SAE Aerospace
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AEROSPACE INFORMATION REPORT

SAE AIR6211

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Ice Penetration Test Method for Runways and Taxiways Deicing/Anti-icing Chemicals

RATIONALE

This test method for liquid and solid runway deicing/anti-icing chemicals, offers a quantitative procedure to evaluate the ice penetration as a function of the time and temperature by such deicing/anti-icing chemicals and is based on the SHRP H-205.4-MODIFIED FOR AIRPORT APPLICATION (draft April 17/02) - Test Method for Ice Penetration of Liquid Deicing Chemicals (or Solids).

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1. SCOPE

This test method provides stakeholders (runway deicing chemical manufacturers, deicing/anti-icing chemical operators and airport authorities) with a relative ice penetration capacity of runway deicing/anti-icing chemicals, by measuring the ice penetration as a function of time. Such runway deicing/anti-icing chemicals are often also used on taxiways and other paved areas.

This test method does not quantitatively measure the theoretical or extended time of ice penetration capability of ready-to-use runway deicing/anti-icing chemicals in liquid or solid form.

1.1 Minimum Requirements

This method sets the minimum testing requirements for the determination of ice penetration capabilities of AMS1431 and AMS1435 runway deicing/anti-icing chemicals in liquid and solid form as a function of time and temperature, under controlled laboratory conditions.

1.2 Hazardous Materials

This test may involve the use of hazardous materials, operations, and equipment. This standard does not address the safety problems associated with its use. It is the responsibility of the user to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

1.3 Standard Units

The values stated in SI units are to be regarded as the standard.

2. APPLICABLE DOCUMENTS

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

AMS1431 Compound, Solid Runway and Taxiway Deicing/Anti-icing

AMS1435 Fluid, Generic, Deicing/Anti-icing, Runways and Taxiways

2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM D 1193 Specification for Reagent Water

ASTM D 1747 Refractive Index of Viscous Materials

2.3 ISO Publications

Available from International Organization for Standardization, 1, rue de Varembe, Case postale 56, CH-1211 Geneva 20, Switzerland, Tel: +41-22-749-01-11, www.iso.org.

ISO 9001-2008 Quality Management Systems – Requirements

2.4 Other Reference Documents

Handbook of Test Methods for Evaluating Chemical Deicers, Strategic Highway Research Program, National Research Council Washington , DC 1992, SHRP-H-332

3. SUMMARY OF TEST METHOD

3.1 Introduction

This test utilizes a Plexiglas® test plate having 5 mm (0.20 in) diameter cavities filled with ice. After equilibration to the desired temperature, a known volume of dyed-liquid runway deicing/anti-icing chemical is discharged onto the surface of ice cones and penetration commences (see Figure 1). Penetration is evidenced by an embedded scale in millimeters behind the Plexiglas® test plate. At specified time intervals, the length of penetration is measured. Testing temperatures shall be within 1 °C (2 °F) of the stated values and tests shall be performed within a freezer or a cold chamber.

FIGURE 1 - PLEXIGLAS® TEST PLATE WITH RUNWAY DYED-DEICING/ANTI-ICING CHEMICAL

3.2 Significance and Use

This test method can be used to evaluate and compare the ice penetrating capabilities of runway deicing/anti-icing chemicals in liquid or solid form over a limited, defined time interval at specified temperatures.

3.3 Test Equipment and Materials

The following test procedure may be performed on runway deicing/anti-icing chemicals in liquid or solid form.

3.3.1 Material

a. Adaptated Plexiglas® [Poly(methyl methacrylate)] test plate

b. Pipettor (single or multichannel pipettor) able to deliver a volume of 25 µL

c. Plastic syringe with needle (capacity 5 mL)

d. Micro centrifuge tubes, 1.5 mL graduated; e.g., Fisherbrand cat # 02-682-550

e. Aluminum plate 10 cm x 10 cm (3.937 in x 3.937 in)

f. Digital thermometer (or equivalent)

g. Digital timer (or equivalent)

h. Refrigerator or room to store the material at 4 °C ± 1 °C (39 °F ± 2 °F)

i. Rhodamine or Fluorescein 0.1% (w/v) solution (other dyes can be used provided that it is clearly specified)

j. Balance (precision ±0.01 g)

3.3.2 Plexiglas® Test Plate

The ice penetration apparatus consists of a rectangular Plexiglas® plate of at least 120 mm (4.724 in) thick x 19 mm ± 2 mm (0.75 in ± 0.08 in) deep x 300 mm ± 2 mm (11.81 in ± 0.08 in) length. Twelve 40 mm (1.575 in) deep cavities are drilled in the center of the plate at 19 mm (0.75 in) spacings with an 5 mm (0.20 in) drill. These cavities are then enlarged in a countersink fashion to yield a surface cone 7 mm (0.28 in) in diameter and 3 mm (0.12 in) long at the point of intersection of the cone with the 5 mm (0.20 in) cavity (see Figure 1). To facilitate measurement of penetration an embedded scale in millimeters behind the Plexiglas® test plate is used. A timer, preferably a digital timer that can be activated at test start, is required.

