The Oil Report

November 2011

Oil the News that's Fit to Print!

We get a lot of questions about storing a sample, and whether it's okay. It's fine to let the oil sit before you send it in. Just make sure the sample isn't exposed to the elements and it's not going to get contaminated with moisture or dirt and it will be fine to send it in. It can sit years, even, and still be a valid sample.

Got Symptoms?

Get answers with Sacramento Sky Ranch!

We often get oil samples with written descriptions of symptoms pilots are noticing regarding the engine--things like oily plugs, variations in EGTs, hard starting, etc. Sacramento Sky Ranch has an extensive website with great pictures and descriptions of all sorts of problems, listed by symptom, and we've pulled together a few here
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Problem area: Camshaft followers
Follower bores in the crankcase are typically not inspected for wear. If they are inspected, they are often not suitably inspected because of the difficulty of measuring run-out and concentricity in the small cavity. Now this is not necessary an omission; if the followers coming out of the engine look good then it stands to reason that the bore was positioning the followers properly. The problem arises in that what happens when the bore is worn and causing the follower not to operate properly? The answer is probably not what you would expect.

The follower on the left shows a normal circular wear pattern. The follower on right has chipped edges and gross deformities.

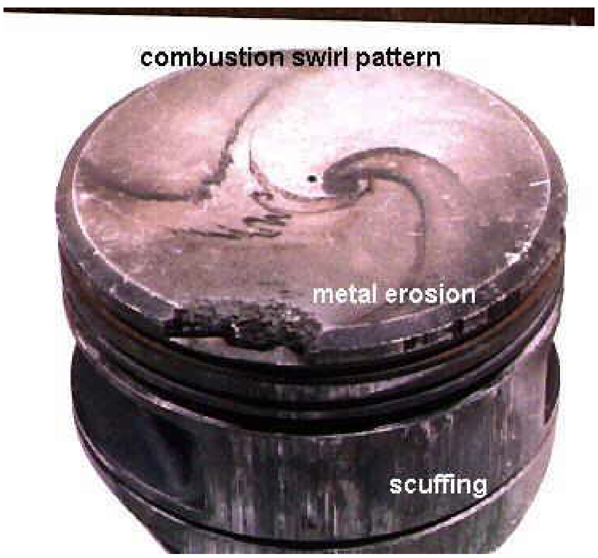
When the bore wears and the follower is allowed to move from side to side, it causes small chips on the outside edges of the follower face. When you see these you would think that they occurred when the follower was dropped on the concrete floor and then installed into the engine. This is usually not the case. The misaligned follower allows the camshaft lobe to push down on the outside edge of the face, causing the edges to chip away. You can verify the misalignment by a careful examination of the wear marks on the lifter. Possible causes of this problem include:

1. A worn camshaft bore allows the camshaft to “walk” and therefore allows the camshaft lobe to press against outer edge of follower face. Loading at edge causes cracks and chips from face.

2. A worn follower bore, which allows the camshaft lobe to press against outer edge of follower face. Loading at edge causes cracks and chips from face (most probable).

3. Nicks on the side of the follower.

If the side of the follower is nicked, as might occur if they are all thrown into a tray during engine overhaul, then the nick creates a raised area on the side of the follower. This raised area creates the same effect as an out-of-round follower. The follower does not center in the bore and thus the camshaft lobe contacts the follower face at the edge.



Swirl markings on the top of the piston are normal combustion pattern markings. Pre-ignition caused the erosion on this piston dome.

Problem: Pre-ignition
Premature ignition of fuel/air mixture in advance of normal ignition is usually caused by a hot spot in combustion chamber or magneto cross-fire. The hot spot is typically the spark plug electrode or exhaust valve. When pre-ignition occurs, ignition timing is lost and the upward movement of the piston is opposed by the high pressure generated by the early combustion. With pre-ignition, think “heat” and “meltdown.” Detonation, on the other hand, is synonymous with violence, explosiveness, and destruction.

Damage caused by pre-ignition:
1. Cracked spark plug ceramic from thermal shock.

