Change the Oil

Changing oil is one of the simplest preventive maintenance tasks an owner can do. However, it's not quite as simple as changing the oil in your car, and there are some items that are often overlooked, so it's best done under supervision the first time. It's also best if you obtain the relevant manuals and service instructions.

Set an Interval

Oil changes are typically done every 50 hours, but if you have an oil screen only (rather than a filter), you should check and change your oil every 25 hours. Because dirty oil is corrosive even when it's sitting still, consider four to six months the maximum time between oil changes regardless of hours. The exception is if you "Prep for Inactivity" (page 76). At each oil change, you'll also inspect and replace the oil filter (page 102), and send a sample for oil analysis (page 100). While you have the cowling off, don't forget to inspect the engine compartment (page 86).

Get it Hot

Ideally, get the oil hot before changing it by running the engine until oil temperature stabilizes. Warm oil flows more freely and drains more quickly. Besides that, circulating the oil captures any dirt and debris in suspension, which will then run out the drain with the oil. Lycoming says to wait 15 minutes after shutting down the engine to begin draining the oil. Timing your oil change to happen after a flight works well.

TIP

Wear disposable gloves. Really.

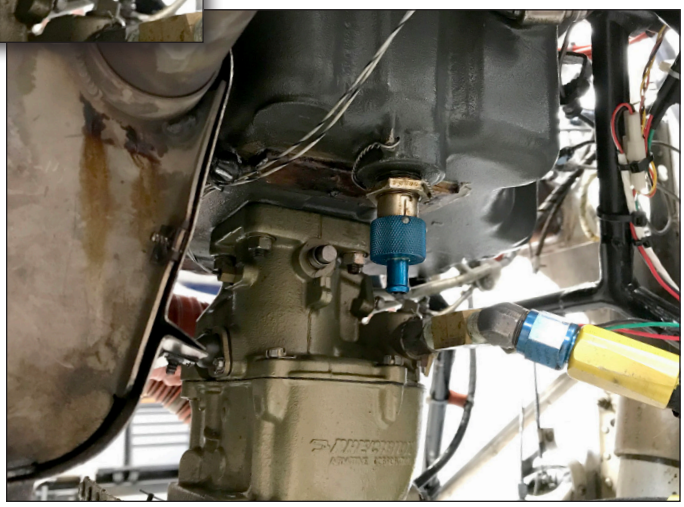
Drain the Oil

It may be possible to access the drain with the cowlings still attached if you have a quick drain fitting that can take a hose. If not, you'll need to remove the bottom cowling (page 84). Put on some disposable gloves. The oil is both hot and bad for your health if it soaks into your skin.

Make sure you have a container with enough capacity to hold all of the drained oil. If you have a simple drain plug, you'll have to position your container where it can catch the oil. It can be a big help to have a wide funnel up close to the plug to guide the oil when it comes out. Without a quickdrain, you'll remove the drain plug and let the oil flow. Don't let the plug fall into the catch basin or you'll have to go fishing for it. If there's a crush washer on this plug, that should be replaced each time the drain plug is removed.

With a quickdrain, you attach a hose securely to the drain and open the valve. If you don't have a large enough container, you can close the valve or simply kink the hose to stop the flow while swapping in a new container. Beware the hose popping off the quickdrain. That'll make a real mess.

If you're changing your own oil, have a quickdrain fitting installed. It makes the oil change faster and cleaner by replacing a simple drain plug with a valve you can just open and close. Attach a hose. Then push up and twist to start the flow.



Oil can get trapped inside the oil filter and make a mess when you remove it. This is more of a problem when the filter is up high on the engine. You can punch a small hole in the top of the filter with a sharp pick and a hammer to let air in and aid in oil getting out before you unscrew it. Some oil will spill and weep out by any oil filter that's not straight down. Rags are your friend.

Once the oil has been draining for 20-30 seconds, collect an oil sample (page 100) per the instructions provided by the lab doing the analysis. You want to collect the sample about midway through the draining process to avoid dirt or other debris around the drain getting in. While the remaining oil drains, remove, inspect, and replace the oil filter (page 102).

Add New Oil

Don't forget to close the oil drain or replace the drain plug with a fresh crush washer. Seriously, it happens, and it's more than a little embarrassing to find all of your freshly added oil in the bucket or on the hangar floor. Drain plugs should be tightened with a torque wrench per the engine manufacturer's specifications. They must also be safety wired once installed (page 90).

