TECHNICAL SPECIFICATION

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Paints and varnishes — Coating systems for wind-turbine rotor blades —

Part 3: Determination and evaluation of resistance to rain erosion using water jet

Peintures et vernis — Matériaux de revêtement pour pales de turbines éoliennes —

Partie 3: Détermination et évaluation de la résistance à l'érosion causée par la pluie au moyen d'un jet d'eau

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Foreword

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 35, *Paints and varnishes*, Subcommittee SC 9, *General test methods for paints and varnishes*.

A list of all parts in the ISO 19392 series can be found on the ISO website.

Introduction

In the wind energy industry, coatings are applied to rotor blades surface to protect the glass fibre reinforced polymer composite substrate. Rain drops and hailstones can damage these coatings in such a way that individual layers come off or the whole coating delaminates from the substrate.

ISO/TS 19392-1 describes the minimum requirements and weathering of the coating system. Rain erosion can be simulated by means of high speed water jets or water droplets impinging on the specimen surface. ISO/TS 19392-2 describes a method which simulates rain erosion by accelerating one or more coated panels, attached to the end of rotating arms, through a simulated rain field at a constant rotational velocity. This document describes a method where a water jet or a series of water jets at defined pressure hits the surface of the specimen.

Paints and varnishes — Coating systems for wind-turbine rotor blades —

Part 3:
Determination and evaluation of resistance to rain erosion using water jet

1 Scope

This document specifies test methods for the determination of resistance of coating systems or tape for wind-turbine rotor blades to rain erosion by using the water jet test.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 291, *Plastics — Standard atmospheres for conditioning and testing*

ISO 1513, *Paints and varnishes — Examination and preparation of test samples*

ISO 2808, *Paints and varnishes — Determination of film thickness*

ISO 4618, *Paints and varnishes — Terms and definitions*

ISO 4628-1:2016, *Paints and varnishes — Evaluation of degradation of coatings — Designation of quantity and size of defects, and of intensity of uniform changes in appearance — Part 1: General introduction and designation system*

ISO 4628-2, *Paints and varnishes — Evaluation of degradation of coatings — Designation of quantity and size of defects, and of intensity of uniform changes in appearance — Part 2: Assessment of degree of blistering*

ISO 4628-4, *Paints and varnishes — Evaluation of degradation of coatings — Designation of quantity and size of defects, and of intensity of uniform changes in appearance — Part 4: Assessment of degree of cracking*

ISO 4628-5, *Paints and varnishes — Evaluation of degradation of coatings — Designation of quantity and size of defects, and of intensity of uniform changes in appearance — Part 5: Assessment of degree of flaking*

ISO 4628-6, *Paints and varnishes — Evaluation of degradation of coatings — Designation of quantity and size of defects, and of intensity of uniform changes in appearance — Part 6: Assessment of degree of chalking by tape method*

ISO 13076, *Paints and varnishes — Lighting and procedure for visual assessments of coatings*

ISO 15528, *Paints, varnishes and raw materials for paints and varnishes — Sampling*

ISO 19403-2, *Paints and varnishes — Wettability — Part 2: Determination of the surface free energy of solid surfaces by measuring the contact angle*

ASTM G73-10, *Standard Test Method for Liquid Impingement Erosion Using Rotating Apparatus*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 4618 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp

3.1
water jet
continuous or discontinuous stream of water in air with defined geometry, velocity and, if discontinuous, frequency

4 Principle

The coated surface of a flat test panel is stressed by an impinging water jet. The erosion damage to the coating for a given duration is produced by one of the following methods:

a) interrupted water jet on fixed panel [pulsating jet erosion test (PJET)];

b) continuous water jet on slowly moving panel (vertical rotation axis);

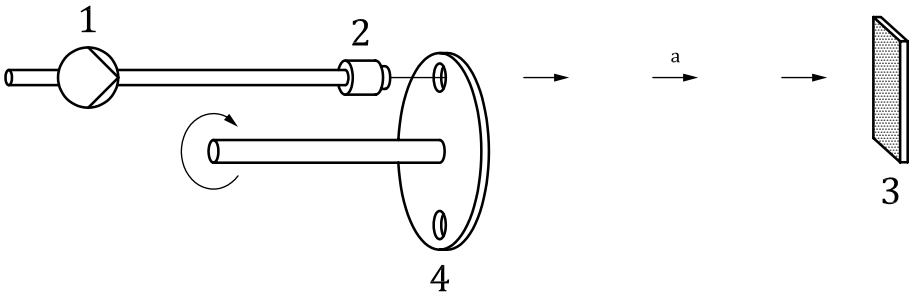
c) continuous water jet on slowly moving panel (horizontal rotation axis).

The test is finished as soon as defects uncover the composite substrate. The end point is detected by visual or microscopic inspection. The evaluation enables a pass or fail decision as well as a comparison with different coating systems in the same conditions. Also possible is the investigation of the course of the damage starting from initiation until complete failure.

5 Apparatus

Ordinary laboratory apparatus, together with the following.

