Blowing Hot Air

A Hybrid System for Aircraft Deicing

Through the Pollution Prevention Equipment Program (PPEP), the Naval Air Systems Command (NAVAIR) Lakehurst and Naval Air Station (NAS) Brunswick evaluated one of the latest technologies for aircraft deicing—hot air.

Deicing: Why and How

Aircraft deicing is a critical operation—whether the weather is just cold enough to form frost on an aircraft surface or the weather conditions include actual snow or other freezing precipitation. The deicing season typically lasts from November through March, with Navy locations in the coldest climates extending beyond this timeframe.

As little as 1/64 of an inch of ice on crucial areas of an aircraft wing can significantly affect takeoff lift and aerodynamic characteristics, according to aviation industry sources. Aside from the risk of reduced lift, there are other, more serious safety of flight implications. When the ice is thicker it can cause damage when it dislodges, usually during taxiing or take off, and "hits" another section of the aircraft. The most severe damage occurs when the engine ingests this ice, resulting in immediate engine failure and loss of thrust. Ice can also freeze up and jam control surfaces such as flaps and rudders.

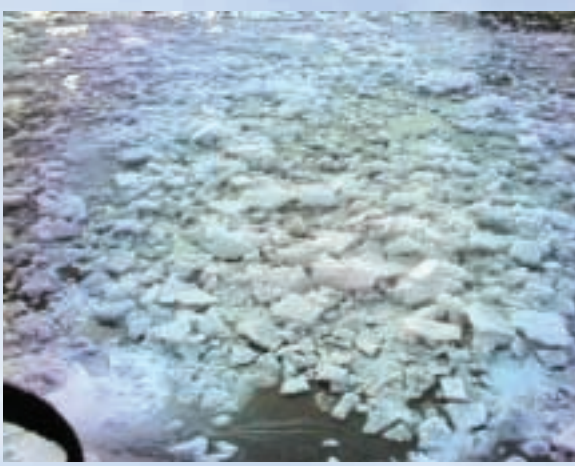
During deicing, Navy aircraft are sprayed with a Type I deicing fluid, which is a mixture of heated water and heated glycol. Glycol is used because it lowers the freezing point of water and prevents the aircraft surface from refreezing for up to 15 minutes after spraying. The proportion of glycol in the mixture is varied based on local environmental conditions (e.g., temperature, humidity, and dew point) during the deicing event, typically from 30 to 70 percent. Currently, the Navy uses propylene glycol-based deicing fluid, although ethylene glycol-based fluids are still approved for use as a backup.

The most common method of applying deicing fluid is a specialized truck that pumps the heated water and glycol through a high-pressure spray nozzle mounted on a boom. The nozzle operator, who is positioned in a cab at the end of the boom, directs the spray at the aircraft by maneuvering the boom and the nozzle. Spraying continues until the aircraft inspections confirm that all ice and snow have been removed. Deicing is performed shortly before the aircraft is ready to taxi out for takeoff. Because the deicing fluid runs off the aircraft as soon as the spraying occurs and becomes diluted with new precipitation, it is sometimes necessary to deice an aircraft multiple times before takeoff.

Forced air does a good job at clearing snow, including dry loose snow to crusty snow, without the addition of fluid.

Environmental Impact

Although conventional deicing methods are effective, the large volume of deicing fluid used can create a significant environmental impact. As much as 80 percent of the deicing fluid applied to an aircraft may be released to the environment.



Chunks of snow blown off the wing of a P-3 Orion, typical of a successful deicing with none to very little deicing fluid used.

A P-3 Orion being blown down with hybrid deicing technology.

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While a small volume of the fluid enters the environment through evaporation, the majority of the fluid ends up on the tarmac. If this deicing fluid is not captured, it will enter the environment in the form of stormwater runoff—potentially contaminating soil, groundwater, and local bodies of water.

Ethylene and propylene glycol are both water-soluble organic chemicals that have been found to adversely affect wildlife and vegetation. Ethylene glycol is classified as a toxic material, while propylene glycol is considered nontoxic; however, both forms of glycol are regulated to varying degrees by the U.S. Environmental Protection Agency and most state regulatory agencies. Ethylene and propylene glycols also exhibit a high biochemical oxygen demand (BOD) during decomposition. Receiving waters (e.g., streams, lakes) contaminated with glycol often have diminished dissolved oxygen (DO) levels, increased odors, and are less able to support aquatic life.

The Navy is examining capture and treatment systems developed specifically for deicing activities, and many sites have taken steps to contain or control deicing runoff. However, it is clear that if the volume of deicing fluid being sprayed can be reduced, then the volume of deicing fluid requiring capture and treatment would be reduced, as well as the overall environmental impact. For this reason, PPEP conducted a technology demonstration project to determine whether new deicing system technology can achieve glycol reduction.

