The Oil Report
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Oil the News that's Fit to Print!

Slick Talk is here! Blackstone's podcast unpacks the questions and concerns you have about aircraft and other engines. Join senior analyst Joe for an in-depth look at topics like exhaust valve guide wear and how it shows up in testing. You can subscribe on your favorte podcast platform. If you like what you're hearing, don't forget to rate/review!

How Big is this Problem?

The numbers are off. How concerned should you be?

by Ryan Stark

One of the main purposes of oil analysis is to find problems that might be developing in an engine, and after doing this for a lot of years, I can say without a doubt that it works. However, some problems are more urgent than others, and part of our job is to determine if a problem is a major one or not. Most engine problems start out minor and if left unchecked can lead to major issues, which eventually result in an engine's demise.

Minor problems

Abrasive contamination

Dirt getting past the air filter will cause a lot of problems in an engine, and piston scuffing is the primary concern. Fortunately, most air filters do a really good job even when they are dirty. If you change your air filter on a regular basis, then this type of problem is pretty easy to avoid, but remember, it's also important to check the whole air induction system down-stream of the air filter to make sure no cracks or other problems exist that could be letting dirt in. It's also important to check the alternatie air door or carb heat door to ensure it's closing properly and not allowing unfiltered air into the system.

Fuel dilution

This generally includes any fuel level between 1.0% and 3.0% that keeps showing up again and again. This is not a normal situation, but it doesn't necessarily cause engine problems in the short term. Still, since fuel is a contaminant, it will cause the oil to oxidize faster that it normally would. That typically causes problems like stuck oil control rings, which leads us to our next minor issue.

Oil consumption

This one isn't really a problem at low levels because all engines are designed to use some oil. What you really want to watch out for is a change in how much oil is being burned. If you always use 1 quart every 10 hours and it suddenly jumps to 1 quart every 3 hours, then you know something has changed. That's part of the reason we ask about oil added between changes when you send in a sample. If you're not losing oil due to a leak, it's either getting past the rings or the valve guides. Granted, you can buy a lot of make-up oil for the cost of a top overhaul, but there will probably come a time you'll have to bite the bullet and fix the issue.

Corrosion

If you fly at least 5 hours per month, that should keep this minor problem off your mind, though we all know that life

doesn't necessarily allow this. Still, if corrosion is minor it should easily disappear once the engine is back to flying regularly. If corrosion gets so bad that it causes pitting on the parts, that's when the problem elevates to major status.

Major problems

Cam spalling

This one is often directly related to corrosion getting out of hand, though it can also be related to oil starvation on things like cold starts and high RPM starts. It takes time for that thick oil to get circulating through the engine and if it doesn't get to the cam and followers fast enough, metal-to-metal contact happens. Problems of this nature won't necessarily cause an engine to fail, but can lead to loss of some power, which might be needed to clear that 50' obstacle at the end of the runway.

Excess heat

This is really a pretty broad category and is often due to operational factors, though it's almost always avoidable if you are paying attention to your cylinder head temperatures. If those are getting too hot, then maybe the cooling baffles aren't quite working like they should. Maybe you have a crack in an air induction tube. That could allow abrasive dirt into the combustion chamber, but would also cause that one cylinder to run leaner than others (due to extra air being sucked in) and likely hotter. Excess heat causes the parts to expand more than they were designed for and that's when wear starts getting heavy.

Stuck or burned valves

Abrasive contamination, fuel dilution, and oil consumption will all contribute to this type of problem. Sticking valves can be identified by things like morning sickness (not necessarily in the morning), intermittent rough running, and high mag drops (not due to a fouled spark plug). Burned valves are usually pretty easy to spot with a borescope, though they might not necessarily cause major operational problems until they burn to a point where compression has significantly degraded.

