BLACKSTONE LABORATORIES

The Oil Report
February 2022

Oil the News that's Fit to Print!

Did you know we analyze filters? We prefer you send just the pleats (not the whole canister). Cost is $125 for filter pleats, and $200 if you send the entire filter. (We really don't want the entire filter.) Or, check out this article to learn how to do it yourself!

Engine Flush Extravaganza!

by Amanda Callahan

We get a lot of questions about engine flushes. Do they work? Should you use one? How do they affect analysis? Your investigative team at Blackstone did some experimenting, and we've got answers.

Testing, testing…
We tested three products: Amsoil Engine and Transmission Flush, Liqui-Moly Pro-Line Engine Flush, and Berryman Oil Change Flush. All three are solvent-type additives, with fairly thin viscosities and low flashpoints. They're meant to dissolve and disperse sludge, varnish, and deposits. Virgin samples of each flush can be found in Figure 1.

Measuring success
So how would "success" of an engine flush show up in our testing? Oil analysis doesn't show things like improvements in fuel economy or whether the lifters are quieter, but in theory, if a product is loosening sludge and deposits, there should be something to show for it in the oil, right? Maybe increased insolubles, or higher metals because they're getting carried out of the engine more easily?

Testing procedure
To do this test, we pulled a sample though the dipstick using a pump, ran the flush according to the flush manufacturer's directions, then drew another sample through the dipstick post-flush.

	Virgin Engine Flush Samples	Amsoil	Liqui Moly	Berryman's
ELEMENTS IN PARTS PER MILLION				
	ALUMINUM	0	2	1
	CHROMIUM	0	0	0
	IRON	5	1	1
	COPPER	0	0	0
	LEAD	0	0	0
	TIN	0	0	1
	MOLYBDENUM	0	0	0
	NICKEL	0	0	0
	MANGANESE	0	0	0
	SILVER	0	0	0
	TITANIUM	0	0	0
	POTASSIUM	0	1	1
	BORON	2	1	1
	SILICON	0	3	1
	SODIUM	1	4	6
	CALCIUM	2	691	2558
	MAGNESIUM	2	3	9
	PHOSPHORUS	2	1482	6
	ZINC	5	1677	9
	BARIUM	0	0	0
PROPERTIES	SUS Viscosity @ 210°F	32.2	32.7	30.9
	cSt Viscosity @ 100°C	1.82	1.96	1.44
	Flashpoint in °F	**210**	**150**	**150**
	Fuel %	-	-	-
	Antifreeze %	-	-	-
	Water %	0.0	0.0	0.0
	Insolubles %	0.0	0.0	0.0
	TBN	1.5	2.3	7.7
	TAN			
	ISO Code			

Fig 1 - Virgin samples of each flush

Results
For the Toyota Corolla/Liqui Moly combination, the most notable changes are the drop in flashpoint and the slightly lower metal counts (see Figure 2).

The drop in flashpoint makes sense. If you have a starting flashpoint of 380°F and you add a product whose flashpoint is just 150°F, the resulting flashpoint is going to be lower. The lower metal counts make sense too. The metals are lower because there's fresh "something" in the oil. Not oil – in this case it's engine flush – but the same principle occurs.

It’s somewhat surprising that insolubles aren’t higher. If the flush is meant to get rid of solids, shouldn’t we see some evidence of that in analysis? But we found no change in insolubles. That doesn’t necessarily mean the flush didn’t work, just that we’re not seeing any evidence of that claim in our testing. Possibly the deposits are getting caught in the filter and removed that way.

An interesting side note on the Liqui-Moly flush in particular, it contained calcium, phosphorus, and zinc in its additive package. You can see the change in those elements in the post-flush sample, with calcium dropping slightly and the other two elements increasing slightly (which makes sense – the initial oil had more calcium and less phosphorus/zinc than the flush had, so adding the flush decreased calcium and increased phosphorus and zinc).

