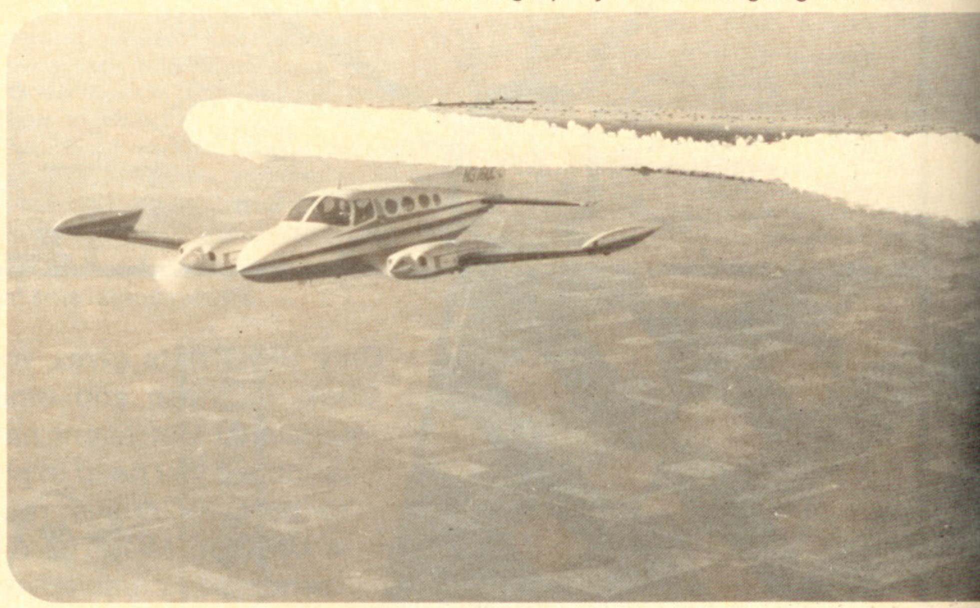
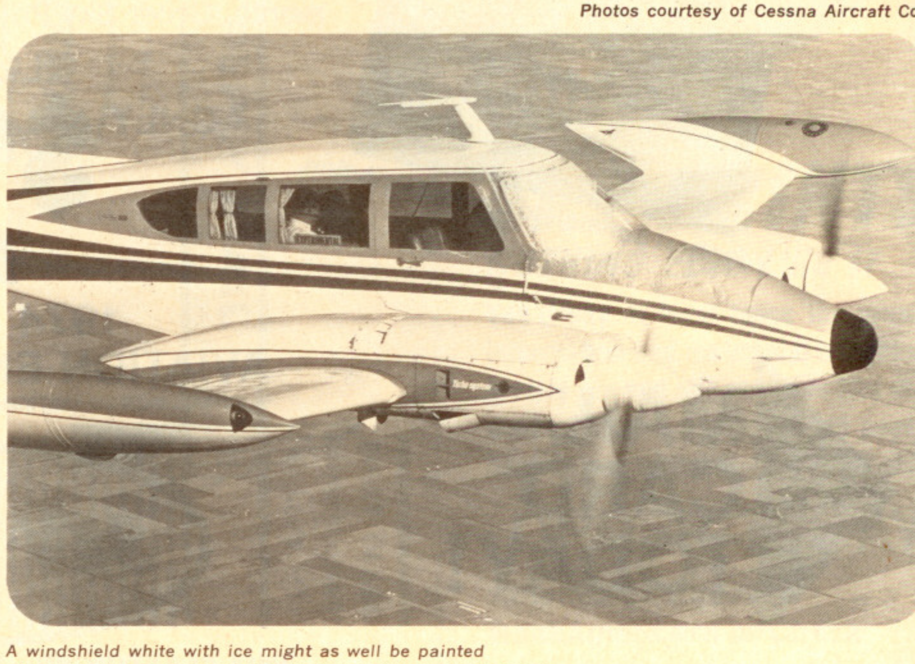
ICE:

A thick layer of rime ice on this horizontal stabilizer is disrupting its lifting capacity while increasing drag on the airfoil.



Photos courtesy of Cessna Aircraft Co.



A windshield white with ice might as well be painted with India ink. Either would make for an interesting landing.

by WILLIAM GARVEY / AOPA 480899

■■ If anything good can be said about aircraft icing, it is that icing can turn callous men to prayer. Beyond that, aircraft icing is without any redeeming value whatsoever.

Ice on an airplane increases its drag, decreases its lift, increases its weight, decreases its thrust, increases its stalling speed, causes it to vibrate violently, binds its flight controls, locks its wheels and brakes, ruins radio navigation and communication, invalidates some instrument readings, obstructs cockpit vision, and can cause engines to fail over cloud-blanketed mountains.

