

Combating Carb Ice

When we think about the dangers of icing, the first thing that comes to mind is usually airframe ice—but carburetor ice, its insidious and often forgotten cousin, can be just as deadly, having contributed to more than 200 accidents and 13 fatalities in less than a decade. As with most risks in flying, though, the keys to combating carb ice are simple: understanding the danger, recognizing the symptoms, and taking prompt action.



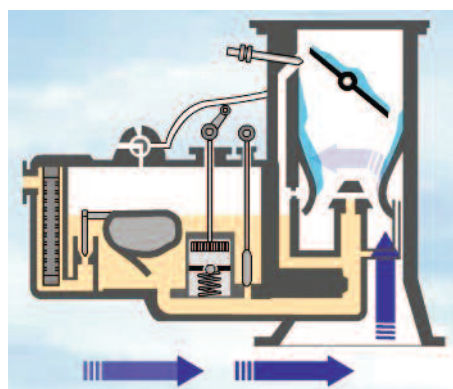
The Problem

At a basic level, carburetor ice is a product of three inter-related factors:

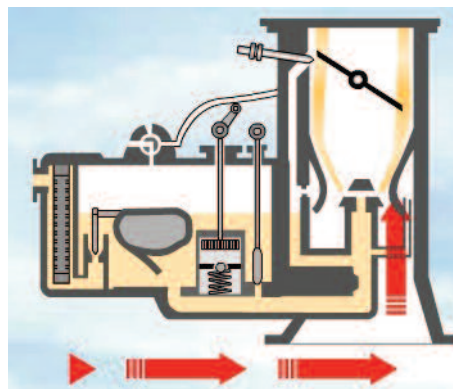
- 1) Air temperature
- 2) Relative humidity
- 3) Carburetor design

The carburetor's job is simple: It blends fuel and air together in the correct ratio before sending it to the engine in the proper quantity. To do this, it draws air through a narrow, curved passageway called a venturi. Much like air flowing over the curved upper surface of a wing, air moving through a venturi speeds up as its pressure decreases. When fuel is injected into this fast, low-pressure airstream, it vaporizes, and the resulting mixture of atomized fuel and air flows to the cylinders.

But there's a problem. The vaporization of the fuel and the pressure change induced by the venturi together cause the air passing through the carburetor to cool rapidly—in some cases, by as much as 70 degrees Fahrenheit. If this lowers the air temperature past the freezing point, and if the incoming air is moist (i.e., humid) enough, ice can begin to form on the inner surfaces of the carburetor. As the ice accumulates, it restricts the flow of the fuel/air mixture to the engine, leading to a reduction in power as the engine is essentially "starved." If the situation isn't remedied, the engine may lose power entirely.



*Rapid cooling:
Carb icing*



*Carb heat
activated: Melting
carb ice*

The “Danger Zone”

Although you may have heard that only a specific set of conditions lead to carb ice, the truth is that most of us fly inside the “danger zone” on a regular basis.

Carb ice can form over a wide range of outside air temperatures and relative humidities. While the word “icing” typically brings to mind blustery winds and frigid conditions, carb ice can form when outside temperatures are as high as 100 degrees Fahrenheit with 50 percent relative humidity. At the other end of the spectrum, the risk doesn’t go away until the humidity falls below roughly 25 percent and/or the outside air temperature drops well below freezing.

In other words, carb ice can form at pretty much **any time, in any phase of flight.**



On a mid-June morning in western North Carolina, a flight instructor and the owner of a Cessna 182 ventured out for a training flight. A weather station 13 nautical miles to the southeast reported visual meteorological conditions (VMC) with a temperature of 80°F and a dew point of 45°F. The relative humidity was 28 percent. Shortly after departure the engine lost power, and the pilot attempted to stretch a power-off glide to a nearby grass strip. The airplane impacted tree branches before it stalled, and subsequently impacted the runway environment. The NTSB determined one of the probable causes of the accident to be carb icing that led to a loss of engine power.

Flight Conditions

Of course, just because carb ice *can* form over a wide range of temperatures doesn’t mean that it always *will*. In reality, certain situations are considerably riskier than others. Icing is most likely to occur—and to be severe—when temperatures fall roughly between 50 and 70 degrees F and the relative humidity is greater than 60 percent.

