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**Paints and varnishes — Wettability —  
Part 7:  
Measurement of the contact angle on a  
tilt stage (roll-off angle)**

*Peintures et vernis — Mouillabilité —*

*Partie 7: Mesurage de l'angle de contact sur un plan incliné (angle  
d'écoulement)*

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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](http://www.iso.org/iso/foreword.html). (standards.iteh.ai)

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A list of all parts in the ISO 19403 series can be found on the ISO website. <https://standards.iteh.ai/catalog/standards/sist/76032543-df0e-4ef0-b0ee-1774-544d/iso-19403-7:2017>

## Introduction

Dynamic contact angles describe the processes on the interface liquid/solid during volume increase (advancing angle) or volume decrease (receding angle) of a drop in horizontal position. As an alternative to the static method (see ISO 19403-2), for the advancing angle always a surface area is wetted, which was previously unwetted. For the receding angle, the contact angle during dewetting is observed. From the difference between advancing angle and receding angle, information on chemical homogeneity and roughness can be concluded. The receding angle is not suitable for the determination of the surface energy.

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# Paints and varnishes — Wettability —

## Part 7:

# Measurement of the contact angle on a tilt stage (roll-off angle)

## 1 Scope

This document specifies a method for the dynamic measurement of the roll-off angle of a liquid drop on a solid surface. From the dynamic measurement, the advancing and receding angles of the drop rolling off can also be determined. The roll-off angle plays a role when evaluating, for example, easy-to-clean or anti-adherent surfaces.

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

ISO 19403-1, *Paints and varnishes — Wettability — Part 1: Terminology and general principles*

ISO 19403-7:2017

## 3 Terms and definitions

<https://standards.iteh.ai/catalog/standards/sist/76032543-df0e-4ef0-b0ee-cb7f741544e9/iso-19403-7-2017>

For the purposes of this document, the terms and definitions given in ISO 4618, ISO 19403-1 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 <http://www.iso.org/obp>

### 3.1

#### roll-off angle

$\alpha_s$

tipping of the surface of the solid body, due to which a liquid drop put down onto this surface rolls off

### 3.2

#### advancing angle

$\theta_a$

contact angle, which is measured during advancing of the three-phase point

Note 1 to entry: Generally, the advancing angle is used for the determination of the interface energy, in which case the measurement should be carried out close to the thermodynamic equilibrium. This is approximately reached if there is no influence of, for example, the dosing speed on the contact angle.

[SOURCE: ISO 19403-6:2017, 3.2]

**3.3**  
**receding angle**

$\theta_r$   
contact angle, which is measured during receding of the three-phase point

[SOURCE: ISO 19403-6:2017, 3.3]

**4 Principle**

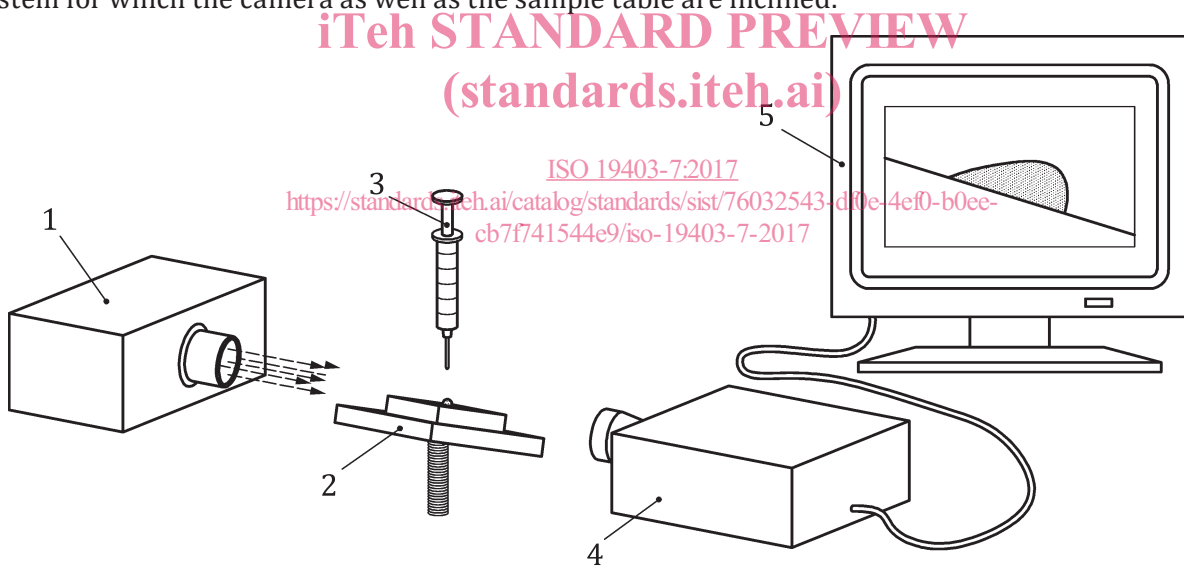
A drop is put down onto the surface to be tested. The surface is tipped with constant inclination speed until the drop rolls off. The advancing and receding angles are determined from the time curve of the left and right three-phase point.