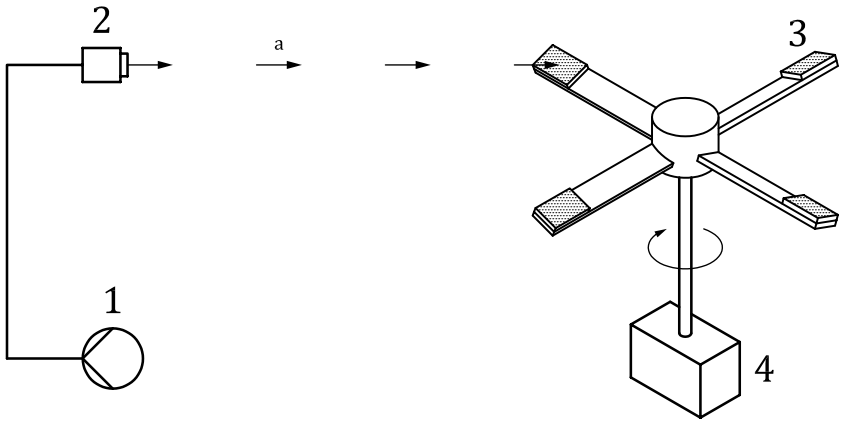
5.1 Device for testing with interrupted water jet on fixed panel (PJET), as shown in Figure 1.



Key
1 high-pressure pump
2 jet nozzle
3 panel holder with panel
4 rotating disc
a Fluid jet.

Figure 1 — Principle of device for testing with interrupted water jet on fixed panel

5.2 Device for testing with continuous water jet on moving panel (vertical rotation axis), as shown in Figure 2.

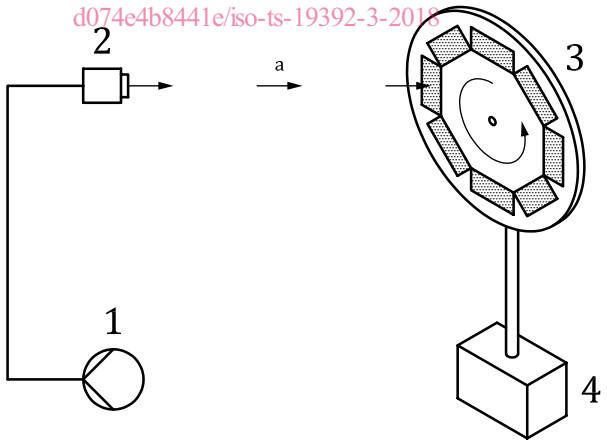


Key

1 high-pressure pump
2 jet nozzle
3 panel holder with panels
4 drive motor
a Fluid jet.

Figure 2 — Schematic illustration of a test device with vertical axis of rotation

5.3 Device for testing with continuous water jet on moving panel (horizontal rotation axis), as shown in Figure 3.



Key

1 high-pressure pump
2 jet nozzle
3 panel holder with panels
4 drive motor
a Fluid jet.

Figure 3 — Schematic illustration of a test device with horizontal axis of rotation

6 Sampling

Take a representative sample of the product to be tested (or of each product in case of a multi-coat system), as described in ISO 15528.

Examine and prepare the sample for testing, as described in ISO 1513.

7 Test panels

7.1 Substrate

Flat test panels made from glass fibre composite material commonly used for rotor blades with a minimum size as given in Table 2.

Table 1 — Typical sample size and geometry (examples)

	Interrupted water jet on fixed panel (PJET)	Continuous water jet on moving panel (vertical rotation axis)	Continuous water jet on moving panel (horizontal rotation axis)
Sample size mm	75 × 150 × 2	85 × 50 × 5	30 × 60 × 5
Sample shape	Flat sheet	Flat sheet	Flat sheet

Table 2 shows the preferred samples size and geometry. Other samples' sizes and geometries can be used by agreement between the interested parties.

7.2 Preparation

Prepare and coat flat panels in a similar way to the production process with the coating system under test.

The coated test panels should have the same configuration as the real blade leading edge, including fillers or whatever material is used for surface preparation before applying the leading edge protection.

The preparation shall be defined or performed by the customer in accordance with the coating supplier's instructions.

If a taped test specimen is tested, the preparation shall be agreed between the interested parties.

NOTE Differences in the application process can affect the test results.

7.3 Conditioning

Condition the coated or taped test specimen for the specified time and under the specified conditions for at least 7 days under standard ambient conditions according ISO 291, class 2 [(23 ± 2) °C/(50 ± 10) % relative humidity] prior to testing.

7.4 Thickness of coating

The thickness of the coating shall be specified and agreed between the interested parties.

8 Procedure

8.1 Number of determinations

Test at least three samples at each specified conditions.

8.2 Examination before exposure

Before exposure, carry out the following measurements:

— visual examination of the area to be exposed;

— thickness of coating.

For further details, see Annex A.

8.3 Calibration

In order to keep conditions and instrument parameters constant, regular calibration of the test device is necessary. The calibration is mandatory with new test devices and at any change of test parameters.

Carry out the calibration according to ASTM G73-10.

Materials for calibration are, for example, aluminium (Al), stainless steel, polyurethane (PU) and polymethyl methacrylate (PMMA) with a defined purity and a reproducible and traceable source according to ASTM G73-10. Test the calibration material at defined time and measure the mass loss.

8.4 Exposure to simulation of rain erosion

Choose the test medium and test parameters (see Table 2) in accordance with the selected facility's options and examine all test specimens for existing defects before testing.

Possible test media are deionized water according to ISO 3696, Grade 2, tap water, chloride-containing water or artificial sea water according to ISO 15711:2003, Table 1, as agreed between the interested parties and according to operating conditions.

The test medium used and its conductivity value shall be defined and reported as agreed between the interested parties.

The test medium temperature shall be defined and recorded. The location of the temperature measurement shall be reported. Typical test medium temperature is (20 ± 10) °C. Tests at other temperatures may be carried out if agreed between the interested parties.

The air temperature shall be observed.

NOTE The degradation behaviour under or above the glass transition temperature, T_g, can influence the test result.