Likewise, certain flight conditions carry greater risks. As engine power is reduced, airflow is restricted and ambient heat is lessened. This makes low-power operations like descents considerably more prone to carb ice. Certain aircraft types are also more prone to ice than others. For example, the pilot’s operating handbook (POH) for many single-engine Cessnas calls for the pilot to apply carb heat whenever power is reduced below the green arc on the tachometer. Most Piper singles, however, aren’t subject to this restriction, even when equipped with similar engines and carburetors. Why? Because differences in airflow and engine heat due to cowling design and other factors affect the formation of carb ice. Still, **no aircraft with a carbureted engine is immune to carb ice.**

A flight instructor and student were in a Cessna 172 working on routine traffic patterns at their home airport. The student was performing the before-landing checklist when he became distracted and forgot to turn on the carb heat for descent. The instructor noted the error, but allowed the student to proceed without carb heat. After landing, the instructor took the controls and initiated a climb-out, at which point the engine noise changed and the airplane stopped accelerating. Only when the instructor applied full carb heat did the engine roar back to life.

Diminishing Returns

Now that we know when carb ice can occur, it’s important to know and recognize the indications that point to *existing* carb ice.

The classic symptoms of carb ice are **reduced power** and a **rough-running engine**. In aircraft with fixed pitch propellers, the first indication is typically a small decrease in engine rpm. Although the engine may still be running smoothly at this point, as ice continues to accumulate the reduction in rpm will continue and the engine will begin to run rough. If the icing conditions are severe enough, and the pilot takes no remedial action, the engine will eventually fail.

The same applies to airplanes with constant-speed propellers, with one important exception: The manifold pressure gauge, rather than the tachometer, should be the focal point for early indications of carb ice. Precise power settings, a consistent instrument scan, and attentive ears can all alert you to the subtle changes in engine performance. You may also want to consider installing a carburetor air temperature gauge to assist in recognizing conditions conducive to icing.

The Remedy

Although carb ice can form any time, under any number of different circumstances, the remedy is always the same: carb heat. Consult your airplane's POH or flight manual for specifics on using carb heat, but remember this general rule: **It's far better to use full carb heat too soon, than to wait until it's too late.**

When carb heat is applied, unfiltered air that's been heated by the exhaust manifold is routed into the carburetor, melting any ice that may have formed. As the ice melts, water is intermixed with the air/fuel mixture, causing the engine to run rough. Be patient: This increased engine roughness may last several seconds to a few minutes as the ice melts. Once the ice is clear and the engine is operating normally, be sure to turn off the carb heat to restore full power.

At the first indication of carb ice:

- 1) Full carb heat ON (partial application could cause additional carb icing)
- 2) Leave carb heat ON until normal engine power returns
- 3) Monitor engine power and re-apply carb heat as necessary

Remember, when carb heat is applied, the warmer air will inherently cause a reduction in engine power.

Preventive Steps

During your preflight run-up, carb heat should be applied fully to ensure that it's functioning properly. As warm air is routed to the carburetor, you should see a small reduction in rpm on aircraft with fixed-pitch propellers, and a slight reduction in manifold pressure for those with constant-speed props. If no ice is present, the rpm or manifold pressure will remain constant. If ice exists, however, there will be a gradual increase in engine power as the water from the melting ice is purged from the system.

If much time elapses between the carb heat check and takeoff (especially in conditions conducive to carb icing), you may want to consider performing another check just prior to departure. Carb heat should not be left on while taxiing, however, because the unfiltered air could allow foreign debris to be introduced to the engine.

Preceding reduced power or closed throttle operations, full carb heat should be applied (unless the aircraft's POH states otherwise). The warm air will aid in the prevention of carb ice—as will an occasional application of throttle to clear the engine. Again, it's best to err on the side of caution when it comes to carb ice.

In extreme cases of in-flight ice, it may be necessary to continue operating with full carb heat to prevent further ice formation. In this case the mixture should be leaned to compensate for the warmer, less dense intake air, which can cause an excessively rich fuel/air mixture.

Wherever your flying takes you, always be aware of the "danger zone" of carb icing. Preflight prevention, alertness to early indications and a prompt, correct response to carb ice will keep you safely in the air—and out of the NTSB accident database.



Copyright 2009, AOPA Air Safety Foundation

██████████, MD 21701 • ██████████ • www.asf.org • ██████████

Publisher: Bruce Landsberg • Writers: Elizabeth Partie, Brian D. Peterson

SB09-10/09