DO YOU KNOW YOUR OIL COOLER?

BY NORM ELLIS

While I was working on my last project, a field approval of an oil cooler swap, I noticed the lack of information available to the average person and how misinformed people are about oil coolers. I came to one conclusion after many hours of talking with A&P mechanics, clubs, and organizations. As long as the oil temperature needle is in the green arc, who cares? This is the general consensus and attitude of the aforementioned.

Aircraft manufacturers design an airplane. The last thing the manufacturers give any thought to is the oil cooler. Most aircraft manufacturers simply find the most convenient place to install the oil cooler. What makes matters worse is that aircraft manufacturer will start with the smallest, cheapest oil cooler available, test the oil cooler in flight, and use whatever oil cooler will work to keep the oil temperature needle in the green arc.

A good case in point is the Cessna 177 Cardinal, first introduced with a Lycoming 0-320E2D, 150 horsepower engine. This model uses the same Stewart Warner oil cooler as the Cessna 172 with a Lycoming O320-H2AD, 160 horsepower. This was not a problem.

However, when Cessna decided to introduce the 177RG Cardinal, with a Lycoming IO-360-A1B6D, 200 horsepower engine, using the same oil cooler, as original first model 177 Cardinal... it does not take a rocket scientist to figure this one out. Using common sense, a bigger engine with more horsepower generates more heat to the engine and engine oil. This requires a bigger oil cooler to cool the engine oil and requires increasing the size of the engine cowling for cooling. However, Cessna did not do this. Ah, why not, you may ask? The oil temperature needle is in the green arc, so who cares?

Engine heat is created from both the friction of moving parts and the ignition of fuel inside the cylinder. Motor oil helps cool the engine. The airflow into the engine compartment is responsible for only 60 percent of the engine cooling that takes place. This cools only the upper portion of the engine, including the cylinder heads, cylinder walls, and valves. The oil cools the other 40 percent.

Oil is directed onto the hot surfaces, such as the crankshaft, main and connecting rod bearings, the camshaft and its bearings, the timing gears, the pistons and many other components in the lower portion of the engine that directly depend on the motor oil for cooling.

The oil pump continually circulates the oil to all areas of the engine, which carries heat away from hot surfaces of the engine and transfers this to the air stream through the oil cooler. The amount of oil required to lubricate an engine is actually very small when compared to the amount needed to ensure proper cooling of these internal parts.

Oil coolers are nothing more than a radiator or a heat exchanger to cool the engine oil. Engines requiring oil coolers have an ideal operating range for engine oil of 180 degrees Fahrenheit through 200 degrees Fahrenheit general. Lycoming recommends the oil temperature to be 165 degrees Fahrenheit through 220 degrees Fahrenheit for maximum service life. While operating in this range, oil acts as a lubricant minimizing friction and wear, cools the engine, works as a cleansing agent in the engine, helps prevents contamination and corrosion, and seals the piston rings and other mating surfaces.

For example, an oil cooler system in a Cessna 177RG airplane, powered by a Textron Lycoming engine model IO-360-A1B6D is an external oil cooler mounted to the firewall. Flexible hoses carry the oil to and from the oil cooler. Cooling air is ducted to the oil cooler from the lower right engine baffle to the shroud-covered oil cooler. Exhaust air from the oil cooler discharges into the engine compartment.

A thermostatically operated oil cooler bypass valve is installed in the oil filter adapter, which causes oil to bypass the oil cooler in the event of congealed oil or an obstruction in the oil cooler. If the oil is cold, the bypass valve allows the oil to go directly from the oil pump to the oil filter. If the oil is hot, the bypass valve routes the oil out of the accessory housing and into a flexible hose leading to the oil cooler. The oil cooler starts operating at 185 degrees Fahrenheit.

One company has an STC for an oil cooler a size larger. It's used on Cessna's 172 and on the Cessna 177. This company claims the oil temperature is reduced to 190 degrees Fahrenheit. I find this hard to believe, especially after speaking to another company that uses an oil cooler two sizes larger.

This latter company claimed it achieved an oil temperature of 220 degrees Fahrenheit at 16,000 feet with a turbocharged engine, when the air temperature on standard day is 2 degrees Fahrenheit, which provides excellent cooling using cold air. Although the air is thinner, this has little if any effect on cooling the oil.

However, if you fly like I do, generally at 6,000 feet, without a turbocharger on the way to that hundred-dollar hamburger at an airport restaurant in California, the air temperature remains the same as the surface temperature. Point being, the air will not help in the cooling of the oil at higher altitudes where the air is thinner vs. low altitudes where the air is dense.