The other two engines/flushes showed very similar changes as the Corolla/Liqui-Moly combination: a very mild (if any) drop in metals, no change in the insolubles levels, and significantly lower flashpoints.

A note on flashpoints: We test for fuel dilution using the flashpoint test. Most unused oils flash around 385 to 415°F. When the test result is lower, that suggests something else is present – in internal combustion engines, that “something else” is usually fuel, so we go on that assumption and calculate fuel dilution accordingly. In this case, the “something else” is the engine flush – not fuel – but they are lowering the flashpoint the same way fuel contamination does.

So do engine flushes work? Our results are inconclusive. Engine flush manufacturers make many claims that we can’t measure in the scope of our testing: decreased blow-by and oil consumption, quieter lifters, improved oil circulation, and reduced emissions, just to name a few. Although we can’t see whether the flushes are removing deposits from the engine, it’s possible they’re getting trapped in the filter and removed that way. In the end, if you want to use a flush, go for it! Just let us know, in case it lowers the flashpoint.

Stay tuned for our next article, where we test different sampling methods, determine the effects of adding fresh oil, and whether it’s okay that oil turns dark so fast. Happy testing!

Corolla with Liqui Moly

	Before flush	After flush
MI/HR on Oil	8,053	8,053
MI/HR on Unit	32,141	32,141
Sample Date	10/10/2021	10/10/2021
Make Up Oil Added		
ELEMENTS IN PARTS PER MILLION		
ALUMINUM	4	3
CHROMIUM	1	1
IRON	13	12
COPPER	**26**	**23**
LEAD	0	0
TIN	0	0
MOLYBDENUM	575	531
NICKEL	0	0
MANGANESE	2	2
SILVER	0	0
TITANIUM	4	4
POTASSIUM	2	2
BORON	85	77
SILICON	**44**	**41**
SODIUM	5	5
CALCIUM	1342	1299
MAGNESIUM	638	588
PHOSPHORUS	682	748
ZINC	795	879
BARIUM	0	0
PROPERTIES		
SUS Viscosity @ 210°F	48.3	46.2
cSt Viscosity @ 100°C	6.76	6.09
Flashpoint in °F	**380**	**295**
Fuel %	TR	**4.5**
Antifreeze %	0.0	0.0
Water %	0.0	0.0
Insolubles %	0.2	0.2
TBN	3.5	2.8
TAN		
ISO Code		

Fig 2 - Flushing a Toyota Corolla with Liqui Moly

Kia with Amsoil Flush

	Before flush	After flush
MI/HR on Oil	7,675	7,675
MI/HR on Unit	194,739	194,739
Sample Date	9/5/2021	9/5/2021
Make Up Oil Added	4 qts	4 qts
ELEMENTS IN PARTS PER MILLION		
ALUMINUM	3	3
CHROMIUM	1	0
IRON	9	9
COPPER	0	0
LEAD	0	0
TIN	1	0
MOLYBDENUM	67	63
NICKEL	0	0
MANGANESE	0	0
SILVER	0	0
TITANIUM	0	0
POTASSIUM	0	0
BORON	32	31
SILICON	16	15
SODIUM	5	4
CALCIUM	1022	969
MAGNESIUM	636	602
PHOSPHORUS	653	619
ZINC	771	731
BARIUM	0	0
PROPERTIES		
SUS Viscosity @ 210°F	52.0	47.5
cSt Viscosity @ 100°C	7.88	6.50
Flashpoint in °F	395	**330**
Fuel %	<0.5	**2.8**
Antifreeze %	0.0	0.0
Water %	0.0	0.0
Insolubles %	0.3	0.3
TBN	2.2	2.2
TAN		
ISO Code		

