IEC TS 62073

Edition 2.0 2016-02

Corrected version
2026-07

TECHNICAL SPECIFICATION

Guidance on the measurement of hydrophobicity of insulator surfaces

IEC TS 62073:2016-02(en)

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 29.080.10

ISBN 978-2-8322-3169-2

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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GUIDANCE ON THE MEASUREMENT OF HYDROPHOBICITY OF INSULATOR SURFACES

FOREWORD

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- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC 62073, which is a technical specification, has been prepared by IEC technical committee 36: Insulators.

This second edition cancels and replaces the first edition published in 2003. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) Changed wettability to hydrophobicity throughout the document
b) Redefined the criteria for the determination of hydrophobicity class in paragraph 3.4;

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
36/363/DTS	36/367/RVC

Full information on the voting for the approval of this technical specification can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- transformed into an International standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

The content of the corrigendum 1 (2026-07) has been included in this copy.

INTRODUCTION

The wetting properties of a surface by water are commonly described by the terms hydrophobic (or hydrophobicity) and hydrophilic (or hydrophilicity). A hydrophobic surface is water-repellent, while a surface that is easily wetted by water is hydrophilic.

The wetting phenomenon of a surface is complex and many different parameters can influence its hydrophobic properties. Some important parameters include: type of insulator material, surface roughness, heterogeneities of the surface, chemical composition (e.g. due to ageing) and presence of pollution. For insulator materials in common use, the hydrophobic properties can change over time, due to the influence of the ambient conditions. This change can be either reversible or irreversible. Thus, the result of the measurement of the hydrophobicity may be influenced by the ambient conditions and the HV corona or dry-band arcing to which the insulator has been previously exposed. This dynamic behaviour of the hydrophobicity is more or less specific to different insulator materials. These types of materials, which have an ability to retain and transfer hydrophobicity, are commonly called Hydrophobicity Transfer Materials (HTM).

The dynamic behaviour of the hydrophobicity exhibited by insulator materials is due to their chemical composition. Different processes such as oxidation, hydrolysis, migration of low molecular weight compounds, formation of complex compounds between e.g. siloxanes and water, rotation of flexible polymer chains, inter- and intra-molecular rearrangements, microbiological growth, deposition of contaminants, adhesion and encapsulation of contaminant particles, may take place at different rates, depending on material and ambient conditions. Thus hydrophobicity along and around an insulator can vary, due to differences in the exposure to solar radiation, rain, corona discharges, deposited pollution, etc. Therefore, hydrophobicity of insulators is usually measured on several separate areas of the insulator.

Measurement of the hydrophobicity of a surface is readily performed in the laboratory on well defined, homogeneous, smooth and planar surfaces of prepared specimens. In the case of insulators, for which non-destructive measurements are usually required (and where cut-out of material samples is usually not desired), these conditions do not exist and measurement with high precision is a difficult task. This is especially true when the measurement has to be performed on an insulator installed in an overhead line, substation or even in a high voltage test set-up in the laboratory.

Previously wettability class (WC) was used as equivalent technology.

GUIDANCE ON THE MEASUREMENT OF HYDROPHOBICITY OF INSULATOR SURFACES

1 Scope

The methods described in this technical specification can be used for the measurement of the hydrophobicity of the shed and housing material of composite insulators for overhead lines, substations and equipment or ceramic insulators covered or not covered by a coating. The obtained value represents the hydrophobicity at the time of the measurement.

The object of this technical specification is to describe three methods that can be used to determine the hydrophobicity of insulators. The determination of the ability of water to wet the surface of insulators may be useful to evaluate the condition of the surface of insulators in service, or as part of the insulator testing in the laboratory.

2 Terms and definitions

For the purposes of this document, the following definitions apply.

