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~~ISO/DTS 19392-5,~~ Paints and varnishes — Coating systems for wind-turbine rotor blades — Part 5: Measurement of transmittance properties of UV protective ~~rotor blade~~ coatings ~~/coating systems~~

~~DTS stage~~

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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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~~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.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

In the wind energy industry, coatings are applied to rotor blades surface to protect the glass fibre reinforced polymer composite substrate from environmental stresses. 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. This applies mostly to the leading edge. Glass fibre reinforced polymer composites and other blade materials can be also sensitive to UV degradation and thus can be damaged during outdoor operation, if not protected accurately against irradiation by solar radiation. Failure of protection can lead to delamination and a subsequent failure of the full blade.

AAn important function of the rotor blade coating is therefore to protect the blade material from UV radiation. This applies to the leading edge, but also to the other surface areas of the blade.

The damage by solar radiation is mainly induced by the most energetic ultraviolet (UV) radiation, but also visible (VIS) radiation (e.g. violet or blue radiation) is still energetic enough to have a negative input on the appearance and durability of the blade.

Pigments and organic or inorganic UV absorbers can be used to reduce the coating film transmittance against UV (and visible) radiation and cause a positive effect on lifetime and functional aspects of the blade material. Pigments and UV absorbers can affect the transmittance in the visible range. This mightmay lead to colour change of the coated blade.

This document, as part of the series ISO/TS 19392 series on rotor blade coatings, describes a method to measure the spectral transmittance or the transmittance in a specific wavelength range. This allows evaluating the UV and VIS radiation protection quality of a coatings film on the sensitive blade substrate below. The focus is to avoid damage of the blade by natural solar radiation especially caused by the most energetic part, the ultraviolet and short wavelength visible radiation.

This document is harmonized with prEN 927-12: Paints and varnishes — Coating materials and coating systems for exterior wood — Part 12: Ultraviolet and visible radiation transmittance.

Paints and varnishes — Coating systems for wind-turbine rotor blades — Part 5: Measurement of transmittance properties of UV-protective rotor blade coatings/coating systems

1 Scope

This document specifies a test method to measure the ultraviolet (UV) and visible (VIS) spectral transmittance in the wavelength range from 280 nm to 700 nm of coatings for wind turbine rotor blades. Single and multilayer coatings or coating systems can be tested.

From the spectral transmittance the transmittance of UV, VIS and the combined UV and VIS wavelength range can be calculated.

It is applicable to free coatings films or coatings applied on a UV-transparent quartz substrate.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3270, *Paints and varnishes and their raw materials — Temperatures and humidities for conditioning and testing*

~~EN~~ ISO 2808, *Paints and varnishes — Determination of film thickness (ISO 2808)*

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

~~CIE S 017, ILV: International Lighting Vocabulary, 2nd Edition (technical content harmonized with IEC 60050-845)~~

3 Terms and definitions

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

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

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

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

3.1
transmittance

τ

quotient of transmitted ~~radiant flux, Φ_t,~~ radiant flux, Φ_t, and incident ~~radiant flux, Φ_m, $\tau = \frac{\Phi_t}{\Phi_m}$~~ radiant flux, Φ_m, $\tau = \frac{\Phi_t}{\Phi_m}$

Note 1 to entry: Transmittance is also defined spectrally in terms of ~~wavelength,~~ wavelength, in which case, ~~"~~"spectral~~"~~" is added before the quantity name.

Note 2 to entry: Due to energy conservation, $\alpha + \rho + \tau = 1$ except when ~~polarized radiation~~ polarized radiation is observed, where α is absorptance and ρ is ~~reflectance.~~ reflectance.

Note 3 to entry: Transmittance, τ, is the sum of ~~regular transmittance,~~ regular transmittance, τ_r, and ~~diffuse transmittance,~~ diffuse transmittance, τ_d: $\tau = \tau_r + \tau_d$.

Note 4 to entry: The transmittance has unit one.

