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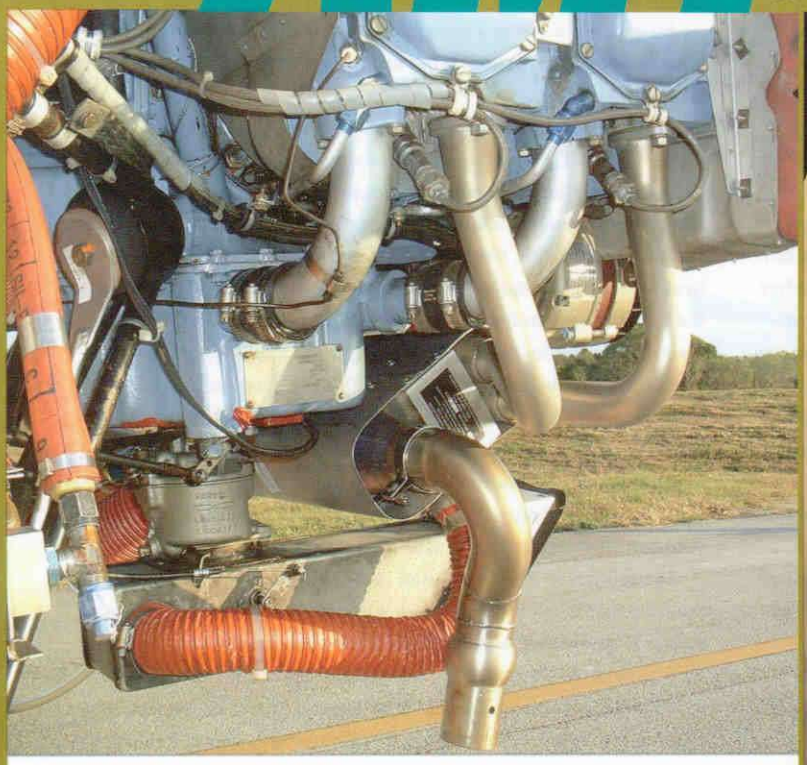

Tuned Exhaust

How it impacts your aircraft engine

A tuned exhaust system is available for some aircraft piston engines. Installation of a tuned exhaust engine can result in increased engine efficiency, increased power, and better performance. We will take a look at a tuned exhaust system, how it affects the engine, and some maintenance items to keep in mind when working on engines with one of these systems installed.

Where are they developed?

The company that specializes in tuned exhaust systems is Daytona Beach, FL-based Power Flow Systems Inc. I talked with general manager Darren Tilman, an A&P and test pilot for Power Flow Systems to learn how it works. In order to understand how a tuned exhaust system works, we need to first learn what is happening on a typical OEM exhaust system.

Traditional exhaust system

"Traditionally, the exhaust system on an engine was purely functional — to remove gases from the cylinder and get them out of the nacelle," Tilman shares. "And then the FAA came along and said 'we need to muffle it' and so they got rudimentary exhaust systems. And then you got pilots that didn't like to freeze, so the manufacturers had to come up with a heating system. So they wrapped a piece of metal around the other metal and came up with a heating system. But everything was sort of a band-aid approach. It was an afterthought."

This traditional type of exhaust system has worked out fine through the years but could be improved. The main way it is able to be optimized is the method that the exhaust gases are able to escape. Tilman explains how this works on an OEM installation. "Picture your typical Lycoming engine running, starting with the number one cylinder. The cylinder fires. The exhaust valve opens and the gases enter a relatively random short length of tubing. Then they will enter a central chamber, and then they have a choice. They can go out, or go up three other chambers, or three

other manifolds if you will. So some of it leaves, but some of it goes up the other three. Well, then the number three cylinder fires. When the valve opens, instead of being able to evacuate itself, it's met with the pressure from the number one. The bottom line is that only 80 percent of a cylinder typically is being emptied. Twenty percent of it is being wasted because it couldn't empty itself fully. So you've lost 20 percent of your efficiency."