2.1
hydrophobicity
state of a surface with a low surface tension and thus is water-repellent

2.2
hydrophilicity
state of a surface with a high surface tension and thus is wetted by water (in the form of a film)

2.3
surface tension
region of finite thickness (usually less than 0,1 μm) in which the composition and energy vary continuously from one bulk phase to the other

Note 1 to entry: The pressure (force field) in the interfacial zone has a gradient perpendicular to the interfacial boundary. A net energy is required to create an interface (surface) by transporting the matter from the bulk phase to the interfacial (surface) zone. The reversible work required to create a unit interfacial (surface) area is the surface tension and is defined thermodynamically as follows:

$$\gamma = \left(\frac{\partial G}{\partial A}\right)_{T,P,n}$$

where

γ is the surface (interfacial) tension or surface energy;

G is the Gibbs free energy of the total system;

A is the surface (interfacial) area;

T is the temperature;

P is the pressure;

n is the total number of moles of matter in the system.

The surface tension (γ) is usually expressed in mN/m (1 mN/m = 1 dyn/cm).

2.4
static contact angle
angle of a drop of liquid resting on the surface of a solid, and a gas is in contact with both, the forces acting at the interfaces are in balance

Note 1 to entry: These forces are due to surface tensions acting in the direction of the respective surfaces. From Figure 1 it follows that:

$$\gamma_{GL} \cos \theta_s = \gamma_{GS} - \gamma_{SL}$$

where

θ_s is the static contact angle of the edge of the drop with the solid surface,

γ_{GL} is the surface tension of the gas-liquid interface,

γ_{GS} is the surface tension of the gas-solid interface, and

γ_{SL} is the surface tension of the solid-liquid interface.

Note 2 to entry: The above equation (Young´s equation) is only valid for ideal and smooth surfaces.

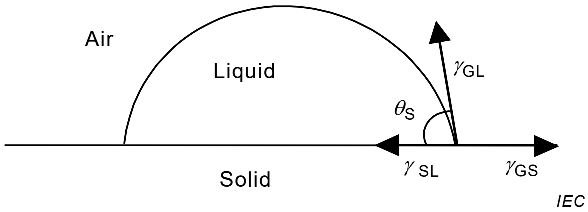

Figure 1 – Definition of the static contact angle

The right side of the above equation (the difference between the surface tensions of the gas-solid and the solid-liquid interfaces) is defined as the surface tension of the solid surface. It is not a fundamental property of the surface but depends on the interaction between the solid and a particular environment.

When the gas is air saturated with vapour of the liquid, γ_{GL} will be the surface tension of the liquid. If the contact angle is 0°, the liquid is said to just wet the surface of the solid, and in this particular case (since cos θ_S = 1), the surface tension of the solid will be equal to the surface tension of the liquid.

2.5
advancing and receding contact angle (dynamic contact angles)
angles of a droplet on an inclined solid surface that exhibits two different angles

Note 1 to entry: The advancing contact angle (θ_a) is the angle inside the water droplet between the solid surface and the droplet surface at the lower part of the droplet on the inclined surface (see Figure 2). The receding contact angle (θ_r) of a droplet on an inclined surface is the angle inside the droplet between the solid surface and the droplet surface at the droplet rear (highest part on the inclined surface). If the receding contact angle is zero, a completely wetted trace of water is formed as the drop moves along the solid inclined surface (see Figure 2). The general physical relation between the advancing and receding contact angle and the static contact angle defined in 2.4 is: $\theta_r \le \theta_s \le \theta_a$.

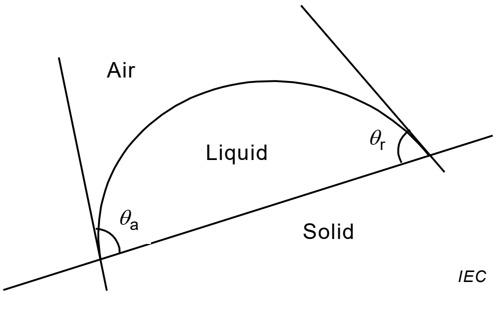

Figure 2 – Definition of the advancing angle (θ_a) and the receding angle (θ_r) inside a liquid drop resting on an inclined solid surface