14	137
Ca	2020	1751	3156	2043	1576	2128	1735	2134	2117	2537	1986
Mg	199	382	89	274	470	20	47	15	611	25	54
P	696	681	713	679	681	700	685	676	715	676	659
Zn	826	806	842	804	800	844	805	783	849	802	775

Fig. 5 - GM 5.3L V8, Iron Wear Rates by Oil Type



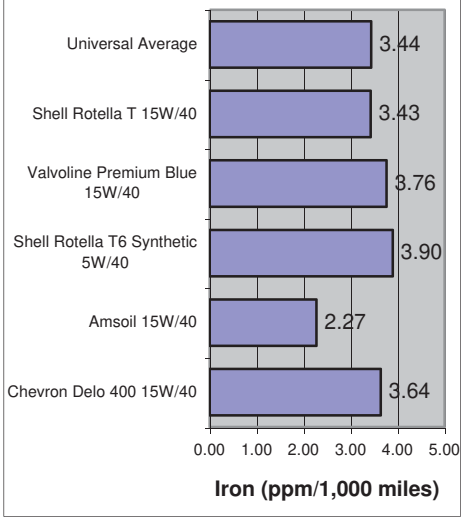
With the GM 5.3L V8 (used mostly in trucks and SUVs like the Silverado, Suburban, and Tahoe), there's a little more variation than with the Subaru engine, but most of the metals still line up pretty well with the universal averages. You'll note in Figure 4 that Castrol and Castrol GTX both showed up with much lower levels of iron than most of the other oils, but check out the mileage on the oil – both of those had a much shorter average oil change interval than the other oil types. Looking at the iron wear rate in the bar graph (Figure 5), the Castrol oils are pretty middle-of-the-road.

Amsoil has much lower iron on a per-mile basis, but the *average* Amsoil oil change interval is close to 10,000 miles, quite a bit longer than most of the other oil types shown here. Amsoil did have the most copper (about 50% higher than average – we've highlighted that reading in Figure 4 above), and that doesn't typically track with oil use, so even with the lower iron, we can't say it was better overall than the others.

Fig. 6 - Cummins 6.7L ISB Averages by Oil Type

	Universal Average	Shell Rotella T 15W/40	Valvoline Premium Blue 15W/40	Shell Rotella T6 Synth 5W/40	Amsoil 15W/40	Chevron Delo 400 15W/40
Count	1837	355	184	186	132	75
Miles	6892	6354	5646	7117	11427	5748
Al	3	3	3	4	4	5
Cr	1	1	1	1	1	1
Fe	24	22	21	28	26	21
Cu	7	8	4	6	**9**	3
Pb	1	1	1	0	1	0
Mo	34	7	43	60	21	80
B	50	33	12	41	19	355
Ca	1649	2180	1232	964	2365	1499
Mg	588	78	962	1139	519	422
P	1025	975	1078	1064	1076	1054
Zn	1218	1158	1274	1260	1272	1249

Fig. 7 - Cummins 6.7L ISB Iron Wear Rate by Oil Type



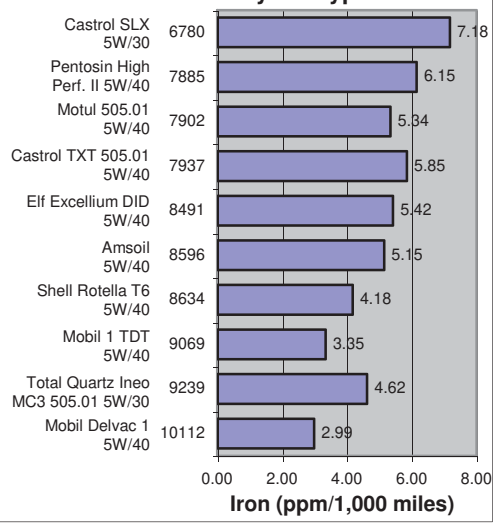
We can see the same pattern with Amsoil in the Cummins 6.7L ISB from the Dodge Ram (Fig. 6 & 7). Amsoil has the lowest iron wear-rate, but the highest copper reading overall.