2. Aluminum erosion on piston dome. In minor pre-ignition the erosion can appear as roughness of the piston dome or dome of the cylinder chamber. In major pre-ignition a hole can be burned through the piston (usually at the outside edge and through the top ring land), or result in major erosion of cylinder chamber.

3. Crack in combustion chamber between intake and exhaust seat from thermal stress.

4. Stretching of the intake valve. A quick check for a stretched intake valve is to place two valves side-by-side with one end up and the other end down. Put a straight edge across the two valves and compare height.

5. Aluminum erosion in the combustion chamber.

Problem: Valves
The image to the right (Figure 1) is an instance of valve face breakage caused by a valve overheating. Notice the dark color of the valve stem. This valve was abnormally hot from leakage past the valve face.

Figure 1

What causes valve breakage? The face of an exhaust valve is a ring. Exhaust gas leakage past the valve face heats one spot on the ring and expands it into an oval shape. This uneven ring expansion creates hoop stress. After a few cycles of uneven expansion and contraction, stress cracks form at the outside edge of the face. These cracks progress inward toward the center of the valve. When the cracks progress about ¼ of an inch, they turn 90 degrees and grow around the valve face. When two cracks come together, a piece of exhaust valve breaks off, the engine loses power, and the piece of broken valve damages the cylinder and most likely the turbocharger.

Valve leakage is much less visible when looking at the valve seat. Notice the uneven coloration.

What causes valve sticking? Exhaust gas leaving the cylinder flows past the valve face, causing heat loading to the valve. Most of the heat the valve absorbs conducts to the valve seat and from there to the cylinder and into the atmosphere. A leaking valve reduces the amount of heat conducted to the seat, causing the valve to overheat. The hot valve causes oil to form carbon deposits on the valve stem, which sticks the valve in the guide.

If the valve sticks closed, combustion gas never leaves the cylinder and compresses during the next compression stroke. The pressure against the intake valve is so high that it cannot open. Either the push rod bends or the rocker arm support breaks. If the valve sticks open, the push rod is no longer held in the hydraulic lifter's socket when the camshaft lobe rotates to the closed position. If the push rod comes out of the socket and does not find its way back in during the next revolution of the camshaft, the push rod damages the crankcase by jamming against it. If the valve is sticky, the high forces required to open the valve usually damage the camshaft lobe and the engine loses power. Although the engine will appear to operate normally from the pilot's view, exhaust valve leakage can be a serious engine defect with the potential to cause engine failure.

Problem area: Rocker arms

Figure 2

You can check rocker arm alignment by making sure the rocker arm face sits flat on the valve stem. This should be done when the cylinder is installed. Such a check verifies alignment for the rocker shaft, rocker arm, rocker arm face, and valve guide. If any one of these is tilted, the rocker face will not rest flat on the valve stem.

The seat, guide, rocker arm, valve springs, and rocker bosses should center the valve stem in the guide. The valve stem then moves through the guide with a minimum of side force against the guide. Rapid wear results when the valve stem pushes against the guide. Proper valve alignment occurs when the rocker arm face rests flat against the valve tip.

Rapid rocker shaft wear can occur when hard abrasive particles embed themselves into the soft bushing. These particles can be dirt abrasives, glass bead abrasives from engine repair, or metal particles from the shaft itself or other areas of the engine. For this reason we recommend that you replace the

Figure 3

bushing along with the rocker shaft when trying to fix this problem.

This rocker arm shown in Figure 2 (previous page) wore the valve guides out in 350 hours. Note the contact on the edge of the face indicating that the face has been ground at a slight angle. This pushes the valve stem against the guide, resulting in rapid valve guide wear. A rocker arm face should have a cycloid curve. Anything less or more results in more movement of the rocker face across the valve stem.

Problem: Fluctuating oil pressure
Sacramento Sky Ranch warns pilots not to fly an airplane with fluctuating oil pressure. Fluctuating oil pressure can occur because of bearing failure and immediately proceed to complete engine failure.

