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The Ten Biggest Lies About Piston Aircraft Engines

When it comes to piston powerplants, there's an astonishing amount of misinformation making the rounds. Some of it may even come from sources you trust: leading aviation magazines, overhaul shops, even your CFI or A&P. Don't believe everything you read or hear.

By Mike Busch

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Lie #1:
Lycoming engines are better than Continental engines. (Or vice-versa.)

I bought my first airplane 30 years ago. It was a Cessna 182 powered by a Continental O-470-R engine. Since then I've owned a succession of airplanes, and each one-quite coincidentally-was powered by a big-bore Continental. My engines have always made TBO and been relatively trouble-free. So it's not surprising that I'm something of a fan when it comes to TCM engines.

It's equally unsurprising that at least half the pilots and aircraft owners I meet are Lycoming bigots. They brashly state "I'd never own a Continental-powered airplane!" If you ask why, they'll tell you a series of anecdotal episodes about how their Lycoming-powered Turbo Saratoga made it to 1,000 hours past TBO, while their best friend wound up having to tear down the TCM factory reman in his Mooney 231 or Beech B36TC after just 475 hours.

Let's set the record straight. Lycoming and TCM engines are very similar designs using very similar technology and metallurgy. Both are horizontally-opposed air-cooled designs with bolt-together aluminum case halves and bolt-on cylinders with sandcast aluminum heads screwed onto nitrided steel barrels. Both use fixed-timed dual magneto ignition systems, and valve trains with overhead rocker arms, shrouded hollow pushrods, and hydraulic valve lifters. Both use similar compression ratios, similar RPM red-lines, and similar power-to-displacement ratios. And both have comparable records of reliability and longevity.

Certain problems tend to occur more frequently in one brand or the other. Continentals have a lot more crankcase cracks, head-to-barrel separations, and premature valve guide wear problems than

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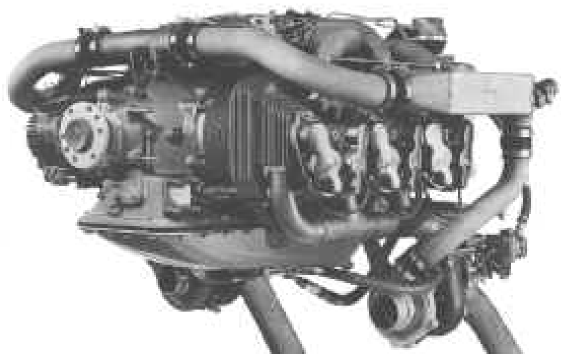
Lycomings. On the other hand, Lycomings suffer stuck and broken valves and spalled cams and lifters much more often Continentals.

Some TCM and Lycoming models have better track records than other TCM and Lycoming models. For example, the TCM TSIO-360 series (used in Mooneys, Skymasters, and various other aircraft) tend to be more troublesome and maintenance-intensive than other Continentals. Likewise, the Lycoming O-320-H2AD engine has had a dismal history of cam and lifter problems when flown irregularly and operated in cold climates.

But while certain specific TCM and Lycoming models are problem-prone, it is simply wrong to make a general assertion that engines of either manufacturer are more reliable than those of the other. It's just not so.

Lie #2:
Turbocharged engines are troublesome, inefficient and costly.



When I learned to fly on the East Coast thirty-something years ago, turbocharging was a dirty word. Everybody said turbos were expensive, inefficient, maintenance-intensive, and problem-prone; it shortens TBO and increases operating cost drastically, and makes no sense unless you live in the mountains. Or so everybody said.

Well, everybody was wrong. I've owned, operated and maintained a turbocharged twin Cessna for the past eleven years. It's proven to be the most reliable airplane I've ever owned: reliable, efficient, and almost completely trouble-free. Both engines made it to 500 hours past TBO without ever having a cylinder off, and when they were finally majored, they turned out to be in great shape.

Most of the anti-turbocharging arguments you hear are bunk. For example, take the claim that turbocharged engines are inefficient. Now, it's true that most turbocharged engines have a lower compression ratio than their normally-aspirated counterparts (typically 6.5-to-1 vs. 7.5-to-1), and that the turbo will burn a bit more fuel at any given power setting. But specific fuel consumption is only part of the story. The other part is that airframes are much more efficient up at the higher altitudes that turbocharging allows.