[SOURCE: CIE S 017:2020; 17-24-065]

~~4 Abbreviations~~

~~UV:~~ 3.2
ultraviolet radiation
UV
radiation in ~~the~~a wavelength range from 280 nm to 400 nm

~~VIS:~~ 3.3
visible radiation
VIS
radiation in ~~the~~a wavelength range from 400 nm to 700 nm

~~5~~4 Principle

The UV and VIS transmittance through a coating film is measured using an UV/VIS spectrophotometer equipped with a radiation source, a limiting aperture, an integrating sphere, and a spectroradiometer with a diffraction element and a detector. See Annex B for application and evaluation references.

A beam of optical radiation, limited by an aperture, with an incident radiant flux, Φ_m, is directed on a film specimen. The transmitted radiant flux, Φ_t, enters an integrating sphere. The sphere is equipped with the input optics of a spectroradiometer with which spectrally resolved measurements of the unfiltered radiant flux $\Phi_m(\lambda)$ and the filtered (transmitted) radiant flux $\Phi_t(\lambda)$ can be performed. The quotient $\Phi_t(\lambda)/\Phi_m(\lambda)$ is the spectral transmittance $\tau(\lambda)$.

NOTE $\tau(\lambda)$ multiplied by 100 represents the percentage of the transmitted radiant flux at a specific wavelength or wavelength range passing through the film compared to the incident radiant flux $\Phi_m(\lambda)$.

From the spectral transmittance, the transmittance in a specific wavelength range can be calculated as described in ~~7~~6.4.

The spectral transmittance is recorded in wavelength increments over the entire wavelength range of 280 nm to 700 nm continuously during a wavelength scanning (e.g. in 2 nm to 10 nm steps depending on

the apparatus used and the resolution needed). Depending on the application the transmittance of the specific wavelength ranges for UV, VIS and UV~~+~~ + VIS can be calculated.

~~6~~5 Apparatus and materials

~~6.1~~5.1 Film applicator for coating material

A suitable blade or spatula to apply coatings films of defined wet layer thickness shall be used.

NOTE~~-~~ A typical dry layer thickness is approx. 90 µm to 120 µm.

~~6.2~~5.2 Substrate for free coating film preparation

~~6.2.1~~5.2.1 Preparation of free film and test specimen

A clean and plane substrate shall be used to apply the wet coating materials to prepare the free coating films of correct uniform layer thickness. ~~Ideal as~~For a substrate to separate ~~later~~ the coating film without damage, it is ~~a~~ ideal to use a polytetrafluoroethylene (PTFE~~1~~) coated smooth metal plate or a PE-, PP-foil or silicone paper fixated on ~~e.g.~~ a smooth glass or metal plate~~.~~, for example. In case of lower viscosity coatings ~~also~~, silicone rubber rings can be used after balancing them horizontally, on ~~e.g.~~ a glass plate to fill in the liquid coating material for example. The coating material ~~has to~~shall be sufficiently dry~~.~~. This normally ~~this is given after~~requires drying for a minimum of 7 days or better ~~of~~, 28 days at (23 ± 2) °C at (50 ± 10) % relative humidity ~~(according to~~in accordance with ISO 3270~~)~~ or as per the coating supplier's specification.

NOTE Soaking in water is another suitable method for the detachment of free films from a substrate. ~~But~~However, this method of preparation of free films can influence the test results. The usual method for preparation of free films is without using water on a low energy substrate such as polypropylene. Alternatively, the coatings can be measured directly on a UV-transparent substrate like quartz.

For each coating, a minimum of three specimens shall be cut out from a uniform section of the film without any damages. The size of the specimens ~~must~~shall be adjusted to the specific spectrophotometer under use.

~~6.2.2~~5.2.2 Coating application

The coating shall be applied on a 1 mm to 2 mm thick quartz substrate with a spectral transmittance of at least 90 % in the wavelength range from 280 nm to 700 nm.

~~6.3~~5.3 Film thickness measurement

The film thickness shall be measured ~~according to~~in accordance with ISO 2808.

~~6.4~~5.4 UV/VIS spectrophotometer

The following are the minimum requirements for the UV/VIS spectrophotometer:

a) wavelength range: 280 nm to 700 nm;

~~1) PTFE – Poly tetra fluoro ethylene (Teflon™).~~