Pour slowly. Oil poured too quickly can back up into the filler tube and run out the overflow, particularly in certain engines (Continental IO-550, we're looking at you). Check your maintenance manual for the proper amount of oil to add. If you're not sure and you changed the filter, fill to capacity minus one quart. This will leave you a bit less than totally full (because oil will fill up the oil filter), which is often a better level than completely full (page 8).

TIP

Lycoming owners should get Service Bulletin 480 on oil servicing and identification of metal in the oil and corrective actions.

Run it Up

Clean any oil that spilled. You're going to check for oil leaks, and you don't want to be misled by oil that was already there. Start the engine and do a normal runup, and then shut down to check for oil leaks at the plug/drain and around the filter. (It's smart to check for any leaks anywhere, if the cowling is off.) Fix any leaks before flying. Finally, remember to make a logbook entry documenting your work. Note that if you changed the filter, the oil level after runup will be lower than what you added, because the filter is now full of oil too.

FIRST FLIGHT AFTER MAINTENANCE

Whether it's something as simple as an oil change or as invasive as a cylinder replacement (page 115), treat every flight after maintenance as a test flight. Even parts unrelated to the repair could have been accidentally compromised.

Don't let new parts lull you into complacency. They're more likely to fail in the first few hours than later on. Entire engines are most likely to fail within the first four *years* or 500 hours. Consider day VFR with airports nearby for a first flight after engine or other maintenance.

Collect an Oil Sample

It's your life that's entrusted to your engine, which means you should be doing oil analysis. By the time metal or other debris show in the oil filter and suction screen (page 102), you already have a major problem on your hands. An oil analysis inspects microscopic particles and can see a nascent problem long before it's a danger. Blackstone Laboratories and Aviation Laboratories are two companies that do oil analyses.

At the time of this writing, an oil analysis kit costs about $30, which includes the collection kit and postage.

The report you get back shows key materials in the oil in parts per million, along with averages for comparison. It explains what's typical, what's not, and what you need to keep an eye on. Different engines and brands of oil have different baseline metal levels. It takes a few oil analyses to establish those baselines. What you're really looking for, apart from something wildly out of the ordinary, is trend information.

The lab's comments help you interpret your results and offer suggestions for action to take if necessary, including things they'll watch for in subsequent samples. Oil analysis should provide peace of mind, especially on an older engine. It's also invaluable information when assessing the replacement of a cylinder or engine (page 115).

Sort of a like a urine sample, you catch the oil mid-drain. The catch cup comes with the oil sample kit, along with instructions for sending it to the lab.

BLACKSTONE LAB'S LIST OF ITEMS AND THEIR SOURCES

- Aluminum: Pistons, piston pin plugs, bearings, and the case
- Chromium: Rings, aftermarket cylinders, steel alloy, valve stems
- Iron: Cylinders, rotating shafts, the valve train, and any steel part sharing the oil
- Copper: Brass or bronze parts, bushings, bearings, oil coolers
- Lead: Primarily leaded gas blow-by. Lead from bearings is usually masked by 100LL.
- Tin: Bearings, bronze parts (with copper), anti-wear coatings
- Nickel: Valve guides, replacement cylinders, trace element in steel
- Manganese: Grease additive
- Silver: Trace element in some types of bearings
- Titanium, Potassium, Boron: Trace elements
- Molybdenum: Anti-scuff piston coating, some cylinder types
- Silicon: Abrasive dirt (via intake air), silicone sealers, and gaskets
- Sodium: Antifreeze and brine-filled valves
- Calcium/Magnesium: Oil additives, rare in airplane engine oils
- Phosphorus: Oil additive
- Zinc: Component of brass (with copper), oil additive common to auto engine oils
- Barium: Oil additive, not commonly used in airplane oil
- Viscosity/Flashpoint: If fuel is present in the oil, the viscosity and flash point will often be lower than what is stated in the "Values Should Be" line. A high viscosity may show oil stress from heat or contamination.
- Fuel %: Indicates the amount of volatile gas found in the oil.
- Water %: Indicates the amount of moisture found in the oil.
- Insolubles %: Insolubles are solid materials present in the oil. They are typically free carbon from the oxidation of the oil itself, along with blow-by products past the rings.

