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Bits and Pieces

Test-Flying My New Homebuilt – Engine Break-In

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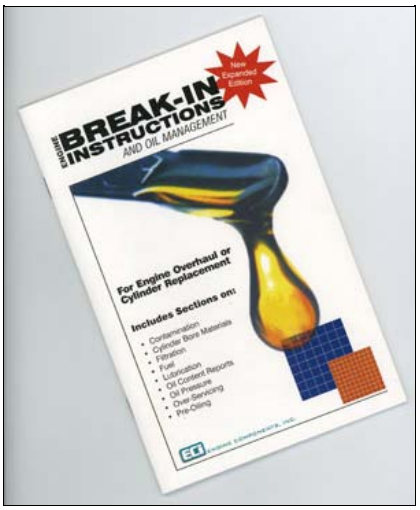
I've now completed my first flight in my new homebuilt. I've worked through all issues and corrected or addressed all snags, and I'm now ready to continue the test-flight phase of 25 hours as mandated by Transport Canada.

This brings up an entirely new concern. In most cases the pilot (and owner) of a new homebuilt will be faced with a new, untested airframe, together with a new or rebuilt engine that requires proper engine break-in. These two are not mutually compatible. The need is to slowly explore the flight envelope for the aircraft while at the same time ensuring proper engine break-in by operating the engine under loaded conditions.

I've borrowed heavily from an instructional booklet entitled *Engine Break-In Instructions and Oil Management*, published by Engine Components Inc., 9503 Middlex, San Antonio, TX 78217-5994, www.eci.aero. I recommend you obtain a copy for your own reference.



Aeroplane owners want the engine to perform and give a long and satisfactory service life.

When an engine fails to give satisfactory service, it is frequently due to:

- Unseated piston rings due to improper break-in.
- Uneven cooling due to improper baffling.
- Poor fuel distribution.
- Incorrect timing.
- Damaged or perforated piston heads caused by detonation or preignition.
- Piston scuffing or seizing usually caused by overheating or unseated rings that allow blow-by to displace the oil film between piston and cylinder bore.
- Bearing and crankshaft wear caused by underlubrication or dirt, excessive piston.
- Cylinder wear caused by dirt, ineffective air filtering, or excessively rich or lean air-fuel mixture.

Run-In vs. Break-In

Most engine overhaul shops will typically run in opposed engines for one to two hours before release for installation. This is not the same as engine break-in. The objective for the run-in is to:

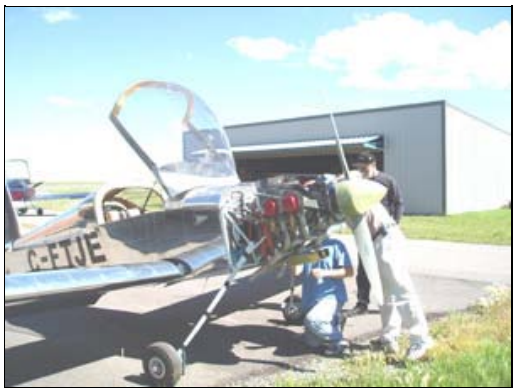
- Prove the engine is producing the rated horsepower.
- Check and correct for any oil, fuel, or induction leaks.
- Check operation of the fuel system.

Adjust the engine operating oil pressure.
- Provide the initial stage of the break-in.

Only after this run-in and after the engine is installed in the actual airframe with appropriate baffling, etc. can the break-in take place. In some installations I have been involved with, even this run-in by the engine overhaul shop has not been accomplished. This makes the initial start-up and first operating hours critical to engine health and life.

So how do we proceed with a new or overhauled engine in an untested airframe?

- Pressure-oil the engine before the first start-up after installing the engine in the aeroplane. There are many systems available and a homemade improvisation is certainly applicable. Unfortunately, pressure-oiling the engine does not lubricate cylinders, pistons, and rings. To do this, remove the spark plugs and oil the cylinder heads with low-viscosity oil. Consider an oil spray to reach the upper portions of a horizontal cylinder assembly. Fill the oil filter with oil before start-up. All work should be performed so as not to introduce any dirt or contamination into the engine.
- Ensure proper fuel-air mixture to the engine. On our RV-9A at start-up, we had one cylinder head temperature (CHT) far above all others, indicating a lean fuel-air mixture. The culprit was a leak in the induction hose connection to that cylinder.



