



The pressure's on

Understanding the art of the compression check

BY PETER A. BEDELL

The differential compression check is one of the most useful and telling tricks that mechanics use to diagnose the health of an engine's cylinders. For owners of aircraft powered by piston engines, the sometimes-dreaded differential compression tester can be looked upon as "the money gauge." If a cylinder fails the compression test, it may indicate the expensive removal and/or replacement of one or more cylinders. The trick is to know when the bad reading is a fluke or whether it truly indicates a problem.

How it works

There are a few ways to test compression, but the widely accepted method in aviation is to use the differential compression tester. This device has a specially calibrated orifice between two gauges, a regulator knob, and a short hose and adapter to be connected to the cylinder.

Typically, the top spark plugs of all cylinders are removed, allowing the engine to rotate freely and eliminating the chance of its firing. (It's also a good idea to first confirm that the magneto switch is in the Off position and the magneto p-lead is correctly installed.) The piston of the cylinder in question should be brought to top dead center on the compression stroke. This is easily determined by placing your thumb over the spark plug hole and rotating the engine until you feel the compression on that cylinder trying to push your thumb out.

While holding the propeller, turn the regulator knob (which allows air to enter the cylinder) until one of the gauges reads 80 pounds per square inch (psi). If you use more than 80 psi, it can become difficult to hold the propeller. The other gauge will indicate how much of that 80 psi is being retained by the cylinder. For example, if the cylinder retains 75 psi, only five psi is escaping from somewhere in the cylinder's top end. The resultant information is written in the engine logbook as 75 over 80.

Why it's done

There are two main reasons to check compression. First, it is mandated at every 100-hour or annual inspection by FAR Part 43. Second, the compression check tells you how well the upper end of the cylinder is able to seal in the combustion pressures. If air is escaping from the combustion chamber, overall engine power will be reduced by some degree. Depending on the cylinder type, compression ratios can vary, but a basic guideline is that if the cylinder leaks more than 25 percent—a score of 60 (or

less) over 80—there's adequate cause for concern. The concern then shifts to what the source of the leakage is.

While the cylinder is still pressurized, listen for the sound of air escaping. Most likely it will blow past the piston rings or the valves. If air is blowing by the rings, you can often tell by removing the dipstick or oil filler cap and listening (or feeling in worse cases) for the air that is now circulating through the crankcase. The oil breather can also be used as a reference for ring blow-by. If air is heard coming through the exhaust pipe, the exhaust valve could be cocked in its seat or the valve guide could be worn beyond its limits.

Moving the propeller back and forth while the cylinder is pressurized can provide you with still more information. For example, a cylinder whose best compression is seen when the piston is farther down in its stroke may indicate that a wear step has formed in the top of the cylinder barrel. A wear step is formed at

the point of reversal of piston travel where the piston rings scrape away material from the cylinder wall. This is a common phenomenon in high-compression cylinders whose inner walls are coated with Cermicrome.

In worse cases, a compression check could reveal a crack in the cylinder or cylinder head. In a quiet hangar, you may hear some air coming from an unknown source. Some dishwashing liquid applied in the right area could reveal some bubbles and, therefore, a crack. More likely, however, a serious crack would have already revealed itself in the form of a rough-running engine or residue on the cylinder in the vicinity of the crack. Since cylinder pressure during cruise operation is in the area of 800 to 1,000 psi, you'll most likely see exhaust, oil, or fuel staining, or a tar-like substance oozing out of the crack, depending on its location. Because these cylinder pressures can get so high, you can see why the discovery of problems at a relatively low 80 psi is cause for concern.



Using a differential compression tester, your mechanic determines how well the engine's cylinders are able to seal in combustion pressure.

How bad is bad?

Like many things involving the troubleshooting of engines, a single bum compression check should not send the mechanic scurrying to remove that cylinder. All of the ring gaps lining up in a row or a little pellet of lead lodged in between the valve and seat could cause a single low compression score. In some cases a trend in previous compression scores may reveal a clue. Check the logbooks for previous compression scores. They may also be scribbled on the cylinder's valve cover(s).

The compression should be checked as soon as practical after the engine has been run. The correct dimensional tolerances for most engines are optimized for normal operating temperature. Therefore, it's not unusual for a cold engine to score a low compression reading. If a cylinder has a low compression reading and the problem isn't readily evident, perform a runup or even fly the airplane long enough to bring it to nor-

mal operating temperature and recheck the compression.

Further complicating matters is the fact that different cylinder brands can have differing acceptable limits. While a score of 65 over 80 would be considered perfectly acceptable for a Continental O-470, it would not necessarily be considered good for a Lycoming O-320. Owners of Continental engines should obtain a copy of Service Bulletin M84-15, which details methods and techniques used in determining proper compression ratios of Continental cylinders. In certain cases, acceptable limits can be quite low. Service bulletins are available by calling Teledyne Continental at 334/438-3411, or by visiting the Web site (www.tcmlink.com/servicebulletins).

“Armstrong” method

Even though most aircraft owners and renters don't have a differential compression tester, there is still the “Armstrong” method to test an engine's compression. After taking the necessary precautions such as confirming that the magneto switch is off, the wheels are chocked, throttle and mixture closed, etc., you can pull the propeller through by hand. Pull it through in the direction of rotation four compression strokes for a four-cylinder engine and six for a six-cylinder engine. You should feel a definite hump at each compression stroke. If not, listen for the sound of air escaping. This is a quick-and-dirty method to determine gross compression, but be sure that you take the proper precautions in hand-propping the airplane and treat the propeller as if the ignition were on.

Cross references

Like most aspects of troubleshooting engines, you can't rely solely on the compression check as a basis for cylinder removal. Checking spark plug condition, inspecting the innards of the oil filter, conducting a spectrographic oil analysis, and the tracking of oil burn rates will provide a more complete picture. There are opportunities for human error and instrument error, so be wary of these factors before prematurely removing what may be perfectly good cylinders. O

Links to other articles about compression checks can be found on AOPA Online (www.aopa.org/pilotlinks.shtml). E-mail the author at Pete.bedell@aopa.org