Preheating for Winter Starts

A warm engine will start easier and last longer

Fast engine preheaters, like the Flame Engineering model shown, can help you be on your wintry way in just minutes while helping extend the life of your engine.

by RAY MARTIN / AOPA 634209

Let's say you go out to the airport one morning, when the temperature is down around 20°F, and start cranking the starter on your aircraft. The engine roars to life after a couple of sluggish turns of the prop, you scream a silent hurrah and everything's hunky-dory. Right? Not necessarily.

In fact, there's every reason to believe that you've just done your engine a grave injustice. And the degree of damage can range from taking hours off the life of your engine to destroying it completely. If the latter occurs in flight, a whole lot more stands to be lost.

Regardless of the season, by far the greatest percentage of wear and tear on an engine comes during its first few seconds of operation. This is because most of the engine oil that reduces friction in the cylinders and other working engine parts has drained down into the oil sump where it likely has congealed and is of no immediate help.

On a given standard temperature day, it takes something like 10 seconds for the oil to work up into the engine. Only then will the oil pressure gauge let you know in the cockpit that your engine oil is more than likely on the job. If there's no such positive reading in the first few seconds, most operating manuals instruct you to shut down the engine and determine the problem.

Now, if the temperature is freezing, chances are that sump oil is going to have about the consistency of cold syrup. A start-up with the oil in that condition may not be possible at all. Should the engine turn over and start, though, there will almost certainly be friction wear, since there will be little, if any, lubricating taking place.

Beyond excessive friction wear, which could mean a major overhaul in 600 hours for an engine that should operate close to 2,000 hours, it's also possible to destroy your engine because of outright oil starvation. More than one unlucky pilot has gotten his engine to start, only to have the oil pump set a mini vortex to whirling as it tries to pick up the gooey crude. This vortex, in turn, can give erroneous "in the green" oil readings. The pilot takes off, thinking everything is okay, only to have the engine suddenly and unceremoniously fail.

When the oil temperature falls below what is called its "pour point"—the temperature at which it will no longer pour—it's advisable to warm up that Mesozoic glop before trying an engine start. Continental, a major general aviation engine maker, recommends preheating the engine when it is subjected to temperatures of 10°F or below. Another, Lycoming, tells us to start thinking about preheat at freezing (32°F), since the chill factor of winter winds can often result in actual temperatures lower than those recorded.

There are a number of ways to put heat in your corner on wintry mornings and get that valuable crude working for you before the starter turns over. First, though, how do you know when it's too cold for normal start-up procedures? And then, how do you determine which of several preheat methods—unorthodox as some are—to employ?

First a little primer about your oil. Like automotive oils—which for several reasons should never be used in aircraft engines—aviation oils are designated in terms of their viscosity, or more simply stated, their consistency. Viscosity refers to the property of oil and other liquids that causes them to resist flowing easily because of the friction of their molecules.

The SAE (Society of Automotive Engineers) rating used to designate the viscosity of automobile oils is doubled when referring to grades of aviation oil. For example, SAE 50 equates to aviation grade 100; SAE 40 to grade 80, and so on. There's only one curious exception: SAE 30 equates to aviation grade 65.

A designation like SAE 40, incidentally, is arrived at by counting the number of seconds it takes for a certain quantity of oil at a standard temperature to run out of a test container with a given-sized hole. SAE 40, for example, takes 40 seconds to run out of the container, while SAE 50 takes longer because it's more viscous, or thicker. Somewhere through the years, people started referring to these SAE numbers as "weights," although weight, per se, isn't the subject at all.

General aviation oils are of two basic types: straight mineral oils, and ashless dispersant (AD) oils, which are seeing more and more use because of their success in keeping new and remanufactured engines clean. Of the two, the straight mineral oils reach their pour points at generally higher temperatures. Also, the acceptable temperature spread for using these oils, based on their viscosity, tends to be smaller than for the AD oils.

AD oils, on the other hand, have multiple viscosity, thus offering a

wider range of acceptable operating temperatures. For example, if a manufacturer recommends the use of two grades of straight mineral oil for aircraft operation in a given temperature spread, it is possible that, again in terms of viscosity, a single AD oil could replace them both.

It's really not as big a decision as it all sounds. Always refer to the owner's operating manual for the aircraft you're flying to determine which aviation oil types and grades to use during given temperature spreads. Many manufacturers require new engine break-in using, say, a straight mineral oil and then have you switch to an AD oil.

