



PISTON ENGINE ICING

FOR GENERAL AVIATION PILOT

SAFETY PROMOTION LEAFLET





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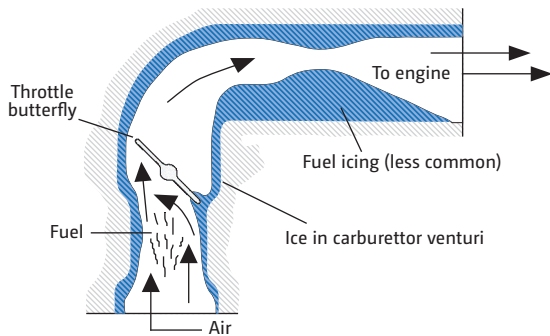
1. INTRODUCTION

- a. This leaflet is intended to assist pilots of carburetted piston engined aircraft operating below 10,000 feet. Although it refers mainly to aeroplane operations, much also applies to other piston-engined aircraft such as helicopters.
- b. Induction system icing in piston engines is commonly referred to as 'carburettor icing'. Although that is only one form, such icing can occur at any time, **even on warm days, particularly humid ones**. If correct action is not taken, the engine may stop, especially at low power settings during descent, approach or during helicopter autorotation.
- c. Engine induction system icing has been assessed as a likely contributory factor in several aircraft accidents. Unfortunately the evidence rapidly disappears.
- d. Certain aircraft and engine combinations are more prone to icing than others.
- e. The aircraft Flight Manual or Pilot's Operating Handbook is the primary source of information for individual aircraft. The advice in this leaflet should only be followed where it does not contradict that Flight Manual.

2. TYPES OF ICING

There are three main types of induction system icing:

BUILD-UP OF ICING IN INDUCTION SYSTEM



a. Carburettor Icing

Carburettor (carb) icing is the most common, first to appear, and the most serious. There is a sudden temperature drop when the fuel vaporises in the air, and another drop when pressure reduces as the mixture passes through the carburettor venturi and throttle valve.

If the temperature drop cools the air below its dew point, water condenses. If the mixture temperature falls below freezing, the condensed water will form ice on the surfaces of the carburettor.

This ice gradually blocks the venturi, changing the fuel/ air ratio and causing a progressive, smooth loss of power.

b. Fuel Icing

Water held in suspension in the fuel may precipitate and freeze in the induction piping, especially in the elbows formed by bends.

c. Impact Ice

In snow, sleet, or sub-zero cloud, ice may build up on air intakes, filters, alternate air valves etc. It may also form in rain if either the rain or the aircraft is below zero°C.

Impact icing can affect fuel injection systems as well as carburettors, and is the main hazard for turbocharged engines. It is unlikely to be removed by selecting carburettor hot air, although selecting hot air, or alternate air in a fuel injected engine, bypasses the normal intake and should allow the engine to run normally, although possibly at reduced power.

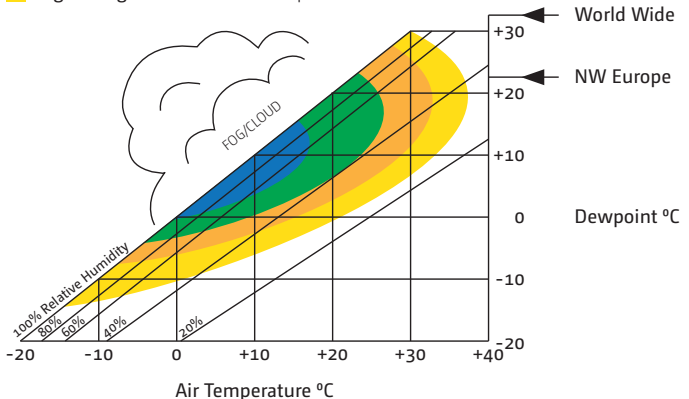
3. ENGINE FACTORS

- a. Carburettor icing is more likely when MOGAS is used, because of its volatility and water content.
- b. Reduced power settings make engines more prone to icing. Induction temperatures are lower, and the partly closed butterfly can be restricted more easily by the ice build-up. This is a particular problem if the engine is de-rated, as in many piston-engined helicopters and some aeroplanes.
- c. A rough carburettor venturi surface is likely to increase carburettor icing severity.
- d. Water-cooled engine bodies tend to cool less quickly when power is reduced, which reduces the severity of carburettor icing. If coolant is directed around the carburettor body, the venturi temperature may remain above freezing.

