OPINION |

The great beyond (TBO)

Lessons learned from geriatric engines.

BY MIKE BUSCH

TIME BETWEEN OVERHAULS (TBO) is a strange concept. The FAA requires aircraft engine manufacturers to publish TBOs for their engines, but doesn't require aircraft owners to abide by them. You are free to continue flying behind your engine as it remains airworthy. Yet many owners and mechanics start getting nervous as they see tach time approach published TBO. Countless healthy engines are needlessly euthanized when their time-in-service approaches that consecrated number. For Part 91 operators, doing so is not an FAA requirement—it's more like a religious belief.

MY TEACHABLE MOMENT

My teachable moment that convinced me to stop believing in overhauling at TBO came about 30 years ago. In 1987, I purchased a Cessna 310 twin whose TSIO-520 engines were just 100 hours shy of Continental's published TBO of 1,400 hours. It didn't take long for me to get there. When I did, I asked for advice from several friends who were veteran A&P/IAs. (This was long before I was an A&P myself.) Their unanimous advice was, "Keep on flying it as long as it's healthy." And so that's what I did.

When the engines reached 500 hours past TBO, I started to get nervous and figured I'd pushed my luck far enough. I bit the bullet and sent the engines off to a very good overhaul facility. I asked the engine shop's owner to call me when both engines had been torn down and measured so I could come visit the shop and survey the damage. I was intensely curious to see what the inside of those engines looked like at TBO plus 500. A few weeks later, the engine shop owner called to say it would be a good time to come look at the torn-down engines.

When I got to the engine shop, I was astonished by what the shop owner showed me. The bottom ends of both engines were pristine. The crankshaft and camshaft were both perfect. The main and rod bearings exhibited hardly any wear. The cylinder barrels measured within 0.001 inches of new limits, although the valve guides were worn. All six cylinders were reused after re-valving and honing them.

"These engines could easily have gone another 1,000 hours without breaking a sweat," the engine shop owner said. "Whatever you've been doing with these engines, keep doing it." At that moment, I vowed that I'd never again allow my engines to be torn down without a compelling reason.

A COMPELLING REASON

I flew those engines uneventfully until they reached TBO again (1,400 since major overhaul) and kept going. They were still doing fine when they reached 200 percent of TBO (2,800 SMOH).

Finally, at about 3,300 SMOH one of the pistons in the right engine experienced a freak fatigue fracture that caused it to drop half of the piston skirt into the oil sump. On its way there, the liberated piece of piston skirt tangled with the spinning crankshaft (and lost), so it arrived at the sump as a bunch of marble-sized chunks of aluminum.

I was cruising at 11,000 feet over the Nevada desert when this happened. Interestingly, the engine didn't quit. It didn't stop making power. It didn't even shake noticeably. In fact, it ran amazingly well despite its underweight and lopsided piston. Ultimately, I decided to shut it down and make a one-engine landing in Las Vegas, but had I been flying a single I'd have had no problem landing the airplane under power.

I considered just dropping the sump and cleaning out all those pellets, but after due consideration I decided this incident was the compelling reason I'd been waiting for. I sent my right engine off to a good engine shop for a major overhaul. It was time.

True to my vow, I did not overhaul the 3,300 SMOH left engine since it wasn't contaminated and was still running fine. As a compromise, I decided to replace all six cylinders (which by now had more than 5,000 hours on them) and all six pistons (which came from the same batch as the one that failed in the other engine). I also had all six connecting rods fit with new bearings and bushings. But the engine never came out of the airplane and the case was never split. Five years later, this left engine is still flying and showing every indication of still being happy and healthy.

FRANK'S TEACHABLE MOMENT

In 2001, my friend Frank bought an early Cirrus SR22 powered by a Continental IO-550-N engine with a published TBO of 2,000 hours. When Frank's engine started to approach this time-in-service that Continental's high priest had etched on a stone tablet, I encouraged him to keep flying.

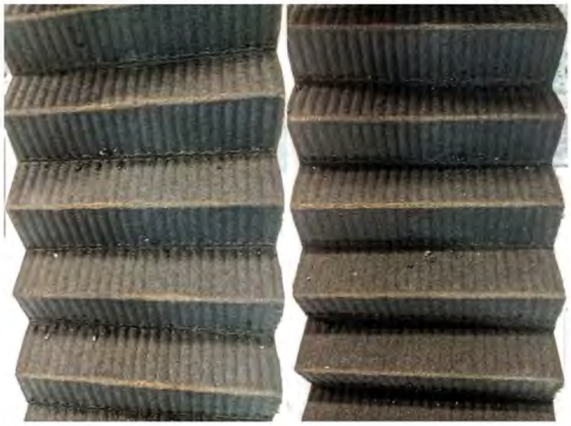
At 2,190 hours, during an annual inspection, Frank's A&P/IA reported that two of the six cylinders had tiny cracks developing between the top spark plug hole and the fuel nozzle. Cracks in this location are common with these cylinders and are not particularly consequential—they never have caused any sort of catastrophic cylinder failure—so I would be inclined to keep an eye on them to make sure they don't grow larger or exhibit signs of fuel seepage. But Frank's IA insisted the two cylinders needed to be replaced.