BLACKSTONE LABORATORIES

OIL REPORT

TIP

Blackstone Laboratories has an FAQ that's worth reading just for the fun of it. Really. And you find out who Oscar is on the sample reports.

UNIT

MAKE/MODEL: Lycoming O-360-A4M
FUEL TYPE: Gasoline (Leaded)
ADDITIONAL INFO: Cessna 172N
OIL TYPE & GRADE: Aircraft Engine Oil
OIL USE INTERVAL: 51 Hours

COMMENTS

There's a lot more aluminum and iron in this sample than we typically see from your airplane. Corrosion shouldn't be a factor with 50 hours of flight time over the last three months, so it looks like aluminum and iron show more piston and cylinder (steel) wear. We didn't find any harmful contamination like fuel or water to blame, and the air and oil filters are working well too (see silicon and insolubles) so maybe there was a temporary overheat or a similar situation. Watch for oil filter metal and use a borescope to look for obvious issues. Check back in ~40 hours to monitor.

ELEMENTS IN PARTS PER MILLION

		UNIT / LOCATION AVERAGES						UNIVERSAL AVERAGES
MI/HR on Oil	50		40	50	53	38	52	
MI/HR on Unit	3,149		3,999	3,060		2,957	2,919	
Sample Date	2/12/2018		11/15/2017	10/2/2017	8/25/2017	7/19/2017	5/30/2017	
Make Up Oil Added				1 qt			1 qt	
ALUMINUM	**19**	7	8	8	8	7	8	5
CHROMIUM	6	4	5	5	4	4	5	4
IRON	**78**	33	31	35	41	31	49	27
COPPER	22	10	15	**18**	**20**	**17**	**22**	6
LEAD	4906	4422	4048	4754	4485	3775	4605	4149
TIN	2	1	1	1	1	0	1	1
MOLYBDENUM	0	0	0	0	0	0	0	0
NICKEL	1	2	1	1	1	1	2	2
MANGANESE	1	0	0	0	0	0	1	0
SILVER	0	0	0	0	0	0	0	0
TITANIUM	0	0	0	0	0	0	0	0
POTASSIUM	0	1	0	0	0	0	0	1
BORON	2	1	0	1	0	1	0	1
SILICON	7	5	5	7	5	6	6	5
SODIUM	3	1	1	3	1	1	2	1
CALCIUM	2	3	0	0	0	0	1	16
MAGNESIUM	0	1	0	0	0	0	0	1
PHOSPHORUS	1312	709	1270	1199	1218	1217	1156	668
ZINC	34	13	16	21	14	14	25	8
BARIUM	0	0	0	0	0	0	0	0

PROPERTIES

	Values Should Be*					
SUS Viscosity @ 210°F	95.0		87.4	102.7	98.0	96.9	98.4
cSt Viscosity @ 100°C	19.18		17.35	20.98	19.88	19.62	19.98
Flashpoint in °F	465	>440	480	485	470	485	455
Fuel %	<0.5	<1.0	<0.5	<0.5	<0.5	<0.5	<0.5
Antifreeze %	-		-	-	-	-	-
Water %	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Insolubles %	0.4	<0.6	0.3	0.4	0.3	0.3	0.3
TBN							
TAN							
ISO Code							

COMMENTS

Aluminum and iron seem to be recovering from the high readings we found last time. Iron is just into the normal range at 54 ppm. Aluminum isn't there yet, but a drop of 5 ppm is a start at least. There was also water in the sample, but we aren't sure if that has anything to do with the higher metals. Isolated water contamination is often just from condensation, and it shouldn't pose a long-term threat if it clears up next time for you. Make sure the oil filter is clean and check back on aluminum and water at the next service.

COMMENTS

The main story here is water contamination. There was enough water to prevent us from finding the flashpoint. If this engine has an air/oil separator installed, check for proper function and installation as a possible point of ingress for this moisture. The only metal that read elevated next to averages is copper, which is likely from nitrided Lycoming parts if this was Aeroshell 15W/50. We're thinking that's the case since that's what you've used in the past too. Aluminum has improved here, and all other metals match up with averages. Check back on water though.

The oil report comments are what you'll focus on when using oil analysis data. The other key is trend information. The full report shown here showed elevated wear without a good reason. However, as the report comments from subsequent oil changes show, the real issue may have been water and corrosion. It's important to remember the airplane showed no symptoms during flight the entire time.