For instance, by climbing from 6,000' to 12,000' and throttling back from 75% to 65% power, my Turbo 310 can fly 5 knots faster than a normally-aspirated 310, and do it at lower fuel flow. If I'm willing to use oxygen and climb to FL200, I can beat the non-turboed 310 by 25 knots with no fuel flow penalty. The normally-aspirated airplane is more efficient than the turbo only if you force both airplanes to fly at the same low altitude, and that's not a meaningful comparison.

How about the claim that turbocharged engines are much more expensive to operate and maintain? It's true that turbos are more vulnerable to abuse in the hands of a ham-fisted pilot. If your airplane is used for training or rental use and flown by lots of pilots, you probably don't want a turbo. But barring such abuse, my worst-case analysis indicates that a 300 hp turbocharged engine should cost no more than $10/hour more to operate than its normally-aspirated sibling. When you consider that the sort of aircraft that use such engines — Bonanzas, Centurions, Saratogas, etc. — typically cost $100 to $150/hour to fly, you can see that the difference is chump change

About the Author ...

Mike Busch is editor-in-chief of AVweb, a member of the technical staff at Cessna Pilots Association, and in a prior lifetime was a contributing editor for The Aviation Consumer and IFR Magazine. A 6,000-hour commercial pilot and CFI with airplane, instrument and multiengine ratings, Mike has been flying for 36 years and an aircraft owner for 33. For the past 14 of those years, he's owned and flown a Cessna T310R turbocharged twin, which he maintains himself. In his never-ending quest to become a true renaissance man of aviation, Mike's on the verge of earning his A&P mechanic certificate. Mike and his wife Jan reside on the central coast of California in a semi-rural area where he can't get DSL or cable TV.

Lie #3:
Modern multi-viscosity oil offers superior lubrication and longer engine life than old-fashioned single-weight oil.

During the 70s and 80s, there was a dramatic shift from single-weight to multi-viscosity oils by operators of general aviation aircraft...due in large measure to very effective advertising campaigns by Shell and Mobil that touted their multi-vis products (Aeroshell 15W50 and Mobil AV 1) as the greatest aeronautical innovation since the nosewheel.

During the same 20-year period, there was a dramatic increase in premature engine problems in the owner-flown G.A. fleet. It was not a coincidence.

In contrast to "working airplanes" that fly almost every day, most owner-flown airplanes spend most of their lives in the chocks. The biggest enemy of their engines is not inadequate lubrication. It's rust.

Multi-vis oil simply does not provide as effective protection against rust as single-weight oil. The defining characteristic of multi-viscosity oil — the fact that it doesn't thicken up at cool temperatures — makes it a lousy corrosion inhibitor. During periods of disuse, multi-vis oil strips off cylinder walls and cam lobes much more readily than does thick single-weight oil, leaving those parts vulnerable to corrosion, followed by spalling and eventually destruction.

But what about the superior lubricating properties of multi-vis oil? Basically bunk!

It turns out that multi-vis oil is <u>not</u> a better lubricant than single-grade oil. It's actually a bit worse. The reason is that multi-vis oil is made by starting with a thin, single-weight oil stock and adding man-made polymers called "Viscosity Index improvers" that increase viscosity as temperature increases. However, such VI improvers are not lubricants, and their addition actually displaces a certain amount of lubricating base stock (on the order of 10%). In other words, there's more "oil" in a quart of single-weight oil than in a quart of multi-vis.

Now this is no big deal, since the lubrication demands of most piston aircraft engines are rather modest (compared to automobile engines, for example). What is a big deal is the fact that single-weight oil does a better job of protecting engines against rust during period of disuse. That's why we've long recommend single-weight oil for any engine that doesn't fly at least once a week.

Fortunately, after two decades of multi-vis mania, it now appears that more and more G.A. operators are starting to recognize the shortcomings of multi-vis oil and are switching back to single-weight. An increasing number of top-rated overhaul shops are now recommending the use of single-weight oil.

