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ICING SYSTEM

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ABSTRACT

In aerospace and aviation industry, the safety of the passengers is must. The icing on the engine creates a great risk for them. In this paper we discuss about icing on engine and its effects. The objective of this paper is to cover the ways on how icing is happening and how it could be undone.

Keywords

ICING, CENTRIFUGAL, PNEUMATIC, PROPELLERS

1. INTRODUCTION

In aeronautical industry, there are many num of problems and ICING on the engine is one of the major problems. There are a lot of problems due to icing. In this paper we are concentrating on these problems. Our objective is to tell, how to cope-up with these problems.

2. ICING ON THE ENGINE

Icing of the engine and the leading edges of the intake duct can occur during flight through clouds containing super cooled water droplets or during ground operation in freezing fog. Protection against ice formation may be required since icing of these regions can considerably restrict the airflow through the engine, causing a loss in performance and possible malfunction of the engine. Additionally, damage may result from ice breaking away and being ingested into the engine or hitting the acoustic material lining the intake duct.

An ice protection system must effectively prevent ice formation within the operational requirements of the particular aircraft. The system must be reliable, easy to maintain, present no excessive weight penalty and cause no serious loss in engine performance when in operation.

Analyses are carried out to determine whether ice protection is required and, if so, the heat input required for limiting ice build up to acceptable levels, filling the areas of a turbo-fan engine typically considered forice protection.

Deicing refers to the removal of ice from the airframe; anti-icing refers to the prevention of ice accumulating on the airframe.

3. TYPES OF STRUCTURAL ICE

Clear ice is often clear and smooth. Super cooled water droplets, or freezing rain, strike a surface but do not freeze instantly. Forming mostly along an airfoil stagnation point, it generally conforms to the shape of the airfoil.

Rime ice is rough and opaque, formed by super cooled drops rapidly freezing on impact. Often "horns" or protrusions are formed and project into the airflow.

Mixed ice is a combination of clear and rime ice.

Frost ice is the result of water freezing on unprotected surfaces. Often forming behind deicing boots or heated leading edges, it was a factor in the crash of American Eagle Flight 4184.

SLD ice refers to ice formed in Super cooled Large Droplet (SLD) conditions. It is similar to clear ice, but because droplet size is large, it often extends to unprotected parts of the aircraft and forms larger ice shapes, faster than normal icing conditions.

4. EFFECT OF ICING

The wing will ordinarily stall at a lower angle of attack, and thus a higher airspeed, when contaminated with ice. Even small amounts of ice will have an effect, and if the ice is rough, it can be a large effect. Thus an increase in approach speed is advisable if ice remains on the wings. How much of an increase depends on both the aircraft type and amount of ice. Stall characteristics of an aircraft with ice contaminated wings will be degraded, and serious roll control problems are not unusual. The ice accretion may be asymmetric between the two wings. Also, the outer part of a wing, which is ordinarily thinner and thus a better collector of ice, may stall first rather than last.

4.1 Other Effects

- Blocking air intakes, static ports, carb air filters.
- Jammed flight surfaces.
- Airfoil changes, especially the disruption of the laminar flow during rime ice encounters.
- Increased drag resulting in changes in stalling speed.
- Increased fuel consumption.
- Weight & balance concerns.
- And a reduction in lift.

5. ICING PREVENTION AND REMOVAL

5.1 Removing Methods

Several methods exist to reduce the dangers of icing. The first, and simplest, is to avoid icing conditions altogether, but for many flights this is not practical.

If ice (or other contaminants) is present on an aircraft prior to takeoff, they must be removed from critical surfaces. Removal can take many forms:

- Mechanical means, which may be as simple as using a broom or brush to remove snow
- Application of deicing fluid or even hot water to remove ice, snow, etc.
- Use of infrared heating to melt and remove contaminants.
- Put the aircraft into a heated hangar until snow and ice have melted.
- Position aircraft towards the sun to maximize heating up of snow and ice covered surfaces. In practice this method is limited to thin contamination, by the time and weather conditions.

All of these methods remove existing contamination, but provide no practical protection in icing conditions. If icing conditions exist, or are expected before takeoff, then anti-icing fluids are used. These are thicker than deicing fluids and resist the effects of snow and rain for some time. They are intended to shear off the aircraft during takeoff and provide no inflight protection.

5.2 Protecting Methods

To protect an aircraft against icing in-flight, various forms of anti-icing or deicing are used:

- A common approach is to route engine "bleed air" into ducting along the leading edges of wings and tail planes. The air heats the leading edge of the surface and this melts or evaporates ice on contact. On a turbine powered aircraft air is extracted from the compressor section of the engine. If the aircraft is turbocharged piston powered, bleed air can be scavenged from the turbocharger.
- Some aircraft are equipped with pneumatic deicing boots that disperse ice build-up on the surface. These systems require less engine bleed air but are usually less effective than a heated surface.
- A few aircraft use a weeping wing system, which has hundreds f small holes in the leading edges and releases anti-icing fluid on demand to prevent the buildup of ice.
- Electrical heating is also used to protect aircraft and components (including propellers) against icing. The heating may be applied continuously (usually on small, critical, components, such as pilot static sensors and angle of attack vanes) or intermittently, giving an effect similar to the use of deicing boots.