**5 Apparatus and materials**

Ordinary laboratory apparatus, together with the following.

**5.1 Contact angle measuring system.**

Any state-of-the-art contact angle measuring device fitted with a tilting device, preferably systems with digital image capture and analysis for measuring the contact angle. [Figure 1](#) shows a schematic example of a contact angle measuring system for which only the sample table is inclined. [Figure 2](#) shows a system for which the camera as well as the sample table are inclined.

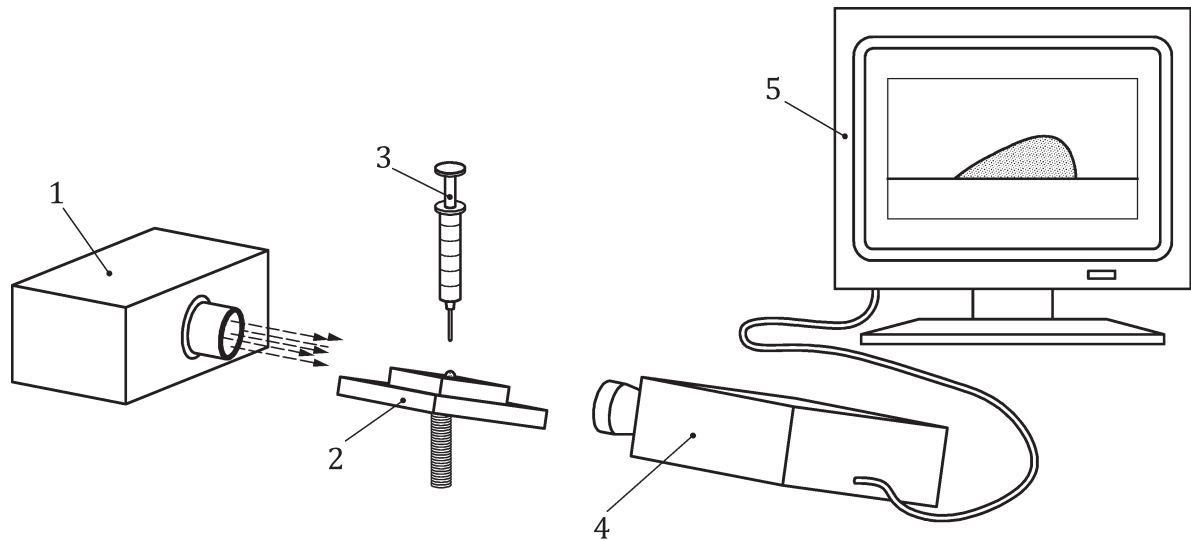


**Key**

- 1 light source
- 2 specimen holder
- 3 graduated microsyringe
- 4 optical system
- 5 screen

**Figure 1 — Schematic diagram of a contact angle measuring system for which only the sample table is inclined**



**Key**

- 1 light source
- 2 specimen holder
- 3 graduated microsyringe
- 4 optical system
- 5 screen

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**Figure 2 — Schematic diagram of a contact angle measuring system for which the camera as well as the sample table are inclined**

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The image capturing system should be oriented in a way that the drop is within the left third of the image (when the table is inclined to the right).

**NOTE** The device used can differ from the schematic diagram in regard to light path and the arrangement of the components.

### 5.2 Dosing unit.

Dosing unit, which makes it possible to precisely apply drops in the range of microlitres to the surface.

### 5.3 Test liquids.

If not otherwise agreed, use at least one of the test liquids suggested in [Table 1](#). The test liquids shall have at least “purity grade” for analysis. Water shall have a surface tension of at least 71,5 mN/m.