Another variable in this equation is the temperature environment or location of where you fly. This can have different effects on oil cooling. If the manufacture and certification of the aircraft is in Kansas, where the climate is different from, say, Alaska or California, you will have a different temperature variation than where the aircraft was certified. This will affect the oil cooling process. Obviously, on a cold day, the oil and oil temperature will be lower than on a hot day.

PROBLEMS OF HIGH OIL TEMPERATURE

Oil that exceeds 220 degrees Fahrenheit losses its ability to lubricate and cool the engine, which will cause accelerated fatigue, premature component failure and requires frequent oil changes. In other words, this reduces the engine life. Coking or cooking or burning the oil on to the engine internal parts induces high engine temperature. The worst-case scenario is oil evaporation leading to engine seizure.

The aircraft with the old oil cooler that was modified for this article registered a high oil temperature using full mixture, richer than peak on a hot day. This effected fuel consumption because gasoline is used to cool the engine. If the oil cooler is not properly sized for cooling the engine oil, running the fuel mixture rich in order to cool the engine directly effects the fuel consumption.

TROUBLESHOOTING FOR HIGH OIL TEMPERATURE

Before swapping the oil cooler out, check each of the following carefully:

- Engine closely inspected (especially at overhaul)
- Compression
- Magneto timing
- Temperature control oil cooler bypass valve (vernatherm) and valve seat
- Oil temperature gauge
- Oil pressure
- Baffling
- Oil cooler
- Oil quantity
- Proper grade of oil
- Fuel mixture, etc.

If the exhaust system is near the oil cooler, install a heat shield on the exhaust pipe or any components near the oil cooler generating heat. Also, follow the "Trouble Shooting Guide for High Oil Temperature" from the engine manufacturer.

TIDBIT INFORMATION ABOUT OIL

There are two systems classifying oil. One system determines the oil's viscosity (the SAE grade), and one system determines the oil performance level, i.e. which oil to use in what type of engine (the API class).

DEFINITIONS

DENSITY is the mass of a unit volume of a substance. Its numerical value varies with the units used.

FLASH POINT is the temperature to which a combustible liquid must be heated to give off sufficient vapor to form momentarily a flammable mixture with air when a small flame is applied under specified conditions.

FIRE POINT is the temperature at which oil will burn if ignited. The flash point is not necessarily a safe upper limit for oil because some decomposition takes places below the flash point.

OXIDATION RESISTANCE is the service life of an oil. Oxidation rate depends on temperature, the amount of oxygen present, and the presence of catalytic metals. Usually, temperature is the most important factor because the oxidation rate doubles for each 18 degrees Fahrenheit temperature rise. The effects of oxidation include the formation of gums and acids, and increased viscosity.

POUR POINT is the lowest temperature at which an oil or distillate fuel is observed to flow, when cooled under conditions prescribed by test method ASTM D 97. The pour point is 3 degrees Celsius (5 degrees Fahrenheit) above the temperature at which the oil in a test vessel shows no movement when the container is held horizontally for five seconds.

VISCOSITY is the resistance to flow. High viscosity flows slowly and low viscosity flows freely. The viscosity of the oil is affected by low or high temperature. Viscosity varies inversely with temperature; its value is meaningless until the temperature at which it is determined is reported.

For example, Shell 100 (50W) oil has a Pour Point of -9.4 degrees Fahrenheit and a flash point of 500 degrees Fahrenheit.

The next time you look at your oil temperature gauge, ask yourself, is this gauge really telling me everything that is going on with my engine?

SIZING AN OIL COOLER

Sizing an oil cooler will require certain amount information:

- Type of oil to be cooled
- Oil inlet temperature (oil from the engine entering the oil cooler)
- Desired oil temperature, required by the engine manufacturer, of the oil returning to the engine from the oil cooler
- Oil flow in gallons per minute from the engine to the oil cooler from the engine manufacture
- Temperature inside the duct to the oil cooler
- Duct area
- Velocity of air inside the duct
- Heat rejection required by the engine manufacturer for the oil cooler

Armed with all this information, you can now call the oil cooler manufacturer. The manufacturer will provide you with a recommended oil cooler that it manufactures for proper oil cooling.

Worst-case scenario would happen if a larger oil cooler is installed such that proper airflow is not provided through the oil cooler fins. It would have to be relocated.

In conclusion, the next time you look at your oil temperature gauge, ask yourself, is this gauge really telling me everything that is going on with my engine and how long do I want my engine to last?

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