Again, it looks like the low iron wear rate coincides with the long oil change intervals compared to the other types of oil.

Fig. 8 - Volkswagen 1.9L TDI Averages, Separated by Oil Type

	Univ. Avg.	Shell Rotella T6 5W/40	Mobil 1 5W/40 TDT	Castrol SLX 5W/30	Motul 505.01 5W/40	Amsoil 5W/40	Mobil Delvac 1 5W/40	Elf Excellium DID 5W/40	Pentosin High Performance II 5W/40	Total Quartz Ineo MC3 505.01 5W/30	Castrol TXT 505.01 5W/40
Count	2324	370	257	108	82	73	54	50	36	36	30
Miles	8529	8634	9069	6780	7902	8596	10112	8491	7885	9239	7937
Al	5	4	5	6	6	5	5	5	5	6	5
Cr	2	2	2	1	2	2	2	2	1	1	1
Fe	39	36	30	49	42	44	30	46	48	43	46
Cu	3	3	3	3	4	3	4	5	3	3	4
Pb	2	2	2	3	3	3	2	3	2	2	3
Mo	25	51	11	3	4	8	9	1	1	2	5
B	35	27	43	6	38	45	40	29	47	4	32
Ca	1958	1589	1454	1952	2226	1918	2812	2320	1929	2033	2121
Mg	393	959	810	23	21	150	544	30	20	15	48
P	955	1148	1077	782	823	855	1107	815	883	787	802
Zn	1134	1372	1286	922	985	1013	1324	974	1033	921	960

Fig. 9 - Volkswagen 1.9L TDI Iron Wear Rate By Oil Type



You might be ready to declare Amsoil as the king of all oils at this point, but hold on a sec. Let's take a look at one more set of data, this time from the Volkswagen 1.9L TDI engine, used in diesel cars like the Passat and Golf (Fig. 8). As before, the average levels are shown on the left, with the most frequently used oil types shown from left to right.

Once again, all the metals line up pretty well with averages, regardless of the type of oil in use, and once again, iron has the most variation from oil type to oil type. This time, though, Amsoil didn't have the longest average oil change interval – Mobil Delvac 1 did. And lo and behold, that's also the type of oil with the lowest iron wear rate for this engine.

This got us curious, so this time, when creating the bar graph for the iron wear-rate (Fig. 9), we put them in order of average oil interval, and wouldn't ya know it, there's a pretty clear correlation: the longer the oil is in use, the lower the wear rate. The only real exception is the Total Quartz, and we're guessing that might have more to do with the viscosity, since it and Castrol SLX are the only 5W/30's in the bunch.

Why? Does this mean the engines are wearing less as they go more miles? Not exactly. It's important to remember that the iron level doesn't start at zero, since there's always going to be some residual oil left over from the previous fill. That drives up the wear rate at the beginning, but it becomes less of a factor as the oil runs longer, which is probably why the longer oil runs tend to have lower wear rates. We think the wear rates would even out a lot on similar oil change intervals, which is why we prefer the overall averages for the engine, instead of specific oil types.

So what does all of this tell us?

Well, we're no closer to saying that one type of oil is better than another, that's for sure. We see much more variation in wear levels from the type of engine, the time on the oil, the viscosity, the use the engine sees, etc. Whatever differences exist from oil brand to oil brand, we don't see a lot of difference in terms of wear for most types of engines.

Now, some people report better fuel economy or other benefits from using one type of oil instead of another, and if that's you, that's great. Our point here is not to tell you that you should or shouldn't use a certain type of oil, so by all means, feel free to stick with what's working for you. All we're saying is, if you want to try an oil that maybe costs a little less, you probably don't need to worry about it causing any problems. Send us a sample of what you're using, and then try a similar oil run with the new stuff – by comparing those results, you might find that you can get the same great results, and save a little money as well! Good luck!

