

Pilot's Handbook of Aeronautical Knowledge



U.S. Department
of Transportation
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Administration



The reduced air pressure, as well as the vaporization of fuel, contributes to the temperature decrease in the carburetor. Ice generally forms in the vicinity of the throttle valve and in the venturi throat. This restricts the flow of the fuel/air mixture and reduces power. If enough ice builds up, the engine may cease to operate.

Carburetor ice is most likely to occur when temperatures are below 70°F (21°C) and the relative humidity is above 80 percent. However, due to the sudden cooling that takes place in the carburetor, icing can occur even with temperatures as high as 100°F (38°C) and humidity as low as 50 percent. This temperature drop can be as much as 60 to 70°F. Therefore, at an outside air temperature of 100°F, a temperature drop of 70°F results in an air temperature in the carburetor of 30°F. [Figure 5-9]

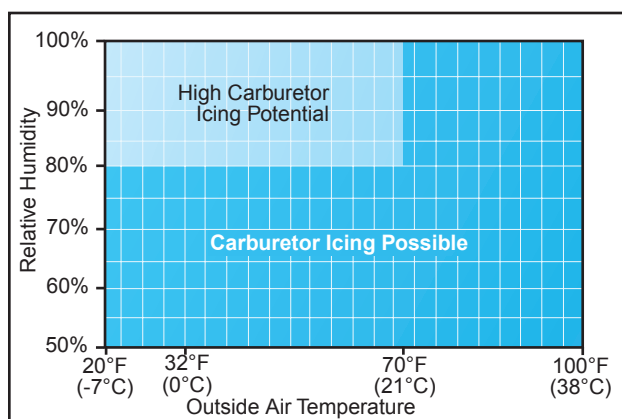


Figure 5-9. Although carburetor ice is most likely to form when the temperature and humidity are in ranges indicated by this chart, carburetor ice is possible under conditions not depicted.

The first indication of carburetor icing in an airplane with a fixed-pitch propeller is a decrease in engine r.p.m., which may be followed by engine roughness. In an airplane with a constant-speed propeller, carburetor icing usually is indicated by a decrease in manifold pressure, but no reduction in r.p.m. Propeller pitch is automatically adjusted to compensate for loss of power. Thus, a constant r.p.m. is maintained. Although carburetor ice can occur during any phase of flight, it is particularly dangerous when using reduced power during a descent. Under certain conditions, carburetor ice could build unnoticed until you try to add power. To combat the effects of carburetor ice, engines with float-type carburetors employ a carburetor heat system.

CARBURETOR HEAT

Carburetor heat is an anti-icing system that preheats the air before it reaches the carburetor. Carburetor heat is intended to keep the fuel/air mixture above the freezing temperature to prevent the formation of carburetor ice. Carburetor heat can be used to melt ice that has already formed in the carburetor provided that the accumulation is not too great. The

emphasis, however, is on using carburetor heat as a preventative measure.

The carburetor heat should be checked during the engine runup. When using carburetor heat, follow the manufacturer's recommendations.

When conditions are conducive to carburetor icing during flight, periodic checks should be made to detect its presence. If detected, full carburetor heat should be applied immediately, and it should be left in the ON position until you are certain that all the ice has been removed. If ice is present, applying partial heat or leaving heat on for an insufficient time might aggravate the situation. In extreme cases of carburetor icing, even after the ice has been removed, full carburetor heat should be used to prevent further ice formation. A carburetor temperature gauge, if installed, is very useful in determining when to use carburetor heat.

Whenever the throttle is closed during flight, the engine cools rapidly and vaporization of the fuel is less complete than if the engine is warm. Also, in this condition, the engine is more susceptible to carburetor icing. Therefore, if you suspect carburetor icing conditions and anticipate closed-throttle operation, adjust the carburetor heat to the full ON position before closing the throttle, and leave it on during the closed-throttle operation. The heat will aid in vaporizing the fuel, and help prevent the formation of carburetor ice. Periodically, open the throttle smoothly for a few seconds to keep the engine warm, otherwise the carburetor heater may not provide enough heat to prevent icing.

The use of carburetor heat causes a decrease in engine power, sometimes up to 15 percent, because the heated air is less dense than the outside air that had been entering the engine. This enriches the mixture. When ice is present in an airplane with a fixed-pitch propeller and carburetor heat is being used, there is a decrease in r.p.m., followed by a gradual increase in r.p.m. as the ice melts. The engine also should run more smoothly after the ice has been removed. If ice is not present, the r.p.m. will decrease, then remain constant. When carburetor heat is used on an airplane with a constant-speed propeller, and ice is present, a decrease in the manifold pressure will be noticed, followed by a gradual increase. If carburetor icing is not present, the gradual increase in manifold pressure will not be apparent until the carburetor heat is turned off.

