Ice Preventive Coatings Evaluations Tests at VTT

Jeroen Dillingh, Senior Scientist
Wind Power Technologies, VTT Technical Research Centre of Finland, Espoo

Please visit us at stand #15 of the conference exhibition

Introduction

Prevention of ice accretion on surfaces has been investigated for a long time by research groups all over the world. There has been only limited success to date. A more realistic goal currently adopted is the development of durable, industry-viable coatings which reduce ice adhesion forces rather than completely prevent the formation of ice or its adhesion.

In their search for synthetic coatings having low adhesion to ice, researchers have looked for relationships between adhesion strength and other material properties that are easy to measure and control. In accordance with the theoretical predictions discussed in [1] it has been observed that low adhesion to ice is generally connected with low permeability and absorption capacity and high hydrophobicity, i.e. high contact angle with water.

New developments of permanent and semi-permanent coatings focus on delay of nucleation of ice or reduction of the adhesive force between ice and the coated surface. Often the development of new surface coatings is done by experimental searching. Testing is therefore an essential part in the development process.

Because adhesion of ice produced by droplet accretion is different than that of bulk-formed ice, it is essential that the tests and the test requirements are defined with the application to wind turbine rotor blades in mind.

VTT offers a test program that is tailored to the needs of the customer. The test package includes tests for performance and effectiveness, as well as durability. The different possibilities are listed below.

Performance

- **Ice adhesion reduction test**
- **Static ice accumulation test**: these tests are conducted in a climate chamber on specimens that are placed in different angles to the horizontal.
- **Dynamic ice accumulation test**: laboratory test with ice accreted in the VTT icing wind tunnel to test effectiveness as well as durability.
- **Surface analysis and characterisation**: water contact angle, surface free energy, scratch resistance, surface roughness, hardness, Young's modulus, etc.
- **Field test**: full-scale test on a wind turbine in operation. VTT has a test site in Olos, Finland.

Mechanical durability

- **Accelerated weathering tests**: the specimens are exposed to UV, temperature and humidity to measure the level of surface degradation due to environmental exposure.
- **Mechanical tests**: these include tests for tensile strength, fracture strain, modulus of elasticity in tension, dimensional stability under heat, etc. Basically, all the tests that are needed for GL certification of topcoat resins can be conducted at VTT.
- **Rain erosion test**: to determine the resistance to erosion. The test method is based on the ASTM G73 standard. The test method covers tests in which solid specimens are eroded or otherwise damaged by repeated discrete impacts of liquid droplets. Results are expressed in terms of erosion rate and time-to-failure.
- **Wear test**: to determine the resistance to abrasion. The method is the Taber Abraser method, to measure resistance to abrasive wear under the action of abrasive wheel. Results are expressed in terms of mass loss and change in surface roughness.

VTT offers the possibility to perform an initial screening (using a small set of selected tests) of different coatings in order to pick out the most promising candidates. These can then be subjected to a wider range of tests.

VTT has specialists in many of the relevant areas ,such as surface treatment technologies, material science and ice physics. VTT is therefore able to provide a valuable interpreta-tion of the results and act as a sparring partner for any coating developer.

Reference: [1] L. Makkonen, *J. Adhesion Sci. Technol*. **25**, 2011

VTT test site in Olos, Finland

Contact information:
Tekniikantie 4 A
P. O. Box 1000
FI-02044 VTT, Espoo, Finland
Jeroen Dillingh
+358 40 162 9349
Jeroen.Dillingh@vtt.fi