Fluctuating oil pressure, seen as rapid needle movement, is the result of the pump gulping air. Air is compressible and drives the needle crazy. This leak may come from the pump body where a little nick in the surface prevents the body from lying flat.

Lycoming engines have two ways of picking up oil: via the pickup tube or through the casting. Those engines that use a pickup tube may suck air through the inlet gasket on the pickup tube. Engines that pick up oil through the casting may suck air through the sump gasket.

Incorrect oil pressure housing can cause fluctuating oil pressure in Lycoming engines. This will usually cause problems after the oil warms up. Frictional forces melt the bearing babbit until the bearing shell starts to extrude out the side of the connecting rod. Excessive clearance causes the rod bolts to pound and they eventually fail in fatigue. Notice also the heat damage to the rod bolts. In the engine that produced the image above (Figure 3), the pilot assumed that the loss of power might be caused by an ignition problem, so he made an emergency landing. With the engine still running, he tried to take off but aborted due to not enough power. When the maintenance shop checked the engine they found no oil in the sump. The connecting rods were burnt, the bearing was destroyed (including the crankshaft’s journals), and one bearing was extruded between the connecting rod and the crankshaft cheek.

Sacramento Sky Ranch has closed since we ran this article so we have removed the links to the site. But we thought the article was good enough information to leave up on our site. Hopefully you found it useful!

Report of the Month

What went wrong for this O-470 engine? Take a look at the data, then read the caption below to see what happened.
To learn more about where the elements are coming from, click here.

		UNIT/ LOCATION AVERAGES					UNIVERSAL AVERAGES
MI/HR on Oil	59		53	50	50	44	
MI/HR on Unit	902		844	791	742	692	
Sample Date	07/16/10		05/15/10	02/19/10	10/24/09	08/29/09	
ELEMENTS IN PARTS PER MILLION							
ALUMINUM	5	5	4	4	4	5	9
CHROME	7	11	6	5	6	8	10
IRON	62	49	51	46	47	55	36
COPPER	5	4	4	4	4	5	4
LEAD	3966	4685	3454	3487	3405	3659	4216
TIN	1	1	3	0	2	2	1
MO LYBDENUM	3	3	2	2	2	3	4
NICKEL	16	16	13	11	12	17	6
PO TASSIUM	2	1	2	2	0	0	0
BORON	1	1	1	1	0	1	0
SILICON	8	8	6	7	7	6	7
SODIUM	1	1	1	1	1	1	1
CALCIUM	83	83	92	98	85	90	5
MAGNESIUM	2	2	2	1	1	2	1
PHOSPHORUS	60	60	87	83	77	91	507
ZINC	15	12	17	24	29	27	3
BARIUM	0	0	0	0	0	0	0

PROPERTIES		Values Should Be*				
SUS Viscosity @210°F	93.2	86-105	90.9	91.1	92.7	92.0
cSt Viscosity @ 100°C	18.74	17.0-21.8	18.20	18.24	18.62	18.47
Flashpoint in °F	450	>430	430	435	450	485
Fuel %	<0.5	<1.0	TR	<0.5	<0.5	<0.5
Antifreeze %	-	-	-	-	-	-
Water %	0.0	<0.1	0.0	0.0	0.0	0.0
Insolubles %	0.5	<0.6	0.4	0.5	0.4	0.4
TBN						
TAN						
ISO Code						

*THIS COLUMN APPLIES ONLY TO THE CURRENT SAMPLE

We didn't see much sign of it before it happened, but this engine failed catastrophically when a valve stem broke. The valve took out the piston, which bent the rod, which then cut four holes through the case. The bad news is the pilot was over a heavily populated area of San Francisco when it happened. The good news is, he was able to make an emergency landing without further damage. This engine had Cerminil cylinders installed, so nickel would have been higher than average even if there hadn't been a problem. If you have replacement (non-factory) cylinders on board, they might cause elevated chrome or nickel that will mask wear. In that case, keep an eye out for other abnormalities; in the case of a sticking valve, for example, you may find roughness when idling or cruising, or poor mag drops that aren't due to plug fouling.