Replace and Inspect Oil Filter

It's standard practice to replace the engine's oil filter whenever you do an oil change (page 98). Not only does the new filter mean less obstruction to oil flow, it lets you cut open the old filter to inspect for metal.

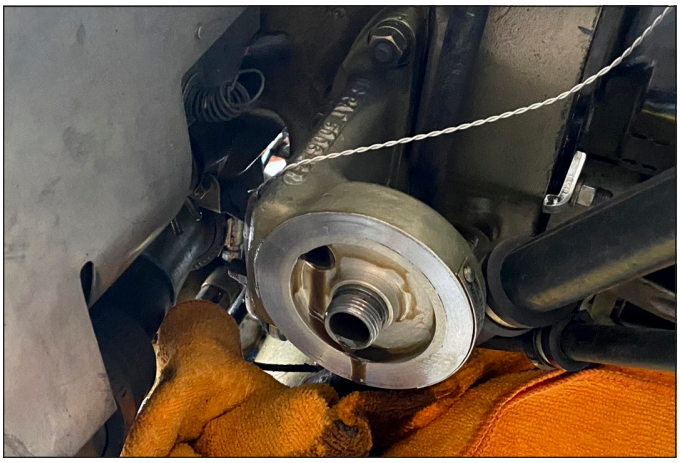
These are simple spin-on oil filters just like those for a car engine. The obvious difference is an extra section on top where the safety wire connects. While some airplane engines originally came without oil filters, most have been retrofited. If you're a purist with no oil filter, you'll have to change your oil twice as often.

Remove the Old, Install the New

Step one is draining the engine oil. Once that's done, you can remove the safety wire for the old filter and get a rag ready underneath the old filter. It's at least partially full of oil, so it's almost impossible not to spill some on removal. If you have a rag ready, it won't end up on the engine, where you'll just have to clean it off.

If you can simply unscrew the filter with your hands, it probably isn't tight enough. Luckily, airplane oil filters have a nut on the top that you can use with a wrench to start it moving. Never use a torque wrench for unscrewing anything. Once it's loosened, you can unscrew it by hand. Remove it, pour out any remaining oil into your catch basin from the oil change, and then put the filter aside.

After you've done the filter change a few times, you'll know if you have the right filter. However, it's a good habit to match up the size of your old filter to its replacement. The important part is the bottom where it screws onto the engine. The gasket outside all the holes must be the same diameter. The size and style of the center connection must be the same. Sometimes the thread goes into the filter, and sometimes the filter has threading that goes into the engine.



Pressurized oil enters the filter from the side, flowing through the multiple outer holes in the filter. Then it passes through the paper, collects in the center, and re-enters the engine—now cleaner—through large center hole where the threads are.

TIP

While it may seem like a great time-saving idea to simply collect your oil sample (page 100) from the oil filter, don't do that. The filter traps metal and debris that would give you false—and worrisome—readings when the sample is analyzed.

Before you spin on the new filter, it's good practice to apply a light film of clean engine oil or Dow Corning 4 to the gasket. This can be done just with your gloved finger. Skip this step with "SPIN-EZ" Tempest filters, as they come pre-lubricated.

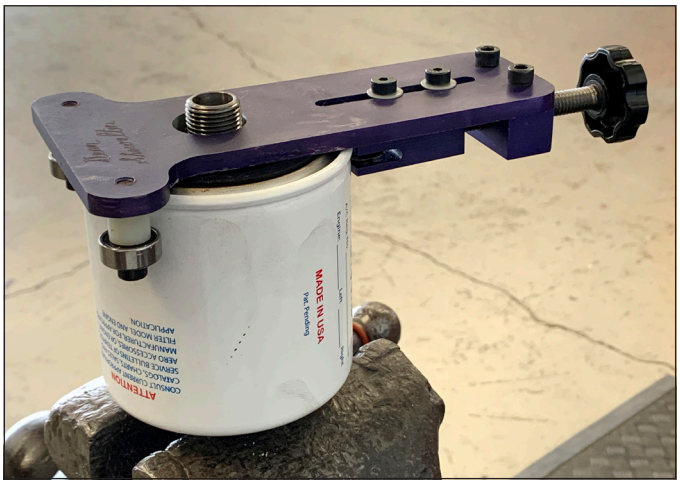
Screw on the new filter until it's finger tight. Then tighten it to the proper torque per your airplane's maintenance manual. (16 foot-pounds is common.) Tempest and Champion offer torque wrenches set to their specific recommended value, but any torque wrench will do the job. Then replace the safety wire to ensure the filter can't loosen in flight (page 90).