Fig 3 - Flushing a Kia Optima with Amsoil

Milan with Berryman Flush

	Before flush	After flush
MI/HR on Oil	9,885	9,885
MI/HR on Unit	189,049	189,049
Sample Date	10/18/2021	10/18/2021
Make Up Oil Added		
ELEMENTS IN PARTS PER MILLION		
ALUMINUM	4	4
CHROMIUM	1	1
IRON	15	14
COPPER	0	0
LEAD	0	0
TIN	0	0
MOLYBDENUM	154	142
NICKEL	0	0
MANGANESE	0	0
SILVER	0	0
TITANIUM	0	0
POTASSIUM	0	0
BORON	20	18
SILICON	12	12
SODIUM	4	4
CALCIUM	1335	1482
MAGNESIUM	515	473
PHOSPHORUS	691	634
ZINC	817	750
BARIUM	0	0
PROPERTIES		
SUS Viscosity @ 210°F	54.4	50.2
cSt Viscosity @ 100°C	8.59	7.33
Flashpoint in °F	410	**325**
Fuel %	<0.5	**3.0**
Antifreeze %	0.0	0.0
Water %	0.0	0.0
Insolubles %	0.3	0.3
TBN	2.4	2.8
TAN		
ISO Code		

Fig 4 - Flushing a Mercury Milan with Berryman

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Report of the Month

This 1995 Land Cruiser has a problem. What is it?

To learn where the elements are coming from, click here and scroll down.

UNIT

MAKE/MODEL: Toyota 4.5L 6-cyl (1FZ-FE)
FUEL TYPE: Gasoline (Unleaded)
ADDITIONAL INFO:
OIL TYPE & GRADE: Gasoline Engine Oil
OIL USE INTERVAL: 1,500 Miles

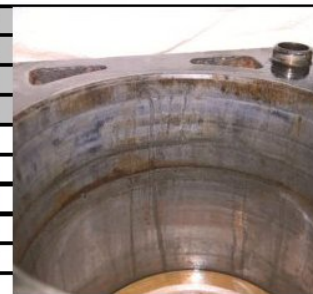
COMMENTS

G.: There's ambiguity due to all the oil that's been added. Sodium can come from coolant, but we're doubtful that's the source since potassium (also in coolant) is low. Instead, sodium is likely from additive in one of the oils you used. Again though, we can't be 100% sure since the fresh oil could be masking contamination. One thing that isn't hidden is the high amount of wear. Iron is most out of line, coming from steel parts like the cylinders, crank, cam, and lifters. Hopefully that's just an artifact of the neglect and improvement will follow now that the engine is in better hands.

ELEMENTS IN PARTS PER MILLION

		UNIT / LOCATION AVERAGES	UNIVERSAL AVERAGES
MI/HR on Oil	1,500		
MI/HR on Unit	195,400		
Sample Date	9/9/2020		
Make Up Oil Added	7.5 qts		
ALUMINUM	**31**	2	2
CHROMIUM	1	0	0
IRON	**441**	5	6
COPPER	**8**	1	2
LEAD	**13**	5	2
TIN	2	0	0
MOLYBDENUM	44	114	65
NICKEL	1	0	0
MANGANESE	2	0	1
SILVER	0	0	0
TITANIUM	4	0	1
POTASSIUM	0	2	4
BORON	62	112	63
SILICON	19	21	12
SODIUM	**81**	20	34
CALCIUM	1634	1959	1847
MAGNESIUM	242	281	300
PHOSPHORUS	1438	788	798
ZINC	1201	938	943
BARIUM	0	0	0


#6 cylinder wall showing corrosion highlighted by mild phosphoric foaming.


#6 cylinder wall with vertical crack and horizontal corrosion line.


Crack highlighted with marker


Oil cooler full of flaking block sealer.

The owner writes: This engine started to overheat just 1500 miles after I bought it. I eventually got around to pulling the head, assuming I might have a leaking head gasket, and got a surprise. Cylinders #1-5 were in very good shape, smooth walls. Then I got to #6 and saw some staining. Closer inspection showed a *horizontal* line of corrosion and pitting, which indicates water had been sitting in that cylinder at some time in the past, before I purchased this vehicle. I also found, with my finger, a slight irregular *vertical* line, crack, or ridge on the rear wall of that cylinder going into the water jacket. To the eye it appeared just as a stain, but the finger swipe told the story.