4. ATMOSPHERIC CONDITIONS

- a. Carb icing is not restricted to cold weather. It will occur on warm days if humidity is high, especially at low power settings. Flight tests have produced serious icing at descent power when the air temperature was above 25°C, even with relative humidity as low as 30%. At cruise power, icing occurred at 20°C when relative humidity was 60% or more. (Cold, clear winter days are less of a hazard than humid summer days because cold air holds less moisture than warm air.) In areas of Europe where high humidity is common,

- Serious icing - any power
- Moderate icing - cruise power
Serious icing - descend power
- Serious icing - descend power
- Light icing - cruise or descend power



pilots must be constantly on the alert for carb icing and take corrective action before the situation becomes irretrievable. If the engine fails due to carb icing, it may not re-start (even if it does, the delay could be critical).

- b. Carb icing can occur in clear air without any visual warning. The icing risk may be higher in cloud, but the pilot is less likely to be surprised.
- c. Aviation weather forecasts do not normally include specific warnings of induction system icing. Pilots must therefore use knowledge and experience. Dewpoint readings close to the temperature mean the relative humidity is high. However, the humidity reported at an aerodrome may bear little relation to the humidity at flying altitudes. When dewpoint information is not available, assume high humidity particularly when:
 - in cloud and fog; these are water droplets and the relative humidity should be assumed to be 100%.
 - in clear air where cloud or fog may have just dispersed, or just below the top of a haze layer;
 - just below cloud base or between cloud layers (the greatest liquid water content is at cloud tops);

- in precipitation, especially if persistent;
- if the surface and low level visibility is poor, especially in early morning and late evening, and particularly near a large area of water;
- when the ground is wet (even with dew) and the wind is light.

However, the lack of such indications does not mean low humidity.

- d. The chart shows the wide range of ambient conditions in which carb icing is most likely. It shows the much greater risk of serious icing with descent power.

5. RECOGNITION

- a. Paragraphs 5, 6 and 7 should help you to avoid icing, but you must refer to the relevant sections of the Pilot's Operating Handbook or Flight Manual for specific procedures related to the particular airframe/ engine combinations. **These may vary for a different model of the same aircraft type.**
- b. If the aircraft has a fixed pitch propeller, the most likely indications of carb icing are a slight drop in rpm and performance (airspeed and/or altitude). The pilot may automatically open the throttle slightly to compensate for a smooth and gradual loss of rpm, and not notice the performance loss. As ice increases, rough running, vibration, further loss of performance and ultimately the engine will stop. Pilots should routinely compare the **rpm gauge** with the ASI and altimeter.
- c. With a constant speed propeller, or in a helicopter, a reduction in rpm would only occur after a large power loss. The onset of icing is more insidious, but the performance reduction will be shown as a **drop in manifold pressure.**
- d. In steady level flight, an exhaust gas temperature gauge, if fitted, may show a decrease in temperature before any significant decrease in engine and aircraft performance.

6. GENERAL PRACTICES

- a. Some engines have electric heaters which directly increase the temperature of the carburettor body, encouraging ice to clear. A similar effect may be obtained in a liquid cooled engine by directing the flow of coolant.
- b. On other air-cooled engines, carb icing is normally cleared by the pilot selecting an alternative air source which supplies air which has been heated in an exhaust heat exchanger to melt the ice obstruction. This source by-passes the normal intake filter.
- c. Fuel injected engines generally have an alternate air intake within the engine cowling. This alternate air does not normally pass through a heat exchanger but may be warmed by engine heat.
- d. Whenever you apply carb hot air, always select **full** heat; partial hot air should only be used if specifically recommended in the Flight Manual or Pilot's Operating Handbook.
- e. Select carburettor body heat whenever carb icing is likely. Hot air should be selected:
 - as a routine, check at regular intervals to prevent ice build up,

- whenever a drop in rpm or manifold pressure, or rough engine running, is experienced,
- when carb icing conditions are suspected, and
- when flying within the high probability ranges indicated in the chart.

However, while hot air is selected, it reduces engine power (as does body heating to a much lesser extent). This power loss may be critical in certain flight phases, for example during a go-around.

- In cruise flight, apply carburettor heat at regular intervals to prevent ice forming. Apply it for at the very least 15 seconds (but considerably more in certain aircraft) to prevent the loss of engine power, or to restore it.
- If the hot air has dispersed ice which has caused a loss of power, re- selecting cold air should produce a higher rpm or manifold pressure than the reading before selection of hot air. This will show that ice has been forming, but does not prove that all the ice has melted! Carry out further checks until there is no resultant increase. Then monitor the engine instruments, and carry out the routine checks more often. If there is no carb icing, there should be no increase in rpm or manifold pressure above the figure noted before selecting hot air.