Detonation

This issue develops in an engine when the combustion process is not completed correctly, usually when an engine is under a heavy load and producing a lot of heat. It can easily burn a hole right through the top of a piston, resulting in all of the oil in your engine being pushed out the breather tube and oil starvation (see below). If your engine had a good muffler, you would hear a ticking or pinging noise, but since those don't exist in general aviation, this problem can often go unnoticed without the help of oil analysis and/or engine monitor data. If this problem exists, running a richer fuel/air mixture to keep the engine cooler should help.

Instant Death

Oil starvation

Whether it's caused by oil consumption left unchecked or severely worn bearings not letting oil get to all of the parts, this type of problem will cause an engine to fail in short order and it's usually accompanied by the worst sound your engine can make — silence.

Spun bearings

When the babbit is worn off your bearings, either due to hard use, abrasive oil, or lack of oil, you will start to lose oil pressure. If the problem gets severe enough, the spinning shaft will actually weld to the bearing itself and spin in place. Once this happens, the engine is pretty much shot, though amazingly enough it might still run (but not for long).

Outside causes

Of course there are lots of other things that can cause instant engine death — see the first cartoon on this link for an example. Unfortunately, outside factors probably take more engines down than anything else.

Conclusion

It's pretty rare for engines to fail suddenly due to minor issues, so when we see something going on, that doesn't necessarily mean you need to get out the wrenches or head straight to the engine builder and demand a repair. Usually, you'll have some time to see if the problem persists or is getting worse. Once that has been established, then some action will likely be required to keep the engine going, but the cost should be minor compared to the hassle and expense of having to replace the whole engine. So test your oil every now and then. Chances are good your engine will look perfect, but if it doesn't, you're better off knowing about it sooner rather than later.

Report of the Month

Something changed between March and August that caused this IO-550 to start wearing a lot better. What did the owner do to improve wear?

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

UNIT

MAKE/MODEL: Continental IO-550-BB
FUEL TYPE: Gasoline (Leaded)
ADDITIONAL INFO: Beechcraft B-36

OIL TYPE & GRADE: Phillips XC (A/C) 20W/50
OIL USE INTERVAL: 31 Hours

COMMENTS

We're not sure what changed between the March sample and now, but we sure do like it. Aluminum and chrome had been a thorn in this engine's side for a long time and it was starting to look like excess wear from the cylinder area might just be a fact of life for this engine, but not anymore. If you changed something operationally or mechanically, that seems to have done the trick. If nothing changed, then this improvement is a mystery, albeit a good one. No harmful contamination was present and the oil's viscosity was on the money for a 20W/50. Great report.

ELEMENTS IN PARTS PER MILLION

		UNIT / LOCATION AVERAGES						UNIVERSAL AVERAGES
MI/HR on Oil	31		15	27	29	26	44	
MI/HR on Unit	352		321		307	280	223	
Sample Date	8/4/2019		3/25/2019	12/5/2018	8/20/2018	5/8/2018	2/17/2018	
Make Up Oil Added	1 qt		0.5 qts	0.50 qts	1 qt	3 qts	0 qts	
ALUMINUM	10	15	**22**	**15**	**17**	11	**16**	7
CHROMIUM	7	18	**26**	**20**	**25**	**21**	**25**	8
IRON	27	31	41	34	35	25	37	31
COPPER	5	10	6	5	7	5	**10**	4
LEAD	2759	3910	3038	3880	3753	4102	6487	4103
TIN	0	1	0	1	0	1	2	1
MOLYBDENUM	2	5	7	5	7	8	8	4
NICKEL	4	5	4	4	6	5	7	8
MANGANESE	0	0	0	0	0	0	0	0
SILVER	0	0	0	0	0	0	0	0
TITANIUM	0	0	0	0	0	0	0	0
POTASSIUM	1	0	1	1	0	0	0	1
BORON	0	0	0	1	1	1	0	1
SILICON	6	9	6	8	8	10	11	8
SODIUM	1	2	2	2	2	2	2	1
CALCIUM	113	61	128	111	91	1	1	41
MAGNESIUM	1	1	1	1	1	0	0	1
PHOSPHORUS	63	51	169	91	63	8	2	561
ZINC	4	4	3	4	4	2	4	4
BARIUM	0	0	0	0	0	0	0	0