It is recommended to test the suitability of the liquids used in accordance with ISO 19403-3 or EN 14370 prior to measuring their surface tensions. For guidance, the values from the literature for the surface tension,  $\sigma_l$ , are indicated in [Table 1](#). It is also possible to use an individually measured value of the surface tension as reference value. According to experience, the measured value should not deviate more than  $\pm 2\%$  from the value from the literature or the individually determined value.

The test liquids shall not physically or chemically affect the surface. They may not show a notable yield value.

**NOTE 1** A notable yield value is shown when a lamella of the liquid teared with a needle does not level within a given time limit (e.g. 30 s).

The test liquids shall not cross-link, show any skinning or evaporate during the measurement.

Liquids having a vapour pressure higher than water at 30 °C shall be measured in the saturated vapour phase.

The test liquids used should have a maximum of different polar and dispersive fractions of surface tension.

NOTE 2 The values given in [Table 1](#) refer to 25 °C measuring temperature. For measuring under standard atmosphere (see [7.1.2](#)), no significant deviations can be assumed.

**Table 1 — Suggested test liquids**

Test liquid	Surface tension $\sigma_1$ mN/m	Dispersive fraction $\sigma_1^d$ mN/m	Polar fraction $\sigma_1^p$ mN/m	Source
Water	72,8	21,8	51,0	Reference [6]
Di-iodomethane	50,8	50,8	0,0	Reference [6]
1,2-ethanediol (ethylene glycol)	47,7	30,9	16,8	Reference [6]
1,2,3-propanetriol (glycerol)	63,4	37,0	26,4	Reference [6]
Hexadecane	27,6	27,6	0,0	Reference [6]
1-bromo-naphthalene	44,6	44,6	0,0	Reference [6]
Benzyl alcohol	38,9	29,0	9,9	Reference [7]
Decalin (isomer mixture)	30,6	30,6	0,0	Reference [6]
cis-Decalin	32,2	32,2	0,0	Reference [8]
trans-Decalin	29,9	29,9	0,0	Reference [8]

## 6 Sampling

Take a representative specimen of the substrate to be tested. The specimens shall not be contaminated before measuring.

Preferably, the specimen should have the minimum size of 10 cm × 10 cm.

For advice on sampling and sample preparation, see [Annex A](#).

## 7 Procedure

### 7.1 General for measuring the roll-off angle

#### 7.1.1 Setting up the contact angle measuring system

Choose the location of the contact angle measuring system so that it is not exposed to

- vibrations,
- intense air flows (e.g. caused by air conditioning), and
- intense exposure to light from outside (e.g. windows, bright lighting).

Align the contact angle measuring system horizontally.

### 7.1.2 Test conditions

Carry out the test at  $(23 \pm 2)$  °C and a relative humidity of  $(50 \pm 5)$  % (see ISO 3270) and make sure that all test media have this temperature.

### 7.1.3 Conditioning of the test panels

Condition the test panels at a temperature of  $(23 \pm 2)$  °C and a relative humidity of  $(50 \pm 5)$  % for a minimum of 16 h prior to testing. Carry out the test immediately after conditioning.

## 7.2 Measurement

### 7.2.1 General

Place a preferably flat test specimen of the surface to be measured on the specimen holder. Adjust the specimen holder so that the surface of the test specimen is located in the lower half of the image and that it is horizontally aligned.

Fill the dosing system with the chosen liquid. Pay attention to fill without contamination or bubbles.

Adjust an image representation that is sufficient in regard to brightness and contrast (mind the specifications given by the manufacturer).

If possible, adjust the light source of the contact angle measuring device so that the grey values within the drop close to the phase interface do not exceed the value 40 (referring to 256 grey value grades) and amount to a minimum of 170 on the outside of the drop.

NOTE It can be reasonable to test the modes of operation of the optical components by means of two-dimensional images of drops. Such reference images are commercially available.

Move the needle to the upper margin of the image and bring into focus.

### 7.2.2 Application of the drop

Position the dosing needle approximately 3 mm to 6 mm above the surface of the test specimen. The volume of the drop depends on the used liquid, the test specimen, the inclination speed and shall be included in the test report.

Apply a drop of the test liquid on the surface (see [Figure 3](#)).

NOTE 1 The contact between the drop and the solid surface can be achieved by putting down by means of the needle or by picking up by means of the sample table.