Now, knowing the grade of oil for the temperature range in which you'll be operating, it might be interesting to learn that AD oils from grade 65 to grade 100 have a pour point of minus 15°F. Straight mineral oils, conversely, have varying pour points for different temperatures: Grade 100 will pour down to 10°F; grade 80 to 5°F, and grade 65 to 0°F.

It is when oil reaches its pour point, and no longer acts like a liquid, that pilots really have a problem on their hands. That's why preheat is recommended at a temperature *above* the pour points of most oils. If you can catch your oil before it takes the temperature plunge and becomes a thick goo, then you've got another mark in your probability-of-start column.

Being aware of when to expect problems created by congealed oil is, of course, only half the battle. But knowing what to expect can result in your learning to handle potential oil problems long before you're ready to go.

So, how do we help keep the oil from congealing? If possible, the ideal way to help make certain the engine is not too cold for a normal cold weather start is to not let it get so frigid in the first place. Heated hangars offer the best protection, because not only does the engine remain warm, but so do the battery, instruments, and avionics. More on these later.

But how many of us can afford to rent a heated hangar? Well, the next best thing would be an unheated hangar or any kind of shelter which stops chilling air from blowing through the cowling. Even a good old horse blanket draped over the cowling will help stop much of the blowing cold air.

If your unheated shelter has an electrical outlet, there are various other ways to help keep the engine compartment warm. But before we get into a discussion of these different types of preheating, it should be emphasized that whatever the method of applying heat, it needs to be done right. Otherwise you might waste your time or, worse, do the engine compartment damage by not understanding the pitfalls of a hasty, haphazard technique.

If you heat just the upper portion of the engine, you're just asking for trouble. Hot air flowing over the cylinders and oil temperature thermocouples may lead you into believing that the engine is warm enough for operation. In actuality, though, oil in the sump, lines, cooler, and oil filter may not have had enough heat applied to completely de-congeal it.

For this reason, hot air should be directed to the lower part of the engine—the oil sump and external oil lines—as well as the cylinders, air intake and oil cooler. In fact, your preheat exercise should begin with hot, dry air being directed in the area of the oil sump and filter.

After heat has been applied there for, say, 15 to 30 minutes, Continental suggests turning the prop by hand about six or eight times every 5 to 10 minutes or so. This will further help loosen the oil and begin working it through the engine.

For safety's sake, however, be certain that you've prepared for turning the prop by hand. The aircraft should be tied down, the brakes set and the master switch off. Make sure the magnetos are off and grounded to prevent accidental firing of the engine. As you turn the prop, however, imagine that it could fire at any moment; that way, there'll be no surprises. Watch your footing, too, especially if the ground is icy or wet.

As you continue warming the lower part of the engine, occasionally feel the top of the engine. When it begins to feel warm there, you can start applying heat directly to the upper portion of the engine for a few minutes. This will heat up the cylinders and fuel lines to promote better vaporization of the fuel for starting. The airplane should be started immediately after you're finished preheating. If you've done a thorough job of preheating, you can use normal engine start-up procedures.

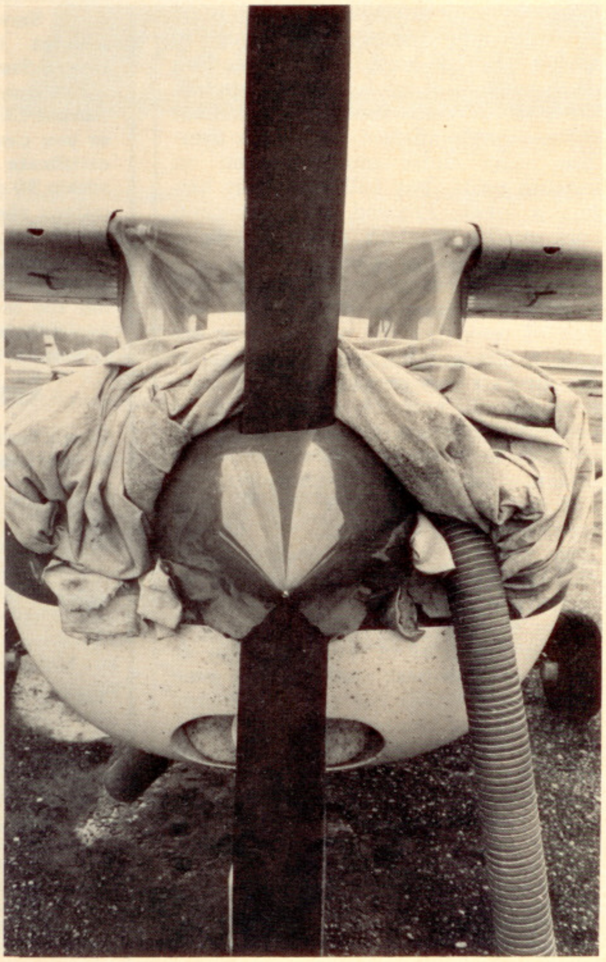
Now for preheating methods. Generally, they're of two varieties: Slow-heat, designed to warm an engine overnight or in a few hours; and quick-heat, which, depending on the unit, can have you on your way in a half hour or so.

