ENGINE AIR-COOLING MADE EASIER

Have you ever touched an engine to see how hot it was? Air-cooled, model aircraft engines can make a lot of heat! This is no surprise to anyone who uses them. The puzzle that often shows up controlling the heat once the engine is all tucked into a cowling. A little background on air cooled stuff can help solve the question. How air cooling actually works is very simple. The engine radiates heat into cooling fins and cooling air flows through the fins to replace the warm air. That is easy enough. However, if we can't exchange the heated air in the fins, the engine will rapidly increase in temperature until it fails or is shut down. This can happen so quickly that some model aircraft engines are ruined in the first minutes of operation. Impossible? No, it is very possible, and it can happen to you, if you ignore the basics of air-cooling.

METHODS OF AIR-COOLING

What makes our model engines more difficult to cool than an air-cooled weed trimmer? Basically the engines are the same but there is one important difference. The manufacturers of saws, weedwhackers and blowers etc., always put their engines in a case which is really a carefully engineered shroud. These cases and shrouds direct airflow from an intake point, through the cylinder cooling fins, and then to an exit. Typically, A small set of fins on the crankshaft circulate the cooling air. The manufacturer realizes that heat control is necessary so the engine and cooling is packaged and ready to be used. Just add gas and go. When the early gasoline engines hit the model airplane market, many of them were simply industrial engines , removed from their cases. This reduced weight but also left the cooling up to the user. These users found that the little saw engines, mounted on a bench and adapted to a propeller, operated pretty well. They also stayed cool. This is where the trouble begins. Although the engine worked well on the bench, but once it was buried in a cowling, the temperatures went sky high. If you look at an engine on a test stand and feel the air blasting over the engine , it seems reasonable to assume that this same blast of air continues to blow into a cowling once the engine is installed in a model. This simply does not happen. What does happen is the air behind the propeller is actually spinning around and not blowing into the cowl inlets. Why?

THE PATH OF LEAST RESISTANCE

Air will always take the path of least resistance, always. If we look at some cowlings, the space between the propeller and cowl is very small. The cowling and engine act as a dam, restricting flow. Air being pulled through the blades, close to the hub will try to follow the easiest path. In this case, it is simply backing up and swirling around and flowing outward to join up with the airflow from the outer portion of the blades. In order to fix this problem, some full scale designers move the entire propeller and hub out as far as practical from the cowl. This helps straighten the prop airflow. Current Formula 1 racers are examples of this. Radial engine aerobatic aircraft props are also set forward, for the same reason. The air flowing through the propeller now has less interaction with the big cowling. Very tight cowlings for the modern radials and large spinners also smooth the flow. This still leaves us with the question: how does the cooling air get to the engine?

LOW PRESSURE AT WORK

Simply put, we have to suck the air into the cowling. This is done by lowering the pressure inside the cowling . The internal low pressure then allows the outside air to flow into the cowl inlets . This is the key to air movement High pressure air moves in to fill a low pressure . Watch the morning weather lady, she will tell you the same thing. As long as a pressure difference exists, the flow will continue. If the pressure differences cease, the air stagnates and temperatures go up (Pictures and news at 11:00). To create this low pressure, we need some kind of setup to create constant low pressure in the cowling. How we do this is exactly the same technique used to cool a home. If you place a fan in a window facing outward, then open a window on the opposite side of the house, the fan , even a small one , will pull fresh air through the entire house. On our models we don't have a fan, so it is necessary to create this low pressure by using an aerodynamic trick. Full scale aircraft, sometimes utilize rows of louvers along the sides, bottom and top of the cowling. Air flowing over them creates a siphoning effect to pull air from inside the cowling. Cowl flaps do the same thing. When opened, they lower internal cowl pressure, pulling more fresh air through the engine cooling fins. This pulling of fresh air through the fins, ducts, vents and louvers, is the key to proper cooling.

EXITS AND AIR DAMS

An effective method to create low pressure in our cowlings, is to make an outlet hole in the bottom of the cowling. The hole can be nicely curved or rectangular, whichever looks best. It should be about 3 times the area of the total inlet holes in front If you can't do the math, don't worry, just eyeball it. Once you make the cutout, cut a piece of 1/64" thick plywood and attach along the forward edges of the cutout. The height of the air-dam (or spoiler) must be at least 1/2in height and may be blended in or left blunt. When the plane is moving forward or the prop is running, the air-dam turbulence will create the low pressure to make the air flow through the cowl and out the exit. This puts us back to the original chain saw setup with the engine in a case and air flowing over it. Actually, not quite. There is still the problem of making certain the air flows through the cooling fins of the engine!

