Operating in Cold Weather

TIPS

A note that came in the mail from a *Flyer* reader included a suggestion that went something like this, “How about an article dealing more extensively with the cold-start problem?” This suggestion was a good one as it provided an opportunity to share information about a variety of cold-weather considerations to help get the engine started and to keep it operating during cold-weather conditions.

Although the suggestion made in the first paragraph was aimed at helping with cold-weather starting, this article has been expanded to include tips and information on preflight, starting, in-flight safety and engine operational considerations. Keep in mind that this material deals with normal cold-weather operation experienced at temperatures to -25° F, and not the extremely low temperatures that may be found in Arctic regions. Operation in those regions may require more specialized knowledge.

Let’s start with the general health of the engine. When attempting a start under adverse conditions, it is imperative that the engine be well maintained and in excellent operating condition. Spark plugs and magneto points should be properly gapped and ready to function effectively. In addition to the ignition system, the proper functioning of other systems such as induction, priming, exhaust and carburetor heat can have an effect on the starting and operation of the engine.

Regular maintenance should include having the heating system checked for leaks. This cold-weather tip is worthy of a separate little sentence all its own – remember, you can’t smell carbon monoxide.

In cold weather, preheat is another factor that must be considered prior to starting the engine. There are specific guidelines in Lycoming service instructions which establish when preheat should be used, but how much, or the method of preheat is generally left to the good judgment of the pilot or maintenance person doing the preheating. Use of the heated dip stick is not recommended by Lycoming, although most other methods are considered to be satisfactory. For most Lycoming models, preheat should be applied anytime temperatures are at 10° F or lower. The exception to this rule is the 76 series models that include the O-320-H, and the O/LO-360-E. These engines should be preheated when temperatures are below 20° F. It is recommended that

these guidelines be followed even when multi-viscosity oil is being used. In addition to hard starting, failure to preheat the entire engine and oil supply system as recommended may result in minor amounts of abnormal wear to internal engine parts, and eventually to reduced engine performance and shortened TBO time.

Water is one of the most likely contaminants of aviation gasoline. The engine will not run on water, and although we may get away with small amounts of moisture in the fuel during warm weather, flight into freezing temperatures makes any amount of moisture in the fuel system very critical. Even a tiny bubble of moisture may freeze in the fuel line and totally cut off the flow of fuel. Two steps should be taken to avoid this problem. First, avoid water contamination if possible. Keep fuel tanks full to prevent condensation, and be sure fuel caps do not allow leakage if the aircraft is parked outside in rain or snow. Second, look for contamination before every flight by religiously draining fuel tanks and sumps.

If flight is planned for bad weather, the preflight inspection should include observation of the relief opening in the engine breather tube so that any freezing of moisture at the end of the breather will not result in a loss of engine oil.

Once on board the aircraft, check the fuel-selector valve for freedom of movement. It may be frozen fast (this has happened), and you'd better find out while still on the ground.

Most of the time, we think of starting any engine as a very simple process. Just engauge the starter, and listen for the engine to start purring. Unfortunately, when the weather turns cold, it is not always that simple. When dealing with a reciprocating aircraft engine, it may be essential to get a start on the first try in order to avoid icing over the spark plugs and making an immediate start impossible. In order to achieve a start on the first try, there are a number of factors to be considered. Those factors will be discussed in the following paragraphs.

Although it might be good procedure to use an external power source for starting during very cold weather, most of us expect our battery to do the job. We should remember that the battery is handicapped by cold weather. Particularly when a single-viscosity oil is being used, the colder the temperature, the more cranking energy required. Combine this with reduced battery output at lower temperatures, and it can be a serious handicap.

While on the subject of batteries, remember that freezing temperatures provide a perfect opportunity to destroy an aircraft battery. The battery with a full charge survives nicely, but one that is discharged will freeze. Once this happens, the problem can only be remedied by replacing the battery, so it is very worthwhile to take preventive measures. Should the battery be run down

during an attempt to start, do not leave it; get it charged immediately. And finally, be absolutely certain that the master switch is always OFF while the aircraft is parked between flights. If left on, the battery will discharge and freeze. These rather minor mistakes can be quite expensive.