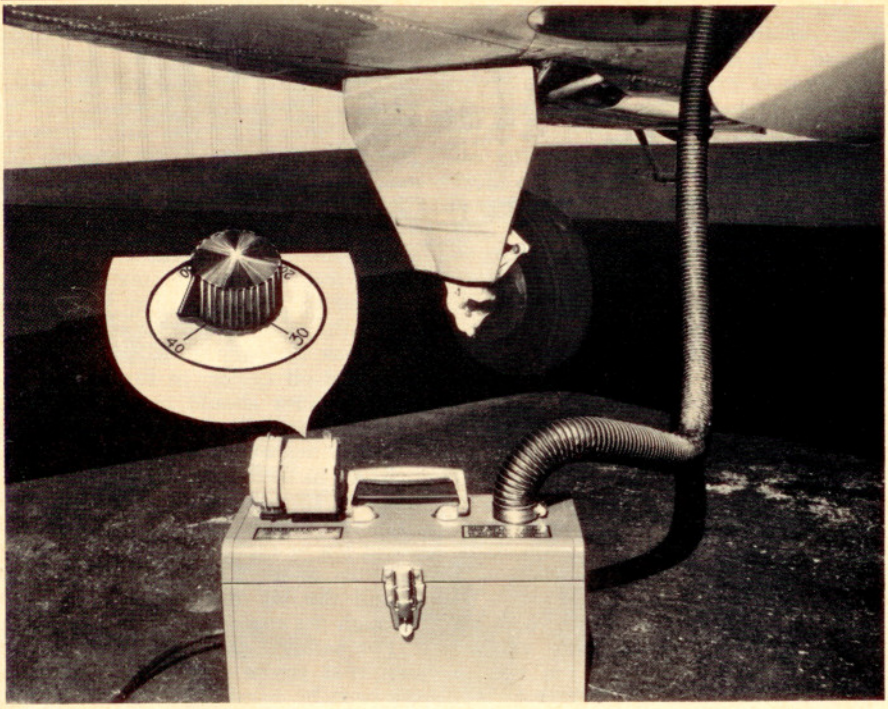
One slow-heat method often used, but not recommended because of potential hazards, is to dangle a light bulb in the engine compartment. Should the wind blow the bulb against an object or moisture in whatever form falls on it while it's hot, there is a good chance of breakage. And, when that occurs, any combustible materials in the engine compartment could ignite from the resulting spark or heat. Also, remember that you're probably warming only the top part of the engine.

For pilots who will continue to slow-heat their engines in this manner, we can at least recommend that you use a coated bulb, such as General Elec-

A commonly employed engine preheat method involves passing hot vehicle exhaust gases from the tailpipe into the engine cowling by way of flexible ducting.

The cowling at right has been wrapped around the ducting to prevent it from melting the fiberglass and to prevent warm air from circulating back out of the engine compartment. Photos by Roger Rozelle





Engine preheaters also come in slow-heat models, such as this one from Manairco, Inc., designed for in-hangar use only. Such slow-heaters can warm engine compartments overnight or in a few hours to several degrees above hangar temperature.

tric's "Tuff-Skin" rubber-coated lamps. These bulbs are resistant to breakage and are said to hold up under freezing rain conditions, as evidenced by their use on used car lots in all kinds of weather. They can be purchased for less than $2 and come in wattage sizes from 25 to 200.