3.3.3 Standard Measuring Devices

All temperature sensors, electronic balances, and timing devices shall be maintained in a known state of calibration by means of a Quality Management System recognized by an international standards organization such as ISO 9001-2008 (or equivalent).

3.3.4 Ice Preparation

ASTM D 1193 Type IV water has to be used for the ice preparation. Water, Plexiglas® test plate and material required for the ice preparation have to be kept at 4 °C ± 1 °C (39 °F ± 2 °F) for a minimum period of 8 h ± 1 h prior to preparing the ice. The pre-cooled water is drawn into a syringe, the needle inserted into the cavities, and the cavities filled while withdrawing the needle. Bubbles in the water column (usually none) should be forced out if necessary. Plexiglas® test plate is then placed into the cold chamber (freezer) at -10 °C ± 1 °C (14 °F ± 2 °F) within 5 min after filling the cavities with water. The ice penetration apparatus is kept in a freezer until the water is completely frozen (minimum of 8 h). The ice formation period may be prolonged until complete turnover into the crystal state. Globules of ice will protrude from cavities surfaces. The globules are melted/sheared off with an aluminum plate previously maintained at 20 °C ± 5 °C (68 °F ± 9 °F). More than one aluminum plate could be required to achieve globules melting/shearing procedure. The excess of water on the surface should be removed using a paper towel after ice globules melting. The apparatus is placed in the constant temperature chamber at -10 °C ± 1 °C (14 °F ± 2 °F) for an additional 3 h before to perform the ice penetration test.

3.4 General Test Procedures

3.4.1 Runway Deicing/Anti-icing Chemical Form

The following test procedure can be performed on deicing/anti-icing chemicals in liquid or solid form.

3.4.1.1 Liquid Runway Deicing/Anti-icing Chemical

Liquid runway deicing/anti-icing chemical shall be evaluated as supplied. No dilution or preparation is needed prior to the test.

3.4.1.2 Solid Runway Deicing/Anti-icing Chemical

Solid runway deicing/anti-icing chemical must be diluted to give a 25% w/w solution. To obtain this 25% w/w solution, dissolve “x” g of solid runway deicer in “3x” g of demineralized water.

3.4.1.3 Reference Control Solution

A reference control solution shall be tested along with the runway deicing/anti-icing chemical. The results are used as a validation test and allows to manufacturer an optional comparative test. The reference solution consists of a potassium acetate (reagent grade ACS > 99%) solution 50% w/w in ASTM D 1193, Type IV water

The 50% w/w reference control solution is prepared by mixing x g of potassium acetate and x g of demineralized water and is calculated according to Equation 1:

$$\%\, w/w = \left(\frac{x\, g\, CH_3CO_2K}{x\, g\, CH_3CO_2K + x\, g\, H_2O} \right) * 100 \qquad \text{(Eq. 1)}$$

where:

CH_3CO_2K: potassium acetate (Reagent grade ACS > 99%)

H_2O: water (ASTM D 1193, Type IV)

3.4.2 Incorporation of Dye

If the liquid runway deicing/anti-icing chemical or the 25% w/w dilution of solid runway deicing/anti-icing chemical do not have a vivid enough (strength) to accurately report the ice penetration capability, a dye shall be prepared and added as follows:

1. Two dyes are recommended to perform the test; the Rhodamine B (CAS # 81-88-9) and the Florescein (CAS # 518-47-8). Both dyes can be used however; the Rhodamine B should be prioritized since it shows better contrast and facilitates the ice penetration measurement. The dye should be chosen so that there are no compatibility issues with the different runway deicer chemistries. The dye used for the test should be specified and agreed accordingly.

2. The dye shall be diluted to 0.1% by volume (0.1% w/v) in ASTM D 1193, Type IV water. To obtain this 0.1% w/v solution, dissolve 0.025 g of dye in 25 mL of demineralized water.

3. Fill a 1.5 mL micro centrifuge tube (vial) with the deicer to be tested. Add 2 drops of the dye (0.1% w/v) solution to the deicing/anti-icing chemical sample, close the vial, and shake vigorously.

4. Keep sample at test temperature minimum 8 h prior to the test.