PROPERTIES

	Values Should Be*						
SUS Viscosity @ 210°	89.0	86-105	88.6	86.3	90.1	94.3	93.3
cSt Viscosity @ 100°C	17.75	17.0-21.8	17.64	17.08	18.01	19.02	18.78
Flashpoint in °F	455	>430	445	450	470	**445**	**450**
Fuel %	<0.5	<1.0	<0.5	<0.5	<0.5	0.8	0.5
Antifreeze %	-		-	-	-	-	-
Water %	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Insolubles %	0.3	<0.6	0.3	0.3	0.3	0.5	0.5
TBN							
TAN							
ISO Code							

*** THIS COLUMN APPLIES ONLY TO THE CURRENT SAMPLE**

After receiving his much-improved report, the owner emailed us to say the only change between those two samples was new spark plugs. We theorized that perhaps one of the plugs was misfiring, though he hadn't noticed any sign of a misfire. He also mentioned that the plugs he had been using were original to the engine, and he switched to Tempest plugs in an effort to smooth out the engine when running LOP. Whether a plug was misfiring or not, the new spark plugs seem to have been just what the doctor ordered for this Beechcraft.

Report of the Month

This relatively young IO-540 has a problem. Can you tell what it is?

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

UNIT

MAKE/MODEL: Lycoming IO-540-K1A5
FUEL TYPE: Gasoline (Leaded)
ADDITIONAL INFO: Piper PA-32-300
OIL TYPE & GRADE: Aeroshell W100 (AD)
OIL USE INTERVAL: 16 Hours

COMMENTS

Thanks for the note. There are always differences in wear when you move between labs, though the metals should roughly correlate. We're seeing more chrome, iron, and nickel than average, and those metals could show exhaust valve guide wear. Or if you have nickel or chrome cylinders, those metals could be normal. If your Piper has done any sitting recently, some of the iron could be from corrosion. We'll learn more with trends, so as long as the oil filter's clean, compressions are good, and temps are normal, check back in 15 hours for another look.

ELEMENTS IN PARTS PER MILLION

		UNIT / LOCATION AVERAGES						UNIVERSAL AVERAGES
MI/HR on Oil	16							
MI/HR on Unit	308							
Sample Date	7/16/2019							
Make Up Oil Added	1 qt							
ALUMINUM	8	8						7
CHROMIUM	**13**	13						4
IRON	**73**	73						27
COPPER	8	8						7
LEAD	2501	2501						3930
TIN	2	2						1
MOLYBDENUM	1	1						0
NICKEL	**11**	11						2
MANGANESE	1	1						0
SILVER	0	0						0
TITANIUM	0	0						0
POTASSIUM	0	0						1
BORON	0	0						1
SILICON	6	6						6
SODIUM	2	2						1
CALCIUM	111	111						19
MAGNESIUM	3	3						5
PHOSPHORUS	113	113						635
ZINC	3	3						4
BARIUM	0	0						0

PROPERTIES

		Values Should Be*					
SUS Viscosity @ 210°	94.9	86-105					
cSt Viscosity @ 100°C	19.16	17.0-21.8					
Flashpoint in °F	525	>460					
Fuel %	<0.5	<1.0					
Antifreeze %	-						
Water %	0.0	0.0					
Insolubles %	0.4	<0.6					
TBN							
TAN							
ISO Code							

*** THIS COLUMN APPLIES ONLY TO THE CURRENT SAMPLE**

This engine has been quite active, flying 265 hours in 34 months. It has both chrome and nickel replacement cylinders. That muddies the waters a bit when it comes to analysis, since nickel and chrome could both be from normal cylinder wear. But after receiving our report and noting unusual indications on his JPI engine monitor, the owner's mechanic opened up the #4 cylinder and found a complete exhaust guide failure. That problem is typified by elevated nickel, which is from the guide, while iron is from the valve itself, and chrome is a plating on the valve. The cylinder was replaced.