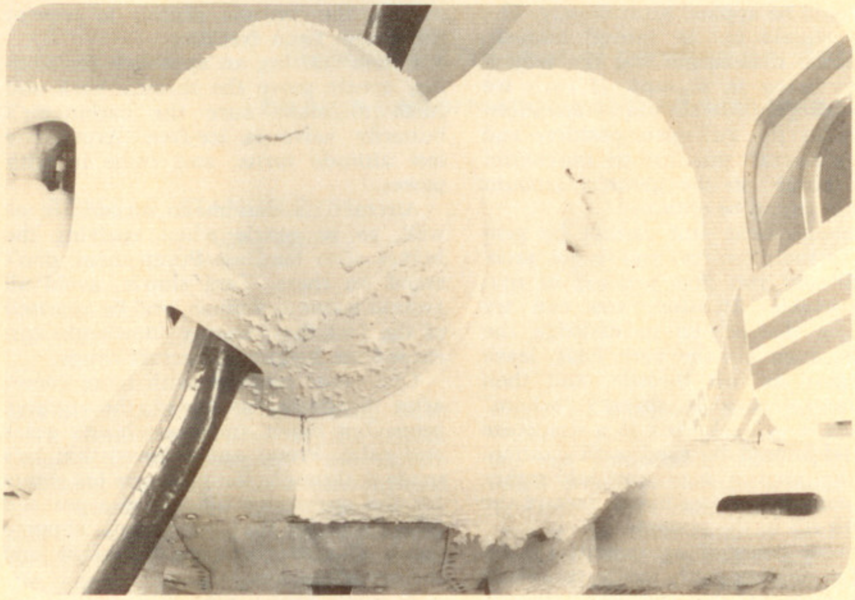
Ice can accumulate on the ground or in the air. It will paint wings and windshields thickly and quickly while the pilot sits, sometimes helplessly, nearby, or will choke an engine to silence with little forewarning. And while this frigid treachery is a year-round problem since carbureter ice can form in hot summer air, the icing hazard is most prevalent during the winter months. Now is a good time to explore the menace of aircraft icing, what it can do, and what you can do about it.

Generally, three conditions must exist before ice will form on any aircraft. First, there must be visible moisture in the air. This moisture can be in the form of clouds, fog, mist, wet snow, or rain. Secondly, the outside air temperature must be freezing. And lastly, the temperature of the aircraft must be freezing as well.

When ice does begin to form, it will likely be either clear or rime ice. Both forms result from the cold airframe passing through areas of supercooled

What it does, and what to do about it

◄ Photos from Icing tests conducted by Cessna Aircraft Co. point out some of the obvious dangers of mixing airplanes with frozen water.



Ice can block the air intake system and actually suffocate the engine.

drops of water which freeze after contacting the aircraft skin. Rime is distinguished by the brittle, crystalline surface and milky coloring. It forms relatively slowly and oftentimes takes on weird shapes as it sticks into the airstream.

Rime ice is more common than clear, but clear ice is more dangerous. As its name indicates, it coats the aircraft's surfaces with a sheetlike glaze. It forms very quickly and then hangs tough.

A third form of icing is frost, which usually occurs on aircraft parked outside overnight, just as with cars. Frost forms when moist air comes in contact with a freezing aircraft. Some pilots have made the mistake of discounting frost as a threat and have tried taking off with it still on the plane—the old "the wind will blow it off" theory. Frost can cause a 5- to 10-percent increase in stalling speed, thus bringing the stall and takeoff speed dangerously close. It should go without saying that all traces of frost, ice or snow should be removed from any aircraft before any flight.

Ice can form on any exposed surface of an aircraft, including wings, stabilizer, tail, props, wheel fairings, antennas, pitot tube, and windshield, and can also form within the air induction system. In each case, special problems result.

When ice accumulates on the wings and empennage, the flow of air is disrupted, thus increasing drag and decreasing lift. A half inch of ice on some airfoils can reduce lift by 50 percent. Consequently, the stalling speed is increased, and so too is fuel consumption, since more power is required to overcome the increased drag. Ice here can also restrict the free movement of flight controls.

Propellers are delicately balanced airfoils. Should ice begin forming on the blades, this balance will likely be lost and severe vibrations will result. The shaking will add stress on the props and engine mounts. Once a prop starts shedding its ice, the hard chunks flash rearward and can strike the wings, tail or fuselage. This pounding may not damage the aircraft, but it's not the most encouraging sound when a cockpit is hushed and thick with concern.

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Water splashed onto the wheels during taxiing and takeoff through puddles or slush can freeze as the aircraft flies through freezing air. Those wheels may not roll when the airplane returns to earth, so avoid ground water as best you can.

Ice can form rapidly on radio antennas, impairing voice communications and navigational signals when they're needed most, since ice is generally an IFR malady. Should the ice grow thick enough, radio signals can be lost completely as the thin antennas snap in half.

When ice forms within the pitot tube or blocks the static port, the turn indicator, vertical speed indicator, and other instruments that depend on the system will give incorrect readings—yet another powerful consideration when you're solid IFR.

Windshields blocked solid with ice might be a minor encumbrance en route IFR, but try landing while looking through an ice cube.

Induction icing, commonly referred to as "carburetor ice," involves internal, rather than structural, buildup of ice and can block air passage into reciprocating engines. It can form in temperatures of 80°F and above, since the reduced air pressure within the venturi tube, combined with the evaporation of gasoline, can cool the air to subfreezing temperatures. This blockage can cause the engine to fail.

