BLACKSTONE LABORATORIES

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

Have you noticed our new square containers? We had them specially designed to help eliminate post office problems. The post office doesn't like round -- round things roll off conveyor belts and jam up the works. Square is a happier shape for everyone!

All About Insolubles

by Jim Stark

Once upon a time I lived in primitive conditions as a soldier in a war zone. We had few amenities, eating our three daily meals from a can. The morning coffee routine wasn't very refined, either. The cooks worked in a tent. They heated water for coffee in large 15-gallon pans over a gasoline-fired stove. To make coffee they simply dumped tins of ground coffee beans into the boiling water, and after it steeped for a while, the water turned brown. When it appeared to be the right color, the heat was turned down and the churning grounds—at least most of them—settled to the bottom. If you were early when you passed through the chow line, you got a top-of-the-brew serving that wasn't bad. If you were late and your cuppa joe came from somewhere near the bottom, you could chew it.

In the Army, we enjoyed coffee grounds in our coffee as much as your engine enjoys insoluble materials in its oil.

We enjoyed the coffee grounds in our coffee as much as your engine enjoys insoluble materials in its oil. These days, there's usually only one reason I find grounds in my coffee: the coffee filter failed for one reason or another. Usually, one or more of the filter pleats has laid down, letting grounds overflow the rim. But the insolubles in your aircraft's oil are not quite as simple as the grounds in my Mr. Coffee machine. There are many reasons that insolubles form in an aircraft oil sample.

Insolubles are the total solids we find in an oil sample. Insolubles are often caused by oxidation, which is a natural process that occurs when oil is exposed to heat or oxygen (in the air). Oxidation leaves free carbon in the oil when the oxygen molecules combine with hydrogen. Virgin oil usually doesn't have any insoluble materials in it. When it occasionally does, the most we normally find is a trace level. The insolubles in virgin oil are from the normal oxidation process of the oil. At least some of the insolubles in

the oil samples we analyze are free carbon particles, which are hard particles that can damage sensitive, close tolerance parts like friction bearings. Keeping insolubles within the normal range is important to most aircraft engine operators wishing to get the longest life possible from their engines.

Measuring Insolubles

There are various methods of measuring insolubles in oils. One way is to draw the oil through a very fine filter (½ micron) and then weigh the filter. The filter's weight gain is reported as a percentage of insoluble materials by weight, compared to the weight of the sample that was drawn through the filter. Another measuring method rates the darkness of the filter patch compared to a standard.

Insolubles are the total solids we find in your sample.

The insolubles test we use at Blackstone is a centrifuge method. A measured volume of oil is mixed with a heated solvent, agitated, and spun at high speed. Insoluble materials collect at the bottom of a tapered glass tube and can then be measured as a percentage of the sample by volume.

We like to see insolubles in piston aircraft engines at or below 0.5% or 0.6% of the sample, depending on the type of engine. Some engines run cleaner than others, so the acceptable range can vary. As engines age, insolubles in the oil tend to increase. You may think, judging from the gray appearance of used aircraft engine oils, that the insoluble level would be quite high. Actually, the grayness of these samples is from lead in the oil, which easily falls out of suspension in the oil and forms insolubles. Blow-by, fuel system problems, and combustion problems will cause the oil to be black rather than gray. If you observe unusually black oil when you collect the sample, you may have a problem that needs investigating.

Why Do I Have High Insolubles?

The insolubles test is a good measure of how fast the oil is oxidizing and receiving contaminants from blow-by or other engine systems, and how effectively the system's oil filtration is functioning. Any contaminant in the oil will accelerate its tendency to oxidize, so the insolubles test is a good crosscheck when we suspect a contaminant like gas, moisture, or excessive blow-by. Excessive metals in an oil will also increase the oxidation process. So will frequent and/or extreme heat cycles.

If we found high insolubles but no excessive contamination from fuel or blow-by in your oil, and your oil change intervals are normal, we often mention a problem at oil filtration as a possible cause of the insolubles. The oil filter bypass valve may relieve if the filter was becoming restricted. The filter system bypass could also open upon cold starts when the oil is too thick to pass through the filter media, which may be partially restricted. Once the bypass relieves, the filter is effectively out of the system. Insolubles may also be forming because your oil use interval is too long, and the filter can't keep up.

Insolubles are just one of the tests we provide to determine the condition of your piston aircraft engines and used oils. It's an important test that helps us gauge the condition of your oil and engine, and helps keep you flying happily for many hours to come!

Report of the Month

These twin IO-520 engines are wearing differently. Can you figure out why?

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

Left engine

ELEMENTS IN PARTS PER MILLION			
MI/HR on Oil	37	42	41
MI/HR on Unit	1,294	1,188	1,118
Sample Date	12/01/09	06/29/09	04/17/09
ALUMINUM	13	13	12
CHROME	8	12	18
IRON	47	54	66
COPPER	11	13	15
LEAD	6155	5877	5229
TIN	7	5	4
MOLYBDENUM	9	11	10
NICKEL	29	13	41
POTASSIUM	1	1	0
BORON	1	1	0
SILICON	9	18	23
SODIUM	2	0	1
CALCIUM	2	4	3
MAGNESIUM	1	1	1
PHOSPHORUS	1053	1107	904
ZINC	5	7	6
BARIUM	0	0	0

Right engine

37	42	41
1,294	1,188	1,118
12/01/09	06/29/09	04/17/09
18	9	10
22	8	8
160	83	74
14	8	7
8565	8444	7592
4	3	1
10	6	5
58	17	15
0	0	0
1	1	0
6	5	5
1	0	0
2	5	3
1	1	2
966	1048	969
4	8	6
0	0	0

PROPERTIES			
SUS Viscosity @210°F	89.8	98.1	89.0
cSt Viscosity @ 100°C	17.92	19.90	17.75
Flashpoint in °F	465	460	465
Fuel %	<0.5	<0.5	<0.5
Antifreeze %	-	-	-
Water %	0.0	0.0	0.0
Insolubles %	0.4	0.4	0.4
TBN			
TAN			
ISO Code			

95.4	93.6	93.0
19.26	18.84	18.71
470	475	455
<0.5	<0.5	<0.5
-	-	-
0.0	0.0	0.0
0.5	0.3	0.4

These twin engines are wearing differently, which makes it easy to see when one has a problem. In this case, the right engine was wearing about the same as its partner in early 2009. As time went on, the right engine started looking worse. For the 12/01/09 sample, the right engine had zero compression on cylinder #2 due to a suspected valve problem. Work was done immediately to replace the cylinder, though over the next few months, iron continued to read high. Compresions are a little lower they'd be ideally, but they've remained within Continental's guidelines so the owner is just monitoring the engine for now.