Lie #4:
If you can't fly regularly, at least be sure to turn over the prop by hand every week or two to redistribute the oil.

Now there's a really dumb idea! I wonder who first came up with it?

Engines that don't fly regularly are vulnerable to rust because the oil film that protects their steel parts from corrosion begins to strip off after a week or two. Gravity is the culprit — oil flows from top to bottom — and so the areas at greatest risk are the tops of cylinder bores, the tops of cam lobes, and so forth.

Now suppose you turn over the prop by hand. Does this "redistribute the oil?" Sure it does! It scrapes oil off the top of the cylinders and accelerates its flow downhill. The same is true of cam lobes and lifters.

Now I realize full well that at least one of the engine manufacturers recommends turning over the prop by hand periodically in its "flyable storage" recommendations. I still maintain, however, that the only way to replenish the protective oil film is to fling large quantities of oil around the innards of your engine with great vigor. And the only way to do that is to run the engine at high RPM...preferably by flying the airplane attached to it. Turning over the prop by hand just won't cut it.

Lie #5:
The less oil an engine burns, the better.

Get a few aircraft owners get together over a few beers, and inevitably the conversation turns to oil consumption. "I'm only using a quart in 30 hours," one will say. "That's nothing," brags another owner, "I don't have to add any make-up oil between 50-hour oil changes!" The owners doing this bragging probably don't realize that they probably won't make it to TBO without a costly mid-term top overhaul! It turns out that ultra-low oil consumption is often a bad omen when it comes to cylinder longevity.

For a cylinder to make it to TBO, it must be protected from metal-to-metal scuffing by the piston rings. This protection comes from a film of oil that coats the cylinder barrel and causes the rings to "hydroplane" instead of scuffing the barrel.

Now, if the cylinder barrel is properly coated with oil, it's inevitable that some of this oil will be burned up in the combustion process. That's why a certain amount of oil consumption is perfectly normal.

Ultra-low oil consumption indicates one of two things: either the oil film is too thin, or the oil is not reaching the critical upper portions of the cylinder walls where the compression rings reverse direction at top-dead-center (the so-called "ring-step area"). Without adequate lubrication, there's a high risk of metal-to-metal contact between the compression rings and the cylinder wall.

Experience seems to indicate that oil consumption lower than about a quart in 20 hours may not bode well for long cylinder life. Barrel wear in the ring-step area becomes likely, leading to rapidly deteriorating compression and accelerating oil consumption at 500-1000 hours.

While low oil consumption has always been acknowledged as a sign of a tight, well-broken-in engine, there is strong evidence that a quart in 30 or 40 hours may well be too much of a good thing.

Lie #6:
The cooler the engine's oil and cylinder head temperatures, the better.

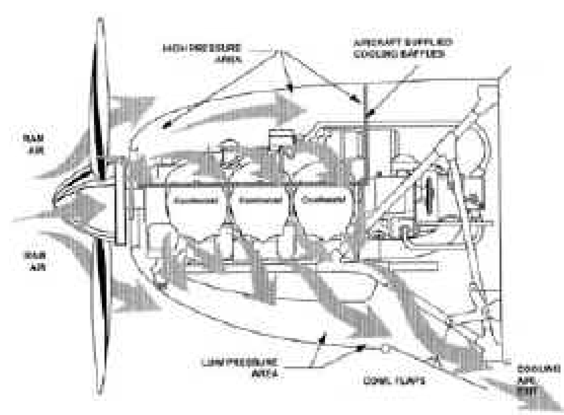
It turns out that the "cooler is better" notion isn't quite right. While excessively high temperatures are bad for your engine, low temperatures are no great shakes, either.

Take oil temperatures. Most of our airplanes have oil temperature gauges that have a green arc running from 75°F to 240°F, with a red-line at 240°F. Now, 240°F is way hotter than we'd like to see. Keep in mind that the oil temperature probe is usually located at the place in the oil system where the oil is coolest, often near the outlet of the oil cooler. So if the gauge reads 240°F, the oil is probably hitting close to 280°F at the hottest point in its circuit through the engine. That's hot enough to cause petroleum-based oil to oxidize and break down at an accelerated rate. We've either got to bring down the oil temps, or change the oil very frequently.