Tuned exhaust

Now consider a tuned exhaust. The main goal is to more efficiently evacuate the exhaust gases from the cylinders. This is mostly controlled by the length of tubing. "There are multiple waves of both pressure and heat that are going to come out when the exhaust valve opens," Tilman shares. "Length dictates whether the pulses are going to benefit you or not. The key thing about tuning is if you send those pulses through a long enough tube, so that they are not interfered or influenced from another one at the time the valve is open, then you can utilize that to create essentially a mirror image — a negative wave or a suction at the time the valve opens."

So the engineers working on a tuned exhaust system determine what the optimum length of tubing is. A tuned system is technically 100 percent optimized for one given set of conditions. Typically, an exhaust is tuned for a peak boost down at sea level at 2,450 rpm.

The four tubes then join at the four to one collector. When they meet at the collector, they are the same length. They then go on to the muffler and out the system.

Muffler

The muffler on the Power Flow system is a different type than the OEM. On an OEM muffler, the exhaust gas enters the muffler where it is diverted by baffles. On the Power Flow system, the muffler is typically an external muffler — a round can. It is around 3 1/2 inches in diameter and has an insert inside of it. It is a perforated tube. You can shine a flashlight in it and see from one end through to the other without any impediment. As the gases enter this perforated tube, they diffuse into an absorption material behind it. As the gases pass down, they get quieter.

The bottom line

The bottom line is that with a tuned exhaust system, you are always suctioning out and emptying out the cylinder more effectively. So less gas is wasted to overcome the inertia. The engine gets a more complete fuel burn. The effect in the cockpit is that it will take less throttle to get the same rpm than you are used to. This means less fuel flow. The EGT ends up going up a little bit because more of the exhaust gases are being emptied from the cylinder.

System installation

The Power Flow system is installed through an STC. When the kit ships to the customer, they get the most current set plus a copy of the STC and a letter or authorization licensed to the particular aircraft N-number. The kit can be installed by a mechanic in about four hours with little or no modifications to the airframe.

Inspection

So, you see a Power Flow system come into your shop for a 100-hour or annual inspection. What inspection items do you need to be aware of?

To begin with, the inspection would include the items listed in AC 43.13-1B. Inspect to ensure no portion of the exhaust system is being chafed by cowling, engine control cables, or other component. Ignition leads, hoses, fuel lines, and flexible air ducts should be protected from radiation and convection heating by heat shields or adequate clearance. Inspect all external surfaces of the exhaust system for cracks, dents, and missing parts. Pay particular attention to welds, clamps, supports and support attachment lugs, bracing, slip joints, stack flanges, gaskets, flexible couplings, etc. Examine the heel of each bend, areas adjacent to welds, any dented areas, and low spots in the system for thinning and pitting due to internal erosion by combustion products or accumulated moisture. If you suspect a crack, you should pressure test that area to make sure there is no leak.

In addition to the items listed in AC 43.13-1B, there are several other areas Tilman suggests paying attention to when inspecting a Power Flow system. As mentioned earlier, the muffler on the Power Flow system has a removable insert. This insert should be inspected for deterioration and replaced as needed. It can be inspected by looking through it with a flashlight. You can also get an indication of deterioration by inspecting the tailpipe. If the tailpipe starts turning brown somewhere in the middle, and it's shiny on either side, that is an indicator the insert has burned through in that area.

Another wear item is the first-generation heating shrouds. These were made of aluminum and don't tend to hold up as well as the newer stainless-steel shields. This is especially true if the shield has been bumped and lays up against the steel exhaust tube. It can mean a melted aluminum shield.

Another wear item to pay attention to is the clamp that attaches the muffler to the rest of the collector assembly. The clamp is familiar to mechanics who work on Pipers, which is a clamp with a pin in it. There's a hole drilled in one tube and a hole drilled in the other tube. The pin goes through the two tubes kind of like a clevis bolt. If there is a lot of wear or movement, the bolt can have a tendency to wear. If it goes uncorrected for too long, it can shear. If that clamp shears off, there is nothing holding that muffler in place anymore, and it will depart the aircraft. So you want to remove that clamp and inspect it. It typically needs to be removed during inspection in order to remove the cowling.

As a final note, Tilman stresses the importance of dynamic balancing. An out of balance engine can wreak havoc on your aircraft including the muffler system.

This has been a brief primer on tuned exhaust systems. For more information, be sure to contact Power Flow Systems. AMT

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