There are various other slow-heat units available. One that has been field-tested in Alaska can, in just a few hours, warm the crankcase and oil to 40°F, while the outside temperature is minus 30°F, just about as cold as it's ever going to get in most parts of the country. The electric TAS-100 engine preheat system is permanently installed in your engine, supplying heat by conduction to the engine from heating elements installed in the cylinder heads and oil intake screen.

The 250-watt unit available for several light single-engine aircraft operates off a 110-volt power supply and costs under $200. The unit, which doesn't require an FAA supplemental type certificate as a major modification, reportedly can be installed in about an hour. The system was designed by Peter Tanis (AOPA 640193), of Tanis Aircraft Services, Glenwood, Minn.

Another slow-heat unit, for in-hangar use only, is available from Manairco, Inc., Mansfield, Ohio. The electric EH-10 engine warmer is thermostat-controlled and can, Manairco claims, raise the engine compartment temperature 40 to 50 degrees above the hangar temperature. The unit retails for $135 and is said to cost about 19 cents a day to operate.

If your aircraft must sit outside where electric lines are not readily available to power slow-heaters and there's no practical way to shield the engine from devastating winds, you can give your engine a helping hand by manually rotating the prop to loosen the congealed oil. Depending on how cold it is—and let's assume it's not yet cold enough for preheat to be strongly advised—this little exercise won't cause much friction on moving parts, but will give your battery a break. Proceed with a normal cold weather start-up, carefully following the operating manual.

Only in extremely cold climates will a pilot ever have to consider the option of removing the oil from the engine to prevent it from congealing. If the aircraft was permitted to get cold, it would still probably be necessary to preheat the engine before pouring the oil back in, since the oil would almost instantly lose its liquid consistency in a frigid engine. There's also a good chance that removing oil from the engine will result in its getting dirty, and dirt is a harmful abrasive in an aircraft engine.

Not everyone, of course, is going to find it practical or even possible to use these slow-heat methods. But even a pilot who finds his airplane nearly frozen to the ground can have hope. If, that is, he's given himself a little extra time to do a thorough job of preheating the engine compartment by using fast-heaters.

But first, a caution. Any fast preheat involving an open flame is bad news. Still, some pilots will build fires in firepots, or "salamanders," for the

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purpose of warming their aircraft engines. We've even heard tell of a fellow who hangs a charcoal bucket on his prop. Remember, though, that you're playing with fire, and your insurance company may not want to talk about your loss.

A fast-heat method commonly seen, but again not recommended, is to attach a flexible hose, like laundry-dryer-vent ducting, to the exhaust pipe of an automobile and run the other end into the engine compartment. It may do the trick, but you'll eventually end up with an engine full of filthy, combustible deposits, unwanted moisture that won't do the engine any good and, possibly, the chance of deadly carbon monoxide gases seeping into the cabin. If your car is a 1975 model or newer, it will have a catalytic converter exhaust system which spews forth, among other goodies, sulphuric acid.

Another word of caution here: Be careful where you actually place the ducting, since it can get so hot that fiberglass engine cowlings and plastic engine components can melt. A blanket tucked into the air intakes in the front cowling to prevent the hot air from escaping can also be laid loosely around the ducting to prevent it from doing any damage.

A safer method, again utilizing your automobile, is to jerry-rig the same kind of flexible hoses from the forced air heater ducts on the auto dashboard or floorboard into the aircraft engine compartment. This method directs dry, warm air into the engine compartment at up to 120°F. A commercial preheating device is available for $228 from Dale and Assoc., Inc., Beloit, Wis.

By far the best way to make use of preheat in the field is to use one of several commercial fast-heat devices on the market. One such unit, tested by the Aviation Maintenance Foundation, is the Red Dragon heater manufacturered by Flame Engineering, La Crosse, Kan. AMF found the heater to offer "more than adequate preheat capabilities at a reasonable cost."

The heater is capable of producing up to 49,000 BTU's of heat per hour, using either liquid or vapor LP gas. An electric igniter, which works off a 12-volt dc power source or 110-volt electric outlet, allows the heater to be ignited at the push of a button. The basic unit weighs 14 pounds, occupies less than a cubic foot and costs $206.

Some pilots have tried heated dipsticks, but most engine manufacturers and many mechanics shy away from them. There are several hazards, one of which is that some Lycoming engines have plastic oil filler tubes that could melt if such a dipstick were to come in contact with them. Also, the dipstick might heat only the top of the crankcase, while the sump oil remains congealed.

