Preparing for Old Man Winter - Engine Preheating

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As I sit here writing this article, it seems awfully early to be thinking about another New England winter. But, nothing stops the march of time, and it's a lot easier to prepare for winter now than it will be in the coming months.

Unless you live in a part of the country where your winter forecast includes a sun and surf report, chances are you should be protecting your plane from the cold. And, the best place to start is with the engine.

Why Preheat?

A cold engine can be a bear to start and low temperatures weaken your battery's ability to crank the engine for extended periods. But that is only the beginning. According to some studies, winter cold starts can account for more engine wear than years of normal flying. That's reason enough to preheat your engine.

Most pilots learn that aircraft need to be preheated in cold temperatures, but not all pilots understand why. Contrary to popular belief, oil flow is not the major reason for preheating the engine. If you operate your aircraft in temperatures at or below 32°F you should already be using a multi-viscosity oil. Modern multi-viscosity oils such as Aeroshell 15W50, Phillips 20W50 and Exxon Elite 15W50 are designed to operate in temperatures as low as 0°F. That is essentially what the viscosity numbers in the oil names mean. Aeroshell 15W50 acts like a 50 weight oil in hot engine conditions, and a 15 weight oil in cold engine conditions.

So, if there isn't a problem with the oil at 20°F, why bother preheating at all? And why do aircraft engines have to be preheated, while car engines seem to do just fine without it?

The answer lies in the basic design of the piston aircraft engine. Our engines are made from a variety of different metals (predominately steel and aluminum). One of the problems with using dissimilar metals in the design of an engine is that each metal reacts differently with temperature changes, and that can affect the clearances in critical parts of the engine. Aluminum and steel have dramatically different expansion properties. In colder temperatures, aluminum will contract almost twice as much as steel will. When the aluminum is heated, it will expand twice as much as the steel as well.

And therein lies the real reason for engine preheating: avoiding metal-to-metal contact. There are two critical parts of our engines that are susceptible to this problem: bearings and cylinders.

The bearings for the crankshaft are an excellent example. The crankshaft bearing is supported by the aluminum case, while the crankshaft itself is steel. The clearances for these parts are designed for normal operating temperatures. In extremely cold temperatures, the aluminum case contracts enough to make the bearings too tight and can cause substantial wear and damage upon start-up.

In the cylinder, the piston is made of aluminum, while the cylinder barrel is made out of steel. When the cylinder is extremely cold, the piston shrinks much more than the barrel. This causes the opposite problem, at first. The piston can wobble too much in the barrel and cause 'scuffing'. But, as soon as the engine gets going, the piston begins to heat up and expand rapidly; more rapidly than the cylinder barrel. This quickly leads to the opposite problem where the piston expands and the piston-to-barrel clearance gets too small, also causing wear and possible damage to the cylinder.

Proper Preheating

Most experts recommend preheating anytime the temperature drops near or below freezing (32°F). However, in a paper written by Peter Tanis (Tanis Aircraft Services, Inc.)[1], Mr. Tanis defines three different temperatures points for pre-heating benefit:

- Preheat below 20°F to prevent engine damage at startup
- Preheat below 40°F to make starting easier
- Preheat below 60°F to reduce engine stress, cylinder wear and "run up" time

As you can see, even below 60°F, preheating can be beneficial to the long-term health of your engine.

Proper preheating involves heating the entire engine, so that all critical engine parts can be brought into the 'safe' temperature range. This can be done in three different ways: heated hangars, installed engine pre-heaters and portable engine pre-heaters.

Heated hangars are, of course, the best all around answer. Of course, the problem with heated hangars is their cost and, in some cases, availability.

So, that leaves us with built-in pre-heaters and portable pre-heaters.

Installed Engine Pre-heaters

The key to proper engine pre-heating is to heat the entire engine; not just the oil sump. Remember, we're not just trying to make the oil flow on start-up. We're also trying to ensure that everything keeps the proper clearances so that we don't get metal scuffing in the bearings and cylinders. In fact, heating just the oil sump for long periods of time can do more damage than good because this can lead to condensation issues and internal corrosion. Heating the entire engine via both sump and cylinder heating elements AND using an engine blanket is the best possible solution for aircraft kept outside all winter. In fact, it is perfectly fine to leave this type of preheating system plugged in all winter long. The engine will remain dry, at a stable temperature, and ready to fly all winter long.

Personal experience has made me a fan of the Tanis pre-heating systems, which heat the entire engine and offer a variety of different heating elements to suit your particular situation. The Tanis systems include an oil sump heating element as well as individual heating probes that mount in the CHT hole on each cylinder. If you use a CHT probe already, you can switch to a gasket-type CHT probe, use their heated induction tube bolts or elements that bolt to the cylinder at the rocker cover.

Portable Engine Pre-heaters

If you don't have electricity available at your tiedown, or if you want to avoid the cost of an installed system, you have two options: portable electric preheating and forced hot-air preheating.

In the early days of preheating, some owners would place a shop light in the cowl to keep the engine warm. This is only effective in very mild conditions and doesn't work at all without an engine blanket.

Forced hot-air preheating is the most common form of rapid engine heating used by FBOs and flight schools. These systems usually require both electricity and propane to create a powerful flow of hot air into the engine compartment. The air is either blown into the bottom of the cowl at the exhaust opening, or through the front of the cowl at the air inlets. The only problem with forced hot-air preheating is that you usually have to pay for it and you may also have to wait in line on a cold day. You can build a system yourself using a small, propane blower heater and adding ducting and an engine blanket to get the air into (and out of) your engine compartment. Keep in mind that most of these systems do require electricity to power the fan.

Whichever method of preheating you choose, remember that the best way to keep your aircraft in top condition is to fly it often. So, as you are shoveling the plane out this winter, just repeat this winter flying mantra: "Smoother air, better climb, greater visibility, no thunderstorms." And don't forget the hot chocolate!

[1] – "Heating Aircraft Reciprocating Engines", Peter G. Tanis, copyright 1999 Society of Automotive Engineers, Inc.