BAFFLES AND DUCTS

Simply pulling air through the cowling works with some engines and cowlings, but typically, the air will try to take the easiest route from inlet to exit and bypass the engine. Making the air go where we want it to go, is the final part of getting the cooling to work. The engines most difficult to cool are inline twins and four cylinder flat boxer types, then radials, then opposed twins and lastly singles. In each case the task is basically the same. Direct all inlet flow to the cylinder and head cooling fins. On inline twins or opposed four cylinder engines, a fitted containment box may do the trick. This setup is used on many four cylinder aircraft engines. On radial engines, air must flow thru all of the cylinders equally, this can be taken care of by leaving the cylinders out in the open, but copying the setups on early full scale aircraft such as 1930's vintage radial engined sport planes, should give you good ideas here if you want to do a cowled setup.

COMMON BAFFLE SETUPS

Properly cooling the opposed twin cylinder engine is the most commonly seen challenge. On a cowling such as the EXTRA aircraft design, the best bet is to first design a plate, which stops any air from sneaking under the cylinders. Poster board templates can be fitted, then the shape transferred to light plywood plates. These should meet in the center and extend horizontally all along the forward inside edge of the cowl inlets and almost touch the engine (within 1/8" is fine). Continue them outward past the tops of the cylinder heads to the sides of the cowl. The vertical location of these plates should be below centerline of the cylinder, but not down to the lower edge of the cooling fins. They can slope upward from the inlets to the lower edge of the cylinder. This type of baffle will direct all inlet air to flow through the bottom of the fins and up and over the top of the cylinders If the cowling is closely fitted to the engine, this may do the trick. Large cowlings may need more ducting. In order to keep the air flowing through the upper fins, add another a plate similar to the ones added to stop air from flowing under the engine. These can be epoxied directly to the cowl. This setup effectively extends the cowl inlet all the way to the front of the engine. Finally, It is desirable to also direct the air around the back side of the cylinders. We are using that arrangement on our new ZDZ Super 160 twin in the huge 42% EXTRA cowling. The parts needed are simply scissor cut from 1/64" plywood, then attached to mounting L brackets against the motor box. It is also possible to change relative cylinder temperature by blocking low at the vertical centerline of the engine. I have not tried this but I can see how it could help control a crosswise airflow. The large radial cowls on Sukhoi, Yak and Waco biplane models can be easily improved by blocking the entire front of the opening except where the cylinders of the engine are positioned. A custom made outlet under the rear of the cowl, incorporating an air dam, provides the necessary low pressure exit. Single cylinder engines are the easiest to do. The front of the engine should be directly exposed and a good extractor outlet made at the rear underside of the cowl. Your own setup may be improved by adding a couple of pieces of 1/64" plywood panels to direct all inlet flow through the fins. The actual work involved is not difficult. Whichever arrangement you choose to do, it is most important that the outlet for the cowl air creates a strong low pressure point. This is the key to cooler running, which maximizes power and protects your engine.

WHAT SHOULD THE OPERATING TEMPERATURES ACTUALLY BE?

I try to use a setup that gives me the most useful feedback. Fairly inexpensive hand held Infra- red heat reading devices, or Pyrometers, are readily available from most hobby suppliers. These can be pointed right at the front of the cylinders (with the engine shut down) and quickly read at any time. Expensive lab grade Pyrometers are not necessary for our use. I run the engine, shut it down and read each cylinder (twin cylinder) quickly as the temperature will rise as the engine sits. Typically, if all is correct, I see temps around 200F and a variance depending on the engine of + or - 10-20F. Using the air-cooling techniques described the engines run cooler and the difference in cylinder temperatures are reduced. Also running the engine at full power on the ground will take more time to raise the heat. This is the proof that the setup actually works. I don't try to run the engine leaner now, just setup for max power and back off a touch. It is a fact that an engine running within the correct temperature range makes the best power. Using the methods described above, you should be able to get best from your engine by controlling the temperature.

By Dick Hanson