While the problems of icing are serious ones, they are not new. Through the years, several devices have been conceived which work to get rid of the ice that has formed or to prevent it from forming at all.

Foremost among this deicing gear are pneumatic boots. These rubber-coated "boots" are located on the leading edges of the wings and stabilizer, two of the most common locations for ice buildup. Compressed air can be cycled through ducts in the boots, causing them to swell and crack the ice that has formed on top of them. The loosened ice is then carried off in the airstream.

Props can be kept ice free if they are coated with anti-icing fluids prior to entry into an icing area. If an aircraft is not equipped with such anti-icing gear, a change in engine speed or prop pitch can sometimes loosen the ice.

Another prop anti-icing method employed by some pilots is to rub the blades' leading edges with a smooth-surfaced steel rod during preflight. After rubbing down the prop's rough edges, coat the blades with a silicone compound. Supposedly, the 10-minute treatment is good for about two weeks.

More modern anti-icing gear depends primarily on heat. Today there are electrically heated wings, windshields, props and pitot tubes. While heat can be used to melt ice that has already formed, it's best to turn on the switches before entering an ice area and thus prevent the ice from forming at all. Such anti- and deicing equipment is expensive to buy and maintain, but it provides the only safe means of flying in ice.

Heat also keeps the carburetor free from ice. But even though carb heat systems are virtually universal for reciprocating engine aircraft, ice in the induction system still takes its toll. A study by the National Transportation Safety Board revealed that carburetor ice was a factor in 360 general aviation accidents over a five-year period. Obviously, a question exists as to when carb heat should be used.

First off, when the air temperature is 80°F or below and the relative humidity is above 50 percent, use carb heat immediately before takeoff—but not during takeoff, since carb heat reduces power appreciably. Carb heat should be applied intermittently during flight when conditions are favorable for induction ice formation.

Carb heat should also be applied throughout closed-throttle operations, such as during descent. However, during an extended descent, give the engine a shot of gas periodically so enough heat can be generated to prevent icing.

In the event of power loss, carb icing should immediately be considered as the possible culprit. Aircraft with fixed-pitch props would show a power loss through a loss in rpm. Planes with constant-speed props would show this loss only through a decrease in manifold pressure.

Should carb ice be suspected, full heat should be applied immediately. The throttle should not be moved immediately, since that might kill the engine if heavy icing is present. If carb ice persists, the throttle should be advanced gingerly to the full-open position and then the aircraft put into its maximum rate of climb, so the greatest amount of carb heat can be obtained.

If enough heat still cannot be generated to melt the ice, you've got problems. Should you find yourself in that uncomfortable situation, you can try backfiring the engine to dislodge the ice. Just turn off the carb heat, leave the engine at full throttle, and then lean the mixture. A throaty "wham" should follow. Backfiring is a desperate trick and should be used with caution, since the engine may quit altogether and it may be impossible to restart the mill with ice in the system.

The best piece of equipment yet devised for dealing with ice is the brain of the man at the controls. Aircraft icing can be minimized through various mechanical and electrical devices, but there is no such thing as an ice-proof airplane. So when ice is encountered, the pilot's brain should immediately be employed to determine the best course of action to get out of there.

For the man in a plane that's booted and heated, the best out may be to hold straight and level for a little while longer. But for the pilot flying an aircraft unequipped for icing, there are three options available to him. One should be exercised quickly.

First, and best of all, he can make a 180-degree turn and land at the nearest airport. Second, he can descend to a lower, hopefully warmer altitude. And third, he can ascend, an option that takes some explaining.

Climbing can bring the aircraft to warmer air if a temperature inversion exists, that is, if a warm air layer is superimposed on lower layers of cold air. Even if this temperature inversion is not present, by climbing the pilot might reach an altitude where the air is too cold to contain sufficient moisture for the formation of any more ice. The only way to stop ice from accumulating on an unequipped aircraft is to find warmer or much colder air.

When the icing is encountered in flight, don't panic, but do take steps immediately to get out of there. Tell ATC your problem and get the latest weather for above and below you. Find out where the nearest airport is.

If you climb, remember that ice increases an aircraft's stalling speed. And whether climbing or descending, try to do it at as rapid a rate, but at as slow a speed, as practical since ice formation increases with airspeed.

If a turn is required, keep it easy. Steep turns and ice don't mix well. And when flying through an ice zone, keep moving the controls slightly to prevent the hinges from freezing.

Before starting an approach for landing, gently move the throttle back and forth to make sure the carburetor's butterfly valve is ice-free. Avoid any low altitude turns, and come in with power.

Aircraft ice can mean airport ice as well, so be gentle when applying the brakes after landing. Pump them; don't stand on them. Taxi slowly, avoid all ground water and slush, and be apprised of the fact that runway snowbanks can exceed the height of aircraft wings.

One other problem with icing comes after the flight has ended, the engine's been shut down and everything's quiet and calm. Proud and relieved that he's made it through, the pilot sets his sights for the operations office coffee pot and fails to notice that one, small, slippery patch of glaze between his plane and the ops office door.

Nothing good can be said about icing, and should the pilot set foot on that slippery patch, nothing good will be said. □