On the other hand, oil temperatures lower than 170°F or so on the gauge present a different problem... namely, that the oil is probably not reaching the boiling point of water at the hottest point in its travel. Why is this important? Every time we shut down the engine, a slug of water condenses inside the cooling engine and runs down into the oil sump. If we don't get rid of this water the next time we fly, there will be a progressive water build-up inside the engine. That water will mix with the sulfur and nitrogen byproducts of combustion to form sulfuric and nitric acid. And that will start eating away at the innards of our engine. The solution is to make sure the oil gets hot enough to boil off the entrapped water, so that the resulting steam passes harmlessly out the breather.

Oil temperatures of 180°F to 200°F on the gauge are hot enough to get rid of this water, yet cool enough not to accelerate the breakdown of the oil. So that's ideally where we'd like to see our oil temperature gauge in-flight.

What about cylinder head temperatures? The CHT gauge on a TCM engine usually has a green arc from 200°F to 460°F, with a red-line at 460°F. Lycomings generally have a CHT red-line of 500°F. Once again, red-line CHT is way too hot for optimum engine longevity. At those temperatures, the aluminum cylinder heads are vulnerable to cracking, and the exhaust valve guides are vulnerable to accelerated wear.



On the other hand, CHTs below about 300°F create another problem: lead fouling. Our engines operate on avgas that contains large amounts of tetraethyl lead (TEL). Even so-called "100LL" contains enough TEL to keep the EPA awake at night. The purpose of TEL is to enhance the octane (detonation resistance) of the fuel. Unfortunately, it also can cause lead deposits in the engine, particularly on spark plug electrodes and in piston ring grooves.

To prevent such lead fouling, avgas contains a "lead scavenging agent" called ethylene dibromide, whose job it is to dissolve excess lead and let it pass harmlessly out the exhaust pipe. However, ethylene dibromide doesn't do its scavenging job unless combustion temperatures are fairly high. That's why lead fouling problems tend to emerge when CHTs are below about 300°F.

Ideally, we should try to keep CHTs in the 350°F to 400°F range as much as possible. That's cool enough to keep the cylinder heads and valve guides happy, but hot enough for effective lead scavenging.

Lie #7:
Aggressive leaning results in burned valves and detonation.

Fear of the red knob is one of the most pernicious areas of misinformation among general aviation pilots. Most pilots operate way too rich most of the time, and do so because of the mistaken belief that leaning will harm their engine. The result is usually trouble: fouled spark plugs, accelerated exhaust valve guide wear, and stuck exhaust valves.

Lycoming has long authorized leaning to peak EGT at any cruise setting up to 75% power. TCM authorizes leaning to peak EGT up to 65%, and its latest recommendations even endorse lean-of-peak operation for many big-bore engines, provided the engines will run smoothly when operated that lean.

Contrary to popular belief, aggressive leaning doesn't cause burned valves. Most burned valves are the result of excessive valve guide wear or valve stem contamination.

Aggressive leaning doesn't cause detonation, either. Most of our engines are incapable of detonation at cruise power settings, provided that we don't exceed CHT red-line or try to burn contaminated fuel. Furthermore, recent tests on Lycoming engines by ASTM revealed this fascinating result: detonation is most likely to occur at a mixture setting 11% richer than stoichiometric (i.e., substantially richer than peak EGT).

Lean as aggressively as the book allows. For Lycomings, that means peak EGT at all cruise power settings to 75%. For Continentals, lean to peak EGT up to 65%, 50°F rich of peak at 75%. For turbocharged engines, also limit TIT to 1600°F.

Lean during all ground operations except for engine start. It is particularly important to lean for taxi and runup. Since EGT is usually off-scale at idle power, the best method is to lean for peak RPM at idle.

Lie #8:
It's bad to cruise at high manifold pressure and low RPM ("oversquare").

The old saw about never allowing MP to exceed RPM/100 is bunk! Fortunately, this one seems finally to be moving toward a well-deserved death, after decades of being accepted as Gospel by countless well-intentioned pilots.