In all these cases usually only critical aircraft surfaces and components are protected. In particular only the leading edge of a wing is usually protected. Carbolated heat is applied to carbureted engines to prevent and clear icing. Fuel injected engines are not susceptible to carburetor icing but can suffer from blocked inlets. In these engines an alternate air source is often available

There are two basic systems of ice protection, turbo-jet engines generally use a hot air supply and turbo-propeller engines use electrical power or a combination of electrical power and hot air. Protection may be supplemented by the circulation of hot oil around the air intake. The hot air system is generally used to prevent the formation of ice and is known as an ant icing system. The electrical power system is used to break up ice that has formed on surfaces and is known as a de-icing system.

5.2.1 *HOT AIR SYSTEM*

The hot air system provides surface heating of the engine and/or power plant where ice is likely to form. The protection of rotor blades is rarely necessary, because any ice accretions are dispersed by centrifugal action. If stators are fitted upstream of the first rotating compressor stage these may require protection. If the nose cone rotates it may not need anti-icing if its shape, construction and rotational characteristics are such that likely icing is acceptable.

The hot air for the anti-icing system is usually taken from the high pressure compressor stages. It is ducted through pressure regulating valves, to the parts requiring anti-icing. Spent air from the nose cowl anti-icing system may be exhausted into the compressor intake or vented overboard.

If the nose cone is anti-iced its hot air supply may be independent or integral with that of the nose cowl and compressor stators. For an independent system, the nose cone is usually anti-iced by a continuous protection. If the nose cone rotates it may not need anti-icing if its shape, construction and rotational characteristics are such that likely icing is acceptable.

The pressure regulating valves are electrically actuated by manual selection, or automatically by signals from the aircraft ice detection system. The valves prevent excessive pressures being developed in the system, and act also as an economy device at the higher engine speeds by limiting the air off-track from the compressor, thus preventing an excessive loss in performance. The main valve may be manually locked in pre-selected position prior to take-off in the event of a valve malfunction, prior to replacement..

5.2.2 *ELECTRICAL SYSTEM*

The electrical system of ice protection is generally used for turbo-propeller engine installations, as this form of protection is necessary for the propellers. The surfaces that require electrical heating are the air intake cowling of the engine, the propeller blades and spinner and, when applicable, the oil cooler air intake cowling.

Electrical heating pads are bonded to the outer skin of the cowlings. They consist of strip conductors sandwiched between layers of neoprene, or glass cloth impregnated with epoxy resin. To protect the pads against rain erosion, they are coated with a special, polyurethane-based paint. When the deicing system is operating, some of the areas are continuously heated to prevent an ice cap forming on the leading edges and also to limit the size of the ice that forms on the areas that are intermittently heated

Electrical power is supplied by a generator and, to keep the size and weight of the generator to a minimum, the de-icing

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electrical loads are cycled between the engine, propeller and, sometimes, the airframe.

When the ice protection system is in operation, the continuously heated areas prevent any ice forming, but the intermittently heated areas allow ice to form, during their 'heat-off period. During the 'heat on' period, adhesion of the ice is broken and it is then removed by aerodynamic forces.

The cycling time of the intermittently heated elements is arranged to ensure that the engine can accept the amount of ice that collects during the 'heat-off' period and yet ensure that the 'heat-on' period is long enough to give adequate shedding, without causing any run-back icing to occur behind the heated areas.

5.2.3 Pneumatic deicing boots

The pneumatic boots is a rubber device attached to a wing's leading edge, invented by the Goodrich Company (previously known as B.F. Goodrich) in 1923. Portions of the boot are alternately inflated and deflated to break ice off the boot, de-icing the wing. Rubber boots are used on jets and propeller driven aircraft.

5.2.4 Bleed air

This system is the method used by the larger jet aircraft to keep flight surfaces above the freezing temperature required for ice to accumulate (called anti-icing). The hot air is "bled" off the jet engine into piccolo tubes routed through wings, tail surfaces, and engine inlets. The spent bleed air is exhausted through holes in the lower surface of the wing.

5.2.5 TKS Ice Protection

Tecalemit-Kilfrost-Sheepbridge Stokes ice Protection is a fluid-based technology that uses a glycol-based fluid to coat the wing surface and prevent ice from accumulating (anti-ice) or chemically breaks the ice bond and allows ice to shed (de-ice). The system was developed in Britain during World War II for the protection of aircraft in icing conditions. Ice Protection with the TKS Ice Protection system is achieved by mounting laser-drilled titanium porous panels on the leading edges of the airframe. The panel skin is perforated with eight hundred 0.0025-inch-diameter laser-drilled holes per square inch. TKS fluid exudes through the panels on the leading edges of the wings, horizontal stabilizers. Fluid is also thoroughly distributed from the slinger ring on the propeller and from the windshield spray bar. Secondary fairings or structures such as lift struts can also be protected. Engine inlets may be protected, as well. The fluid is pumped from a tank by an electrically-driven metering pump through a micro filter to proportioning units. Proportioning units contain calibrated capillary tubes that divide the flow to the individual needs of the porous panels and the slinger ring. One metering pump is provided for inadvertent systems. For systems certified for flight into known icing conditions (FIKI), two pumps are installed for redundancy and can be selected individually. Fluid for the windshield spray bar system is provided by an on-demand gear pump. One or two windshield pumps are provided depending on the certification basis. As the TKS Ice Protection system is used, any accumulation of debris is flushed out. Glycol has cleaning properties and will not harm the paint finish of the aircraft. No performance is lost from the system; only significant ice protection capabilities are added.

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