At this point, Frank did something radical—something I tried but failed to persuade him not to do. He had his mechanic remove the engine from the airplane, crate it up, and ship it to a respected engine overhaul shop in Tulsa, Oklahoma. Frank instructed the engine shop to remove all six cylinders, inspect the cam and other bottom-end components visible with the cylinders removed, and advise him what needed to be done.

I considered this a gross overreaction to a trivial inspection finding and told Frank as much. In hindsight, it was probably indicative of Frank's nervousness about going over TBO, something I can identify with.

The engine shop did as Frank instructed and advised him that the cylinder head cracks his IA was so concerned about were not really cracks at all, just minor cosmetic casting flaws that could be polished out easily. The cylinder barrels had very little wear. The bottom-end components looked great. The pistons were a bit dirty and a couple of the oil control rings were fouled with lead sludge, but otherwise there was really nothing wrong with the engine. The shop cleaned and re-ringed the pistons, honed and re-valved the cylinders, put the engine back together, and shipped it back to Frank's mechanic.

This was Frank's teachable moment. He took the vow.



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WHEN YOUR ENGINE TALKS, LISTEN

Fast forward about a decade. Frank flew his Cirrus on its annual pilgrimage from Southern California to Oshkosh, Wisconsin, for EAA AirVenture. After the show, he continued up to Canada before heading back home. During this extended cross-country, Frank had the vague sense that the engine wasn't running quite as smoothly as usual. He decided to make a stop just northeast of Minneapolis at a shop that specialized in propeller balancing and vibration analysis.

To rule out the ignition system as the source of the perceived roughness, the A&P owner of that shop sent both magnetos out for overhaul and replaced all 12 spark plugs. While waiting for the mags to come back, he changed the oil and cut open the oil filter for inspection. The filter media contained a small number of metallic flakes that were non-magnetic and had a yellowish appearance.

This small quantity of metal wasn't particularly alarming. On the other hand, the engine had now accumulated more than 3,500 hours and didn't seem to be running quite as smoothly as usual. Frank had a visceral sense that the engine was trying to talk to him, and he'd decided he'd better listen.

At my recommendation, Frank sent out an oil sample and the filter media for laboratory analysis. The oil analysis report came back with no elevated wear metals. However, the scanning electron microscope (SEM) report for the filter media stated:

"A trace amount of bronze flakes were removed from the filter element, closest match AMS 4842, ranging in size from 788 X 455 to 546 X 448 microns."

Aerospace Material Specification (AMS) 4842 is a leaded bronze alloy of copper, tin, and lead and used primarily in bearings. I

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told Frank that the flakes were almost certainly bearing material from the engine's main bearings, connecting rod bearings, or both. Frank prudently concluded the engine was telling him, "it's time." So, instead of heading home to California, Frank decided to fly the airplane to Tulsa and put it in the capable hands of his trusted engine shop.

FRANK'S TEARDOWN

The engine shop pulled Frank's engine and commenced to tear it down. Once the case was split, the source of the bronze flakes in the oil filter became obvious—one half of the number 2 main bearing exhibited serious spalling. In fact, so much of the bearing's leaded bronze layer had flaked off (compared to the small amount in the oil filter media) that it was apparent that this deterioration had been going on for some time.

Curiously, the opposing half of the number 2 main bearing was in much better shape, and the remaining main bearings (3, 4, and 5) were in excellent condition. The oil filter contained very little metal.

Frank asked why his regular oil analysis reports had never shown any elevated levels of bearing elements like copper or tin. I explained that this was simply because the oil filter had been doing its job. The flakes coming off the bearing were too large to pass through the filter, so none made it into the sample jars he sent to the lab.

Why had just one of the main bearing shells started coming apart, while all the others remained in good condition?

One possibility is that the airplane had undergone some major structural composite repairs that kept it grounded for many months, and the shop performing those repairs had done nothing to protect the engine from corrosive attack. Perhaps if the engine had been "pickled" during that extended period of downtime, Frank's engine might have made it to 4,000 SMOH.

While the reason remains a mystery, one thing is clear: The engine was talking, and Frank was listening.

WINDFALL PROFITS

Over the years, my team and I have saved our clients millions of dollars by helping them say "no" to unnecessary maintenance. In this spirit, we try to provide them with the knowledge and the courage to continue to fly their engines until the engine itself tells them when the time has come for an overhaul. When their engines start to speak, we help them listen and interpret what they're saying using modern technologies such as borescopy, scanning electron microscopy (SEM), and engine monitor data analysis.

The total cost of Frank's overhaul—including removal, reinstallation, and new shock mounts and hoses—came to about $45,000. Dividing this by the 2,000-hour TBO yields a reserve for overhaul of $22.50 per hour. Thus, by deferring the overhaul for 1,500 hours past TBO, Frank earned a windfall of $33,750. That's enough to buy 7,000 gallons of 100LL, enough for him to fly to Oshkosh and back for the next 20 years.

Using the same approach, the windfall I received by running the engines in my Cessna 310 to 3,300 hours instead of dutifully overhauling them at 1,400 hours comes to $35 per hour times 1,900 hours times two engines, which calculates out to about $133,000. That's about the same as the current fair market value of my airplane. **AOPA**

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