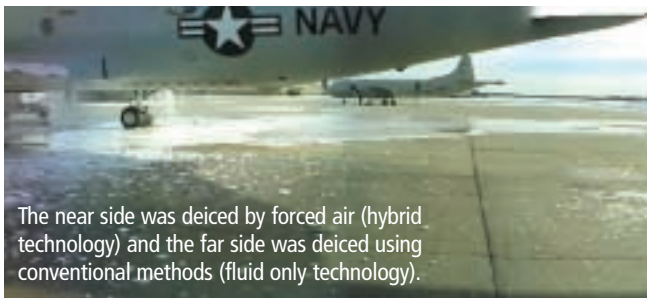
Alternative Application Method

Based on research of new technologies, a hybrid deicing system was selected that uses a combination of forced air and traditional fluid spraying. The hybrid deicing truck provides a high-pressure stream of hot air to remove the ice/snow buildup on the aircraft, similar to a leaf blower. The air is not actually "heated," but the temperature at the end of the nozzle from which the air is discharged is between 90 and 100 degrees Fahrenheit due to the heat of compression. In addition, the hybrid deicing truck incorporates a spray nozzle for dispensing deicing fluid at variable flow rates (9 to 20 gallons per minute (gpm)), which are lower than conventional deicing trucks (60 gpm). Because air is used to remove much of the frozen contamination, less fluid is required to accomplish the same deicing task.

PPEP procured from Premier Engineering a hybrid deicing truck that incorporated an AlliedSignal forced air unit. The new truck was delivered to the Aircraft Intermediate Maintenance Department (AIMD) at Naval Air Station (NAS) Brunswick, ME, during the 1999 deicing season. Testing occurred over the course of several seasons, and provided direct comparison to Navy conventional deicing trucks. The deicing instructions at NAS Brunswick require two trucks to deice larger aircraft (P-3 and C-130). This requirement aided in the ease of conducting direct comparison testing, during which a conventional truck and the hybrid truck deiced opposite sides of the same aircraft under the same conditions.

Demonstrated Benefits

Use of the hybrid deicing truck substantially reduced the volume of deicing fluid necessary to deice aircraft at NAS Brunswick. During side-by-side testing,



The near side was deiced by forced air (hybrid technology) and the far side was deiced using conventional methods (fluid only technology).

Typical runoff from a conventional deicing truck during 'light deicing' conditions.

LEFT: The red nozzle combines the application of conventional deicing fluid (center) surrounded by a stream of forced air (outer), or either individually. The left nozzle is for anti-icing fluid and was unused during the evaluation. Deicing fluid is not currently approved for use by the Navy.

BELOW: Hybrid cab and nozzle arrangement. The red nozzle is the hybrid technology. The left nozzle was for anti-icing fluid used in the private sector and was not used by the Navy during the evaluation.

the hybrid system used an average of approximately 38 percent of the deicing fluid used by the conventional truck. That's 62 percent less deicing fluid to accomplish the same work.

If NAS Brunswick's conventional deicing trucks were replaced by hybrid deicing trucks, it is estimated that the average annual glycol usage of 22,017 gallons (1995-1999) would be reduced to 8,366 gallons. By avoiding the purchase of 13,651 gallons of glycol, annual glycol procurement cost savings would be $73,169.

This reduction in deicing fluid usage directly translates into reduced runoff and reduced environmental impact. Sites that capture deicing fluid runoff may also benefit because the reduced strength and volume of the deicing fluid waste stream will yield savings from less strict treatment and disposal requirements.

The testing at NAS Brunswick was performed under varying deicing conditions. Based on all available data, it appears that the hybrid deicing system is both an efficient tool for deicing as well as a sensitive tool for the environment because forced air, deicing fluid, or a combination of both may be selected by the operator to suit the type of deicing required. Forced air appears to be sufficient to clear light snow. "Crusty" snow also can be easily cleared using a short burst of deicing fluid to punch through the snow crust, and then switching to forced air to "float" the remainder off the aircraft. Deicing fluid remains the primary means for removal of ice and heavy snow—but the operator has the flexibility to combine the forced air with the spray for optimal effect.

NAS Brunswick personnel found that the hybrid deicing truck was as easy to operate as conventional deicing trucks. They also provided recommendations to improve the unit's reliability and effectiveness.

Conclusions and Future Plans

Using hybrid deicing technology provides several environmental and cost benefits when compared to conventional deicing systems, including:

- Reduced deicing fluid usage and procurement costs,
- Reduced volume and concentration of deicing runoff,
- Reduced volume of hazardous waste and the associated cost of treatment and disposal,
- Enhanced compliance with federal, state, and local environmental regulations, and
- Reduced personnel exposure to glycol mist—providing a safer and healthier work environment.

Based on PPEP technology demonstration experience, the hybrid deicer technology is being incorporated into NAVAIR PMA 260's (Common Support Equipment) procurement of new deicer trucks to replace the aging fleet. The PPEP cost analysis shows that this additional capital investment will provide tremendous cost and environmental savings over the life of the new deicing trucks. ⚓

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