TCM and Lycoming authorize cruise operation at 1 to 3 inches "oversquare" for most normally-aspirated engines, and allows 9 to 12 inches "oversquare" for most turbocharged engines. Check the cruise charts in your POH or, better yet, obtain the operator's manual for your engine.

Operating at minimum RPM and maximum MP (within the allowable envelope) actually helps your engine last longer. Low RPM operation provides numerous benefits: better cylinder compression, lower frictional losses, improved propeller efficiency, cooler-running valves, lower EGTs and TITs, and a quieter cabin.

Cruise at the lowest RPM and highest MP that the book allows for the percentage of power that you desire. You usually have several possible RPM/MP combinations to choose from at lower altitudes in a normally-aspirated airplane, and at virtually all altitudes in a turbocharged airplane.

Lie #9:
Continuing to fly an engine beyond the manufacturer's recommended TBO is dangerous, illegal, and could void your insurance coverage.

Hogwash!

First of all, it's important to understand that TBO is an actuarial figure...the manufacturer's best guess about how long a typical engine will be able to operate before needing an overhaul. Some engines won't make it. Other engines will sail past TBO in great shape and provide many hundreds of additional hours of reliable operation before teardown is warranted.

Think of published TBO as being similar to published human life expectancy. We don't expect all humans to live to that age and then keel over. Some will die before their time, others will outlive their children. Certainly, we don't arbitrarily euthanize people when they reach the average expectancy age!

Published TBO has no legal significance for the majority of us who fly under FAR Part 91. For commercial operators under Part 135, TBO is theoretically "compulsory" because TCM and Lycoming publish their TBO figures in the form of a service bulletin, and Part 135 operators are required to comply with service bulletins. However, a Part 135 operator may apply to his local FSDO for a TBO extension, and such extension are routinely granted by the FAA. For example, one company that operates a huge fleet of Cessna 402s (published TBO is 1600 hours) has FAA approval to go to 2400 hours before overhaul.

Your aircraft insurance carrier could care less whether your engine is past TBO. Your policy simply requires that your aircraft and its pilot be legal under the FARs. As we've seen, published TBO has no legal impact on Part 91 operators. Part 135 operators need to ask the FAA's permission before flying past TBO, but such permission is commonplace.

We recommend that you overhaul your engine when it gets tired, not at some arbitrary number of hours.

Lie #10:
A factory reman is better than a field overhaul, because only the factory offers a true "zero-timed" engine.

While it's true that a factory rebuilt engine comes with a zero-time logbook while a field overhauled engine does not, it's not for the reason you may think.

When you have your engine overhauled by Mattituck, RAM, T.W. Smith, Victor, or whomever, that engine retains most of its original parts, as well as its serial number, data plate, and engine logbook or other maintenance records. The overhauled engine you get back is legally the same engine you sent in, all cleaned up with lots of new parts.

On the other hand, when TCM or Lycoming receives a runout core from a customer, that engine loses its identity. The data plate is removed and destroyed. So are the logbooks. The case halves are cleaned up, inspected, and added to a big pile of reusable case halves. The crankshaft is cleaned up, inspected, and added to a big stack of reusable cranks. The same is true of camshafts, rods, accessory gears, and so forth. Those reusable parts become "anonymous" because they're no longer associated with any particular engine serial number.

Now, when TCM or Lycoming builds up a factory rebuilt engine (colloquially but incorrectly referred to as a "factory reman"), it pulls some "anonymous" case halves from one pile, an "anonymous" crankshaft from another pile, and so forth. When the engine is completely assembled, it gets a new data plate, a new serial number, and a new logbook.

The logbook starts out at zero time-in-service. Why zero? Because there's no other reasonable figure to put in the logbook. The case halves are certainly not zero-time, but there's no record of how much time they've accrued. The crankshaft may not be new, but there's no record of how much time is on the crank, either. And so on.

In short, the "zero-time" logbook that comes with a factory rebuilt engine in no way implies that the engine is "newer" or "better" than a field overhaul. All it implies is that the reused components in the engine are of unknown heritage...nobody knows how long they were in service prior to the time then were cleaned up, inspected, and reused in your engine!