Perhaps the best time to consider

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using a heated dipstick is just after you've made a flight and want to help keep the engine warm for a short time until you're ready to roll again.

Preheat doesn't simply de-congeal the oil. Your battery also will benefit from preheating if it's located forward of the firewall where pilots usually apply preheat.

At freezing temperatures, the standard lead-acid battery puts out about half the normal cranking time than it does at 70°F. In warm weather, a 12-volt starter may require in the neighborhood of 350 amps initially, whereas the same battery in freezing weather would be required to supply 700 amps.

Isn't that how it goes? Just when you need the ol' battery the most, it's at about half capacity, or less. This means that you probably have something like less than a minute of cranking time. Most probably, seconds.

Your battery actually begins to wear out from the day you buy it. Its total capacity of amperage delivery is relative to the amount of plate area the battery has. When you crank the starter, you are discharging the battery, which then must be recharged by the alternator or generator. Each time the battery is discharged, a little of the plate material deteriorates and falls into the sediment chambers below. In this way, capacity is gradually reduced.

Make sure your battery cells are filled to prevent freezing of the battery. Also, battery terminals, cables and hold-down should be kept clean so that current doesn't flow between terminals and slowly discharge the battery. Mechanics recommend, too, smearing a thin coat of petroleum jelly on the battery posts and cable clamps to retard corrosion.

There's yet another factor concerning your success in getting a start in cold weather by using preheat. Getting an aircraft engine to fire means, in the first place, getting the fuel to vaporize—that is, converting it from a liquid into a gaseous state. In normally aspirated engines, this is achieved by use of a carburetor, which converts the liquid fuel into a vapor mist, which then vaporizes into a gas. A warm engine will aid vaporization.

The volatility of fuel—its ability to readily vaporize at a relatively low temperature—is another matter. Unlike automotive fuels that can be custom-blended for quicker or slower vaporization under differing seasonal conditions, the volatility of aviation fuel remains constant. This has to be, because aircraft move through vastly differing temperatures on, say, a long cross-country flight.

If the fuel is too volatile for the temperature, vaporization may take place in the fuel lines and interrupt the fuel flow from the tanks to the carburetor. This situation, called a vapor lock, will stop the engine.

The fact that automotive fuel is so much more volatile than avgas is one of the chief reasons why it shouldn't be used as substitute for avgas. The Experimental Aircraft Assn., though, is currently conducting experiments using automotive fuel in some aircraft in hopes of working out a safe avgas substitute.

Engine priming is another factor in cold weather starts. All carbureted aircraft must be primed in below-freezing weather since some of the fuel condenses in the intake manifolds between the carburetor and the cylinder. The fuel/air ratio is then weak on the fuel side and priming with raw fuel compensates for the deficiency.

But don't pump the throttle or primer willy-nilly, hoping you'll get the right amount of raw fuel in the cylinders to assist starting. If you overprime your engine, you wash the oily film off the cylinder walls and harmful scoring of the walls can result. Overpriming also can result in reduced compression and, consequently, cause hard starting. Aircraft engine fires, too, have more than once been the result of overpriming. Follow operating manual instructions.

Prolonged idling should also be avoided, since insufficient heat is produced to keep the plugs from fouling. Engines that fire and then quit under these circumstances are frequently found to have iced-over plugs.

This situation results from sufficient combustion to produce some moisture condensation in the cylinders, but not enough to heat them up. A little bit of water condenses on the spark-plug electrodes, freezes to ice, and shorts them out. If no large heat source is available, the only remedy is to take out the plugs and heat them up in a low oven, by sitting on them awhile or by whatever method you choose to clear the moisture.

So far as your avionics go, leave all the radios off until the engine has been running a few minutes. With the battery already weak, too low an rpm during an engine warm-up may mean that the generator or alternator may not produce enough current to recharge the battery and supply the electrical load of radios and other accessories. Low voltage, as well as overvoltage, conditions can damage electronic equipment.

Nobody ever said that applying preheat is an easy exercise to undertake. It can be time-consuming, inconvenient, difficult to arrange and downright exasperating. Many pilots won't bother, and take their chances without it. But intelligent application of heat when your engine needs it can be a lifesaver—of your engine, battery, avionics and, possibly, yourself.

There's no doubt but that Old Man Winter can give you a rough go of it. But with a little forethought and preparation, there's no reason in the world why you—and your airplane—can't snuggle up for a cozy, warm relationship as the winter winds howl. □