Update: Running the eBay Oils In My Truck

Back in April 2012, I wrote an article about buying old cans of oil off of e-Bay and testing them out. At the end of the article, I mentioned that I was actually going to run some of that oil in my truck. There was a follow up article to that in October 2013 as well, where I talked about running more of the e-Bay oils after I changed out the first batch. Well, I'm happy to say my classic GM 350 is still running.

Of course, I have noticed the engine is starting to smoke a bit on start-up. It also has some morning sickness which I suspect is due to sticking valves, though I have to say it was kind of like that after the initial rebuild (see the July 2010 newsletter). Still, the truck does start and once it gets going, it runs fine. I hauled about 20 loads of wood with it during the summer of 2015 without a problem at all. So is the smoke on start-up due to using the e-Bay oil? I really can't say, but I doubt those oils helped anything. I guess the best conclusion I can draw here is, don't run oils you buy off of e-Bay! There you have it, words of wisdom from the oil gurus.

~ Ryan Stark

Report of the Month

That's a lot of aluminum. Can you tell what's going on with this 2003 Mustang GT?

To learn more about where the elements are coming from, click here.

ELEMENTS IN PARTS PER MILLION								
	MI/HR on Oil	4,900	UNIT/ LOCATION AVERAGES	4,500	4,714			UNIVERSAL AVERAGES
	MI/HR on Unit	108,918		104,000	99,587			
	Sample Date	5/20/2016		1/4/2016	8/9/2015			
	ALUMINUM	479	199	80	39			4
	CHROME	2	2	1	2			1
	IRON	33	18	9	12			15
	COPPER	22	12	7	6			5
	LEAD	0	0	0	1			2
	TIN	0	0	0	0			1
	MOLYBDENUM	2	2	2	3			62
	NICKEL	3	2	2	2			1
	POTASSIUM	2	3	4	4			2
	BORON	1	3	7	7			55
	SILICON	66	35	17	17			15
	SODIUM	313	325	342	342			41
	CALCIUM	2030	2077	2115	2086			2120
	MAGNESIUM	13	11	12	9			153
	PHOSPHORUS	588	608	694	542			716
	ZINC	728	716	758	662			846
	BARIUM	1	1	1	1			1

PROPERTIES			Values Should Be*				
	SUS Viscosity @210°F	53.6	46-59	55.5	52.7		
	cSt Viscosity @ 100°C	8.35	6.0-10.2	8.91	8.08		
	Flashpoint in °F	420	>385	415	430		
	Fuel %	<0.5	<2.0	<0.5	<0.5		
	Antifreeze %	0.0	0.0	0.0	0.0		
	Water %	0.0	0.1	0.0	0.0		
	Insolubles %	0.2	<0.6	0.2	0.2		
	TBN						

After seeing a video online about oil analysis, the owner of this Mustang decided to give it a try. In August 2015 he got his first report back, noted aluminum, and didn't think too much of it. In 2015 he sent another sample and the report showed aluminum nearly doubled. He says he was starting to get a bit nervous about the timing chain or bearings, but decided to wait till he could hear noise. When he sent the final sample in May and it came back with extremely high aluminum, he realized that although he couldn't hear or see any symptoms, the oil report was enough to take action. "I took my vehicle to a repair shop and explained the situation to the service advisor. He seemed very skeptical about what I had told him, and even more skeptical when he started the ignition and it ran like a clock. He said he really didn't think it was the timing chain, since the vehicle only had 109,000 miles on it. I requested that his team check the oil pressure and use a borescope to check the timing chain and tensioners. I received a call back about a day later and was informed that the timing chain guides were worn down, which ultimately would have led to possible catastrophic engine failure. The chain had worn through the plastic guides and were now rubbing against the motor. These reports basically saved me from a costly motor rebuild or replacement even when the vehicle wasn't displaying any tangible symptoms."