Oil is another factor to be considered in the cold-weather starting process. All oils are affected by temperature and tend to thicken as the temperature drops. The engine may be reluctant to turn over when the oil is stiff; a summer weight oil is not suitable in cold weather. It is also the condition which brings out the primary advantage of multiviscosity oils and of preheating. Because multiviscosity oils are thinner (lower viscosity), they allow the engine to be turned over more easily. The easier and quicker oil flow also promotes faster lubrication of internal engine parts when the engine does start. Since the proper oil viscosity is so important in all aspects of engine starting and operation, the recommendations of oil grade vs. temperature range shown in Lycoming Service Instruction No. 1014 should be followed.

Probably the most important factor in starting an engine is achieving a fuel/air mixture that is satisfactory for combustion. Since the engine usually starts very easily, many pilots are unaware of or ignore the change of starting procedure needed to successfully start under varying temperature conditions. In warm weather, the air is less dense, and therefore must be mixed with a lesser amount of fuel than in cold weather. In addition to this, in warm weather, the fuel will vaporize readily and make starting easier. Simply stated, as temperatures go down it becomes more and more important that we have a plan for priming that will achieve the correct fuel/air mixture.

When priming a carbureted engine, the pilot's plan must consider the temperature, the number of cylinders which have priming lines installed, and the number of strokes of the primer needed to produce the correct fuel/air mixture. The primer lines are ordered or installed by the airframe manufacturer and not all aircraft are configured the same. Some aircraft have actually been produced with only one cylinder being primed, and these engines are extremely hard to start in cold weather. The number of cylinders that are primed must be considered since the total fuel delivered by the primer will be divided and sent to these cylinders. As the air becomes colder and denser, the amount of prime used must be increased, but the number of strokes to be used should be planned as a result of some trial and error experimentation for each aircraft a pilot flies. When the correct number of primer strokes for each temperature range has been established, the engine will usually start very quickly. We may find that an engine starts easily when one stroke of the primer is used in the 60˚ range, two strokes in the 50˚ range, three strokes in the 40˚ range, etc. This is an example of the trial and error we might use to establish the number of primer strokes to use under any particular temperature condition.

While discussing the priming of an engine, there have been situations where primer lines

become clogged. This makes engine starting difficult and negates any trial and error experimentation that may have been done. When maintenance is done on an aircraft before the start of winter, it may be wise to have those primer lines checked to ensure that fuel will flow through them.

The amount of fuel needed to achieve the correct fuel/air mixture for starting a fuel-injected engine is controlled by timing rather than number of primer strokes. With the electric fuel pump on, moving the mixture control to the rich position allows fuel to flow to the cylinders. For coldweather starting, it may be necessary to keep the mixture control in rich somewhat longer than in warm weather.

The fuel part of the fuel/air mixture may be the part we have the most control over during the engine start, but keep in mind that the amount of throttle opening does have an effect on the air that is pumped through the engine. Just as we compensate for cold/dense air by adding more fuel for start, it may also be appropriate to reduce the air part of the mixture when the temperature is very cold. For example, if the throttle is normally set open one-half inch for warm weather starting, it may be helpful to reduce this to one-quarter inch in cold weather. Again, it will require some experimentation to determine what is needed to achieve the correct fuel/air mixture for any particular aircraft at any temperature range.

When an engine does not start easily, it can be frustrating. Of course, this can occur at any time of the year, and it is very tempting to just keep grinding away with the starter in an attempt to get it going. Should this happen to you, RELAX. Take care of that starter, or it may fail. The general rule for starters is that they should only be operated for short periods, and then allowed to cool. If engine start has not occurred after three 10-second periods of operation with a pause between each, a five-minute cooling off period is required. Without this time limit for operation and an adequate cooling off period, the starter will overheat and is likely to be damaged or to fail completely.

The previous paragraphs have addressed several issues that relate to the cold-weather preflight and the cold-weather start. There are other cold-weather items that should be considered in the operation of the engine.

Assuming the engine has kicked off, check for an indication of oil pressure. Learn the characteristics relative to response of oil pressure indications of your aircraft/engine combination. On most single-engine aircraft, an almost immediate response is noted. On twin-engine aircraft, the response may be much slower. On some twins, the oil pressure may go up, and during warm-up, may drop again for a short period of time, then again rise to normal. All cases mentioned

may be normal, but the important thing is to know what to expect from your aircraft/engine combination.