Prelubing engine before first start-up

- Check out the ignition system and timing. Magneto timing should be set and verified to engine manufacturer's specifications. Make sure the spark plugs have the correct heat range and gap as specified.
- Check all fuel and oil lines for leaks. Check hard lines for proper support to prevent fatigue. Ensure heat protection for fuel and oil lines as required.
- Use only a mineral-based oil for break-in purposes. Continue using mineral oil until oil usage is minimal indicating complete break-in of the engine. This can take from 25 to 50 hours.
- For the initial start-up, run the engine at a fast idle (850 to 1,000 rpm). Limit higher engine rpm to 3 or 4 minutes at 1,800. Shut down and inspect for oil leaks. During ground runs do not exceed CHTs of 400°F, and/or oil temperature of 200°F.

Now for Flight!
In order to break in your new or newly overhauled engine, you need to observe two basic variables:

- Keep all operating temperatures to minimum recommended.
- Work the engine and keep the manifold pressure high to force the seating of the rings to the cylinder walls.
    - Start the engine, run up normally, taxi, and take off immediately. (Minimize ground time.) Reduce

manifold pressure in your climb and reduce engine rpm to "maximum continuous" (top of the green). Reduce power to 75 percent. Do not cycle or feather the propeller.
- On takeoff, use minimum power to reach 40 mph IAS before applying required takeoff power.
- Maintain a shallow angle of climb in order to keep the CHTs as low as possible. Check your specific engine for the appropriate maximum CHTs.
- Level off at desired altitude (2,000 to 3,000 feet AGL) and maintain 75 percent power for at least 30 minutes. The engine should then be operated at various power settings and engine parameters observed until at least 45 minutes of flight time have elapsed. All power changes should be made very gradually, especially power reductions. During the first 50 hours, the piston rings will seat better if higher power (and manifold pressure) is maintained under controlled CHTs and oil temperatures.
- Keep flying weight to a minimum as you progress through these first critical hours. This will help in keeping the CHT low during climb-out. Depending on the type of cylinder bore you have, (steel/cast iron, chrome, or nickel composite), break-in will commence immediately, and oil consumption should start to reduce within a few hours. (Note: Porous chrome-plated cylinder bores have more critical cooling requirements than the other cylinder-bore surfaces.)
- If during any of the test flights a persistent high CHT or oil temperature is noted, a precautionary landing and inspection should be made to determine the cause.
- Ground operations and continuous climb at low airspeed should be minimized until the engine has accumulated at least 25 hours of operating time. Cylinder overheating can cause bore glazing and/or piston scuffing at any time, but cylinder assemblies are the most susceptible during the first 25 to 50 hours of operation. If glazing and/or scuffing become severe, the cylinder will need to be removed and the glaze mechanically removed, the piston and rings replaced.

A Note About Oil
For the break-in of an engine, use only mineral-based oils. You can use a multiviscosity oil in higher-usage aeroplanes, and a single viscosity oil works well in lesser-flown aircraft. Synthetic or semisynthetic oils are not recommended. Do not use any antiscuffing additives during break-in.

How About Fuel?
Use only 100LL for engine break-in for an engine that was designed, tested, and certified on 100LL or 80/87. Under no circumstances should unleaded auto gas (mogas) be used when breaking in an engine.

Years ago, I rented a C-180 from a friend for a flight from the Yukon to EAA AirVenture Oshkosh. This aircraft had accumulated about 40 hours since having a complete engine overhaul by a popular repair shop, including an hour of run-in time. My buddy was disappointed with the engine's abnormal high use of oil—over a quart per hour. He had been using a popular synthetic multigrade oil right from the get-go. Before leaving for Oshkosh, I drained the oil and replaced the filter and the oil with a single-viscosity mineral oil. During the flight to Oshkosh, we flew at an appropriate altitude, with the rpm in the appropriate range, and maximum manifold pressure, always carefully monitoring engine temperatures. Within about 10 hours, the oil consumption had reduced, and by the time I returned to the Yukon, oil consumption was down to a quart every 5 to 6 hours.

Summary

- Do not use synthetic oil.
- Check oil/fuel levels.
- Prelube engine prior to starting.
- Start engine, run up normally, taxi, and take off.
- Do not cycle propeller during flight.
- Climb out at a low angle of attack (i.e. higher airspeed) to prevent cylinder heads from overheating.
- Level off at 2,000 to 3,000 feet AGL.
- Keep power at the top of the green arc on the tachometer and manifold pressure gauge or 75 percent power (whichever is higher) for 30 minutes.

Having completed a first flight, and having gained a degree of confidence and comfort with the aircraft, for the next few hours I will concentrate on flying the aircraft and becoming more familiar with it. But my additional focus will be on working the engine to these above parameters to achieve a proper break-in and ensuring the lasting performance and service of my engine.
