The Oil Report

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"Oil the News That's Fit to Print!"

Sticker Confusion

A few months ago, we started sending out "oil change stickers" in kits to our aircraft customers. These are similar to the sticker you'd get at an oil change place for your car — it's meant for your windscreen to reflect the last time the oil was changed, or the next time it needs to be changed.

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The idea behind this was that the sticker might be handy to let the pilot know at a glance when the oil needs to be changed. But we're not sure how well it has gone over. We have heard one complaint, and nothing else.

There seems to be confusion about the stickers' purpose. Some people have filled them out and sent them back to us. Some have just left them in the container (perhaps not realizing they were there). So we are curious: Do you like them? Are they helpful, or more of a nuisance? No one has said they like them, and if they're not

Spotlight on... Oil Filter Analysis

by Mike Busch

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Oil filter inspection is probably the most important tool for monitoring the health of a piston aircraft engine, with the possible exception of compression checks. If your engine isn't equipped with a full-flow filter, it's worth adding one simply for the diagnostic value. (It'll also pay for itself quickly by doubling your oil change interval from 25 to 50 hours.)

The filter should be changed at every oil change, and should always be cut open and inspected. Tossing an old filter in the trash without cutting it open for inspection is a capital offense. In fact, whenever CPA tech reps visit a maintenance shop, they always make a point of sneaking a peek in the shop's trashcan, and if they see any uncut filters there, the shop is immediately crossed off the good-guy list.

Every shop — and every owner that does his or her own oil changes — needs a good oil filter can cutter with a sharp cutting wheel. Cheap cutters tend to leave shards of the can in the filter medium, which can really confuse the filter inspection. Champion makes a good cutter, albeit pricey. I prefer the oil filter can cutter ($75) and holder ($30) from Sacramento Sky Ranch (www.sacskyranch.com or 800-433-3564).

After cutting open the filter and cutting the filter medium from its spool with a sharp knife or hacksaw, take it outdoors and examine it in direct sunlight. If that's not practical, inspect the medium under the brightest light you can find. Small metallic particles embedded in the filter medium are reflective and will generally glisten when viewed in direct sunlight, but may well be invisible under ordinary indoor lighting.

Sometimes it's difficult to determine whether flakes in a filter are metal or carbon. Here's an easy way to tell them apart: Place some between your fingertips and rub your fingers while squeezing hard. Carbon flakes will break apart, while metal flakes won't.

A newly overhauled engine or one that has just had one or more cylinders replaced will often have a small amount of fine metal particles in the oil filter, but once the break-in has been completed and the break-in

helpful, we'll stop sending them out. You can reply to the email that alerted you to this newsletter to let us know if you think we should keep them or not. Thanks for your input!

oil replaced, any appreciable amount of metal in the filter should be cause for concern.

How much metal is considered "appreciable"? There's no hard-and-fast rule. I've heard it said that anything more than about a quarter-thimbleful of small metal particles, or any single metal chunk larger than a pencil point, should be cause for grounding the aircraft until the cause is found. In my view, however, a better guideline is that any substantial increase in metal above what has been the norm for your particular engine deserves a closer look.

The first step in that "closer look" is to rinse the filter medium in a clean jar or can using clean solvent to wash the particulate matter out of the filter medium. Then slowly pour the now-dirty solvent through a large, clean coffee filter. This will allow you to examine the particles much more clearly.

Next, pass a strong magnet underneath the filter paper to determine whether the metallic particles are ferrous (steel) or non-ferrous (aluminum, chrome, tin, bronze, etc.). A small amount of non-ferrous metal is normal; ferrous particles are of greater concern.

Non-ferrous metal can often be distinguished by appearance or other simple tests. Bronze particles have a characteristic yellow color. Chrome flakes are shiny, sharp, and very hard. Tin is dull and melts at a very low temperature. Aluminum will fizz and dissolve when exposed to lye.

What to Look for in the Filter

Carbon particles. A certain amount of carbon in the filter is normal, and turbocharged engines generally exhibit more carbon than do normally aspirated ones. An unusually large amount of carbon in the filter suggests that oil is getting excessively hot and coking. This can be caused by several things. One is excessive blow-by past the rings and is usually accompanied by elevated oil consumption and marginal compression readings in one or more cylinders. Another cause is one or more badly worn exhaust valve guides, and is usually accompanied by carbon build-up under the cylinders rocker covers, heat-damaged valve springs, and/or valves that move ore than a very small amount in a "wobble test." Yet another cause of carbon occurs in turbo-charged engines that are shut down without a reasonable turbocharger cool-down period.