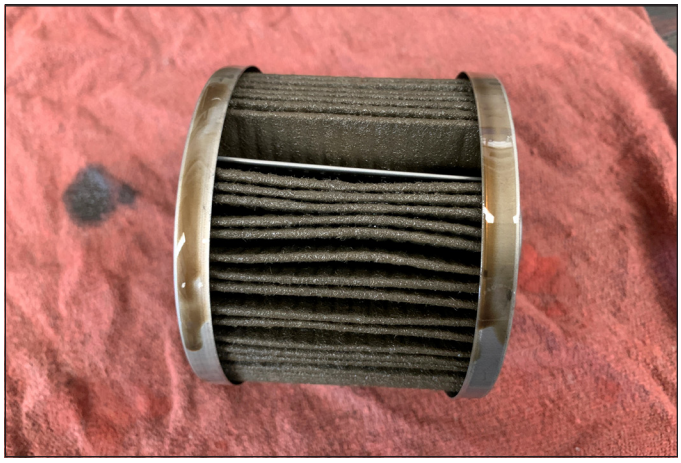
Cut Open and Inspect

To cut open the used filter and remove the filter element, you'll need an oil filter cutting tool. These work like large can openers, locking onto the outside of the can and cutting while rotating around the perimeter. Unlike can openers, it takes several laps around the can to cut it.

Clamp the filter in a vice to hold it steady, and connect the cutting tool to the can by tightening it just enough to hold on. Turn it through one full circle, then tighten it slightly and make another circle. Repeat the process until it cuts through and the top pops free. Don't try to cut all the way through in one go, as you may damage the cutting wheel.

Once the outer case is removed, you'll see the





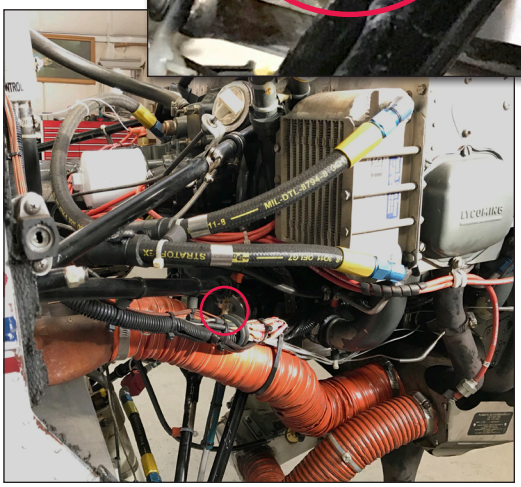
Once you cut open the filter (above), you can remove the outer case and see the oil filter element (upper right). Oil passes through the filter element from the outside to the inside, so you'll see debris on the outside of the pleats. To better see between them, cut out the filter material with a knife, so you can spread it out flat on a table (right).

side of the filter where particles are trapped. To get a better look though, use a knife to cut out the pleated filter at the top and bottom. Then, spread out filter paper on a table. Be careful not to introduce any contaminants from the knife or a dirty surface.

Ignore black carbon pieces that break in your fingers when rubbed. You're looking for any shiny metallic particles or residue. Lycoming says that any particles larger than 3/16-inch in size need immediate attention and that smaller debris in sufficient quantity does too. They also say that more than five small particles on each pleat, or a quarter-teaspoon total of metallic particles, requires further investigation.

In reality, that's a lot of metal, and smaller quantities should also have your attention. Trend is very important. An engine that rarely makes any metal suddenly producing some, might be more concerning than one that routinely does. If you're unsure, seek out a mechanic's opinion.

Ferrous (iron-based) metals can be picked up on a magnet, while non-ferrous metals won't. That along with the color and shape (viewed with a magnifying glass) of the material can help indicate what engine component it came from. Oil filters can also be sent to oil analysis laboratories (page 100).



Extra-large particles get caught in a suction screen that protects the oil pump from damage. Metal large enough to get caught by the suction screen is rare, but it's bad news for your engine. Lycoming suction screens can be checked at each oil change, though it's often only done at annual. The screens on most Continental engines are not easily accessible, so the easiest way to check for very large metal chunks is to strain the oil drained at an oil change. There's also a magnet in the cap of Tempest filters to check.