After start, do not idle engine below 1000 RPM. It's not good practice to idle engines below 1000 RPM at any time. This is particularly true during cold weather to prevent lead fouling of spark plugs. (Exception – Piper Pressurized Navajo)

Now, here's a tip for novice pilots. When setting up for cruise configuration, be precise, read your instruments and remember what you read. Example: If you decide on 22" of manifold pressure, set it right on 22. If the RPM is to be 2350, make it 2350. Select an altitude. Trim the aircraft to hold that selected altitude. Note airspeed. Now, if anything changes, barring turbulent air, it has to be a change in power. Perhaps it is carburetor or induction-air icing. Suppose you picked up a bit of carburetor ice, and the engine suffers a slight power loss. There will be a slight drop in manifold pressure, a loss in airspeed, and the aircraft will want to lose altitude, and if you hold altitude, you'll find back pressure on the wheel is required. Therefore, even though you didn't discover the power loss through instrument scanning, you'll get a warning through the "heavy" wheel or stick.

During flight in very low temperatures, exercise constant speed props about every 30 minutes to help prevent congealing of oil in the prop dome.

Should one engine of a twin, for any reason, indicate the prop must be feathered, don't tarry too long with reduced power in very cold weather. At reduced power, the oil may congeal making feathering an impossibility.

A tip for every pilot: don't run one set of fuel tanks nearly dry before switching tanks. Switch with plenty of fuel remaining in the tanks first used. This is "money in the bank," should you find the selector valve frozen.

Although carburetor ice is not necessarily a wintertime phenomena, a check of carburetor heat should be made during the engine run-up. Generally speaking, we can say that carburetor heat should never be used for takeoff, but there is one exception. This exception occurs when operating in temperatures so cold that application of carburetor heat produces a rise in RPM. Most pilots will never find themselves in circumstances which require use of carburetor heat for takeoff and climb; those who fly carbureted engines will almost certainly have occasion to use carburetor heat during cruise or let down. Use of the full-hot or full-cold position is recommended. An intermediate setting should only be selected if the aircraft is equipped with a carburetor air temperature (CAT) gauge.

Engine operating temperature is another item that is not usually given enough consideration in cold weather. We usually are very cautious about high oil temperature which we know is detrimental to good engine health, while a low oil temperature is easier to accept. The desired oil temperature range for Lycoming engines is from 165˚ to 220˚ F. If the aircraft has a winterization kit, it should be installed when operating in outside air temperatures (OAT) that are below the 40˚ to 45˚ F range. If no winterization kit is supplied and the engine is not equipped with a thermostatic bypass valve, it may be necessary to improvise a means of blocking off a portion of the airflow to the oil cooler. Keeping the oil temperature above the minimum recommended temperature is a factor in engine longevity. Low operating temperatures do not vaporize the moisture that collects in the oil as the engine breathes damp air for normal combustion. When minimum recommended oil temperatures are not maintained, oil should be changed more frequently than the normally recommended 50-hour change cycle. This is necessary in order to eliminate the moisture that collects and contaminates the oil.

And finally, power-off letdowns should be avoided. This is especially applicable to cold-weather operations when shock-cooling of the cylinder heads is likely. It is recommended that cylinder head temperature change not exceed 50˚ F per minute. Plan ahead, reduce power gradually and maintain some power throughout the descent. Also keep the fuel/air mixture leaned out during the descent. If an exhaust gas temperature gauge is installed with a normally aspirated engine, keep it peaked to ensure the greatest possible engine heat for the power setting selected; for a turbocharged installation, lean to peak during descent unless otherwise specified in the Pilot's Operating Handbook, or under conditions where the limiting turbine inlet temperature would be exceeded.

Exposure to snow, frost and cold weather while flying requires the consideration of many factors, both airframe and engine related. This discussion deals with issues relating to the engine. While there may be other issues, those items which are asked about most frequently have been discussed. Safer flying and longer engine life could result from careful consideration of the material addressed.

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