Steel. Steel is readily identifiable because it is magnetic. Any significant quantity if steel particles or flakes in the filter is cause for concern. Generally, you should not fly the aircraft until the source has been determined. If the cause is not readily apparent, you may want to consider sending your filter contents to an expert for microscopic examination, which often can pinpoint the source.

Aluminum. These are silver-colored non-magnetic particles that dissolve when exposed to a dilute solution of sodium hydroxide (lye), including common household drain cleaners like Drano and Red Devil. Small amounts of aluminum are normal in some engines, but significant quantities warrant further investigation. Possible sources of small aluminum particles include fretting crankcase halves (check torque on spine bolts and through bolts), a loose valve guide (check rocker boxes for metal), and piston pin plugs (check with boroscope). Larger aluminum chunks suggest burned pistons, possibly caused by preignition (check with boroscope).

Chrome. Chrome is shinier than aluminum and much harder, and is often found as flakes rather than particles that feel sharp to the touch. Any amount of chrome in the filter is not normal except possibly during break-in. The most common source is from chrome-plated piston rings abraded by a rough or pitted cylinders, or from chrome-plated cylinder barrels that are developing a problem (check with boroscope). Another source is abnormal wear of chrome-plated exhaust valve stems,

particularly if the engine has hardened Nitralloy exhaust valve guides (introduced in the early 1990s by TCM and subsequently discontinued).

Brass/copper/bronze. Identified by distinctive yellow color. In TCM engines, the presence of long bronze slivers often indicates failure of the starter adapter spring. Smaller particles may come from worn bushings, or older aluminum/bronze valve guides.

Dry Particle Analysis

If you find metal in the filter that prompts concern something might be coming apart inside your engine, it's often a good idea to seal the filter contents in a plastic bag and overnight it to a lab for microscopic dry particle analysis.

An expert can often tell from the size, shape, and appearance of the particles or flakes, as seen under the microscope, whether they came from a spalled lifter, a damaged cam, an oil-starved main or rod journal, a defective gear, or a scored cylinder barrel. Both TCM and Lycoming operate metallurgy labs that will perform microscopic dry particle analysis of filter contents from their engines.

Another excellent resource is Howard Fenton's Second OilPinion service. Howard will perform microscopic analysis and render an opinion for a very reasonable fee; he presently charges just $15 is you send him your filter medium in a plastic bag, or $30 if you send him the whole filter and he has to cut it open. Howard is a world-class expert on piston aircraft engine oil analysis; you can contact him at 918-492-5844.

Report of the Month

What's wrong with this O-540 engine? See the caption below for an explanation.
Don't look right away -- take a good look at the report first.

(To learn where the various elements might be coming from, click here.)

MI/HR ON OIL	10	UNIT/ LOCATION AVERAGES	56	20	41	36	UNIVERSAL AVERAGES
MI/HR ON UNIT	724		701	626	607	569	
SAMPLE DATE	12/02/03		8/12/03	1/6/03	9/17/02	4/21/02	
ALUMINUM	7	7	**9**	6	10	6	6
CHROMIUM	7	7	11	6	8	5	5
IRON	33	49	66	54	61	51	28
COPPER	8	6	6	4	5	7	7
LEAD	1379	2537	3668	2250	3208	3082	2550
TIN	2	1	0	1	0	2	1
MOLYBDENUM	0	0	0	0	0	0	0
NICKEL	3	5	12	3	4	3	2
POTASSIUM	0	0	0	0	0	0	0
BORON	0	0	0	0	0	0	0
SILICON	3	5	4	5	6	6	6
SODIUM	1	1	2	0	0	1	1
CALCIUM	1	1	1	1	3	1	2
MAGNESIUM	1	4	4	5	4	6	5
PHOSPHORUS	164	574	574	863	253	799	832
ZINC	120	24	2	2	2	3	11
BARIUM	0	0	0	0	0	0	0

TEST	cST VISCOSITY @ 40 C	SUS VISCOSITY@ 100 C	cST VISCOSITY@ 100 C	SUS VISCOSITY@ 210 F	FLASHPOINT IN F	FUEL %	ANTI-FREEZE %	WATER %	INSOLUBLES %
VALUES SHOULD BE				82-105	>440	<1.0	-	<0.0	<0.6
TESTED VALUES WERE				102.9	530	<0.5	-	0.0	0.5

After the August 2003 sample, the owner of this O-540-E4A5 found two burned exhaust valves. We see exhust valve wear primarily as iron and nickel. The valves also contain a little chrome, and that's where the chrome comes into it. The owner replaced cylinders numbers 3 and 4 after the August 2003 sample. The December 2003 sample was only run 10 hours, and metals are still high, both from residual metals and from the new parts breaking in. The next sample that we see from this aircraft should contain average, or near average, wear metals.

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