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.

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.
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).

**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 run-up, 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).

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**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.
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 retrofitted. 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.

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 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.
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.