It is imperative that a pilot recognizes carburetor ice when it forms during flight. In addition, a loss of power, altitude, and/or airspeed will occur. These symptoms may sometimes be accompanied by vibration or engine roughness. Once a power loss is noticed, immediate action should be taken to eliminate

ice already formed in the carburetor, and to prevent further ice formation. This is accomplished by applying full carburetor heat, which will cause a further reduction in power, and possibly engine roughness as melted ice goes through the engine. These symptoms may last from 30 seconds to several minutes, depending on the severity of the icing. During this period, the pilot must resist the temptation to decrease the carburetor heat usage. Carburetor heat must remain in the full-hot position until normal power returns.

Since the use of carburetor heat tends to reduce the output of the engine and also to increase the operating temperature, carburetor heat should not be used when full power is required (as during takeoff) or during normal engine operation, except to check for the presence or to remove carburetor ice.

CARBURETOR AIR TEMPERATURE GAUGE

Some airplanes are equipped with a carburetor air temperature gauge, which is useful in detecting potential icing conditions. Usually, the face of the gauge is calibrated in degrees Celsius ($^{\circ}\text{C}$), with a yellow arc indicating the carburetor air temperatures where icing may occur. This yellow arc typically ranges between -15°C and $+5^{\circ}\text{C}$ (5°F and 41°F). If the air temperature and moisture content of the air are such that carburetor icing is improbable, the engine can be operated with the indicator in the yellow range with no adverse effects. However, if the atmospheric conditions are conducive to carburetor icing, the indicator must be kept outside the yellow arc by application of carburetor heat.

Certain carburetor air temperature gauges have a red radial, which indicates the maximum permissible carburetor inlet air temperature recommended by the engine manufacturer; also, a green arc may be included to indicate the normal operating range.

OUTSIDE AIR TEMPERATURE GAUGE

Most airplanes also are equipped with an outside air temperature (OAT) gauge calibrated in both degrees Celsius and Fahrenheit. It provides the outside or ambient air temperature for calculating true airspeed, and also is useful in detecting potential icing conditions.

FUEL INJECTION SYSTEMS

In a fuel injection system, the fuel is injected either directly into the cylinders, or just ahead of the intake valve. A fuel injection system is considered to be less susceptible to icing than the carburetor system. Impact icing on the air intake, however, is a possibility in either system. Impact icing occurs when ice forms on the exterior of the airplane, and blocks openings such as the air intake for the injection system.

The air intake for the fuel injection system is similar to that used in the carburetor system, with an alternate air source located within the engine cowling. This source is used if the external air source is obstructed. The alternate air source is usually operated automatically, with a backup manual system that can be used if the automatic feature malfunctions.

A fuel injection system usually incorporates these basic components—an engine-driven fuel pump, a fuel/air control unit, fuel manifold (fuel distributor), discharge nozzles, an auxiliary fuel pump, and fuel pressure/flow indicators. [Figure 5-10]

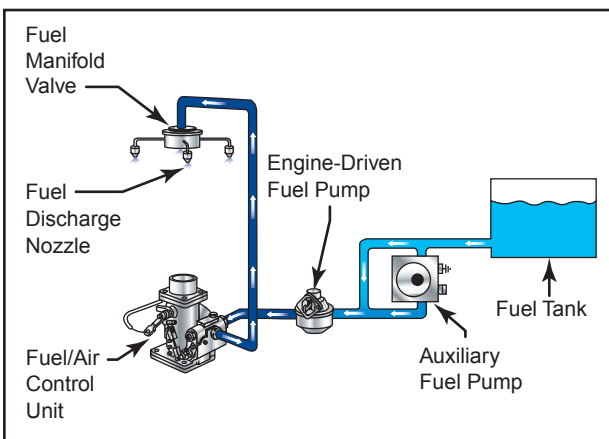


Figure 5-10. Fuel injection system.

The auxiliary fuel pump provides fuel under pressure to the fuel/air control unit for engine starting and/or emergency use. After starting, the engine-driven fuel pump provides fuel under pressure from the fuel tank to the fuel/air control unit. This control unit, which essentially replaces the carburetor, meters fuel based on the mixture control setting, and sends it to the fuel manifold valve at a rate controlled by the throttle. After reaching the fuel manifold valve, the fuel is distributed to the individual fuel discharge nozzles. The discharge nozzles, which are located in each cylinder head, inject the fuel/air mixture directly into each cylinder intake port.

Some of the advantages of fuel injection are:

- Reduction in evaporative icing.
- Better fuel flow.
- Faster throttle response.
- Precise control of mixture.
- Better fuel distribution.
- Easier cold weather starts.