- h. If you select hot air when ice is present, the situation may at first appear worse, because the engine will run roughly as the ice melts and passes through it. **Do not be tempted to return to cold air.** Allow the hot air time to clear the ice. **This time may be over 15 seconds**, and will feel like a very long time!
- i. Unless it is necessary, avoid using hot air continuously at high power settings. However, carburettor heat should be applied early enough before descent to warm the intake, and should remain fully applied during that descent, as the engine is more susceptible to carb icing at low power settings.

7. PILOT PROCEDURES

a. Maintenance

Periodically check the operation and condition of the carb heating system. Pay particular attention to seals which may have deteriorated and allow cold air to mix with the hot air.

b. Start Up

Start up with the carb hot air control in the **COLD** position.

c. Taxiing

Although carb body heat should normally be selected ON, the use of carb hot air is not generally recommended while taxiing: the air is usually unfiltered when HOT is selected. However, ice may build up at the low taxiing power settings, and if not removed may cause engine failure after take-off. If carburettor heat is needed – USE IT.

d. Ground Power Checks

Select carburettor hot air fully ON for at least 15 seconds. Check that power decreases noticeably when hot air is selected (typically 75– 100 rpm or 3– 5” of manifold pressure) and that power is regained (but to a level no higher than before) when cold air is re-selected. If the power returns to a higher value, ice was present and further checks should be carried out until the ice has cleared.

h. Cruise



Avoid clouds as much as possible. Monitor engine instruments for changes which could indicate icing. If a body heat system is fitted, check it is ON whenever carb icing is possible. If a hot air system is fitted, make a carb heat check (see below) at least every 10 minutes, or more often if icing is likely. If ice has reduced your power, **use full heat** and note the warning of para 6 (h). It may take 15 seconds or more to clear the ice and the engine will continue to run roughly as ice melts and passes through the engine. If the icing is so severe that the engine has died, keep the hot air selected; the heat remaining in the rapidly cooling exhaust may be effective (opening the throttle fully and closing the mixture control for a while may also help).

j. Descent and Approach

Carb icing is much more likely at reduced power, so select carb heat **before** power is reduced for the descent, and especially for a practice forced landing or a helicopter autorotation. (A full carb heat check just before selecting hot air for the descent is advisable). Maintain FULL heat during long periods of flight with reduced power settings. At intervals of about 500 ft, or more frequently if conditions require, increase power to cruise setting to warm the engine and provide sufficient heat to melt any ice.

k. Downwind

The pre-landing check should include the cruise carburettor heat check at 6(i) above. You may wish to select and leave the heat on, however speed or altitude will reduce unless you have added some power beforehand.

I. Base Leg and Final Approach



Unless otherwise stated in the Pilot's Operating Handbook or Flight Manual, select HOT well before you reduce power, and keep it on till touchdown. On some engine installations, to ensure better engine response and to permit a rapid go-around, it may be recommended to return the carb hot air to COLD at about 200/ 300 ft on final approach.

m. Go-around or Touch and Go

Ensure the carb hot air is COLD when, or immediately after, applying power for a go-around.

n. After Landing

Return hot air to the COLD setting before taxiing, if not already there.

8. SUMMARY

- » Icing forms stealthily.
- » Some aircraft/engine combinations are more susceptible than others.
- » Icing may occur in warm humid conditions and at any time of the year.
- » MOGAS makes carb icing more likely.
- » Low power settings, such as in a descent or in the circuit, are more likely to produce carb icing.
- » Warming up the engine before take-off improves the effectiveness of any carb body heat.
- » Use full carb hot air frequently when flying in conditions where carb icing is likely. Remember the RPM gauge is the primary indication for a fixed pitch propeller; manifold pressure for variable pitch.
- » Treat the carb hot air as an ON/OFF control – either full hot or full cold.
- » It takes time for the heat to work and the engine may run roughly while ice is clearing.
- » Using appropriate procedures can PREVENT THIS PROBLEM.



FINALLY

If the carb heat system fails in flight:

- Avoid likely carb icing conditions.
- Maintain high throttle settings – full throttle if possible.
- Weaken the mixture slightly.
- Land as soon as reasonably possible.

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Jürgen Mies, Clement Audard, David Cockburn and Jan Fridrich

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EUROPEAN GENERAL AVIATION SAFETY TEAM (EGAST)

Component of ESSI

EUROPEAN AVIATION SAFETY AGENCY (EASA)

Safety analysis and Research Department
Ottoplatz 1, 50679 Köln, Germany

Mail egast@easa.europa.eu

Web <http://easa.europa.eu/essi/egast/>