So at some point before I got this vehicle the engine likely either hydrolocked and/or overheated and the cylinder wall cracked. Then the previous owner, undisclosed at the time of sale, had dumped in a few bottles of block sealer, then sold the vehicle to me. Also, when I took the cooling system apart, I found block sealer coating the inside of all components, everything coated in that sodium silicate stuff. So the previous owner knew he had a problem and dumped in the sealer, then sold the vehicle.

The cause of the elevated iron and couple other metals was likely from corrosion and a crack in a cylinder wall, and maybe some other minor damage causing other metals to go up a bit. The slightly elevated sodium could be explained by the sodium silicate block sealer added by the previous owner. Now I'm trying to find another block, or maybe sleeve the bad cylinder, and rebuild this block.The photos show the horizontal line of corrosion in the cylinder wall (the whitish foam is weak phosphoric acid I put there to highlight the rust and damage). Another photo was with a marker trying to outline the crack.The photo of the side of the block is where an oil cooler plate would be. That plate is removed so you're looking where the oil cooler normally would sit bathed in coolant. In that one you can see the old block sealer flaking off the surfaces of the water jacket that the previous owner had dumped in the cooling system to try to seal the crack in the cylinder wall.

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Report of the Month

This 2016 Subaru BRZ has a problem. What is it?

To learn where the elements are coming from, click here and scroll down.

UNIT		
MAKE/MODEL: Subaru 2.0L (FA20/4UGSE) 4-cyl	OIL TYPE & GRADE: Motul 300V 0W/20
FUEL TYPE: Gasoline (Unleaded)	OIL USE INTERVAL: 250 Miles
ADDITIONAL INFO:	

COMMENTS

TIMOTHY: There's a lot of metal and silicon present, especially for just 250 miles. Race engines do tend to wear more than their street-only counterparts, but we're not sure that's the only reason why metals are so much higher than universal averages (based on ~5K miles). Parts like pistons/bearings (aluminum), steel shafts and cylinder liners (iron), and brass/bronze bushings (copper) might not be wearing well. Silicon might be partly to blame if it shows dirt, so check air filtration. Recent repairs could be another more harmless explanation. A trace of fuel is usually fine.

		UNIT / LOCATION AVERAGES						UNIVERSAL AVERAGES
MI/HR on Oil	250							
MI/HR on Unit	30,275							
Sample Date	4/10/2021							
Make Up Oil Added								
ELEMENTS IN PARTS PER MILLION								
ALUMINUM	**25**	2						3
CHROMIUM	2	0						0
IRON	**57**	9						10
COPPER	**7**	2						3
LEAD	0	0						0
TIN	2	0						0
MOLYBDENUM	669	373						162
NICKEL	0	0						0
MANGANESE	2	0						1
SILVER	0	0						0
TITANIUM	0	16						3
POTASSIUM	0	1						1
BORON	20	55						88
SILICON	**87**	28						25
SODIUM	6	5						29
CALCIUM	2269	1822						1756
MAGNESIUM	16	440						331
PHOSPHORUS	781	864						709
ZINC	859	1024						801
BARIUM	0	0						0

A fuzzy oil plug is never a happy find.

PROPERTIES		Values Should Be*					
SUS Viscosity @ 210°F	51.5	46-57					
cSt Viscosity @ 100°C	7.74	6.0-9.7					
Flashpoint in °F	**385**	>385					
Fuel %	TR	<2.0					
Antifreeze %	0.0	0.0					
Water %	0.0	<0.1					
Insolubles %	0.2	<0.6					
TBN							
TAN							
ISO Code							

The owner writes: About 120 stage miles (so a good chunk of them with the engine at redline) after this report, the engine blew up. You'd correctly called out the high metal content, and a spun bearing on cylinder four finally came apart completely. Attached is a photo of the oil plug. We debated sending what drained out of the pan in for analysis, but decided that we weren't really hunting for trace amounts at that point.