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Paper and board — Measurement of water contact angle by optical methods

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National foreword

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Foreword

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This document was prepared by Technical Committee ISO/TC 6, *Paper, board and pulps*, Subcommittee SC 2, *Test methods and quality specifications for paper and board*.

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

The interaction between the liquid and the solid phases influences the contact angle. Contact angles above 90° define a situation where the liquid is repelled by the solid; below 90° defines a situation of attraction where the liquid wets the surface. The magnitude above or below 90° shows the relative degree of repulsion or attraction between the two phases.

On many surfaces the contact angle varies with duration of contact through a combination of spreading, penetration (in the case of porous substrates) and evaporation. Both manual and automated apparatus are available for optical measurement of contact angle, but automated equipment is preferred for precision and rapid measurement, and because it is often applicable to a wider combination of liquid and paper or board samples.

Contact angle measurement is used to predict how liquids interact with paper surfaces. This document describes the most common form of test, using water as probe liquid, and from the data a probable interaction between the paper surface and another liquid with comparable surface tension and viscosity characteristics is often inferred. The veracity of this inference should be tested wherever possible.

Notwithstanding the above, contact angle measurement is used widely as a predictive tool in several industrial settings, for example:

a) for assessing writing, ruling or printing quality with water-based or solvent based inks (e.g. in inkjet, gravure or flexographic printing);

b) for gluing applications;

c) for wet offset lithographic printing;

d) for hot-foil applications;

e) for barrier or release coatings;

f) for coating applications.

In some cases, measurements of contact angle are used to calculate two or three components of the surface energy of the paper or board, which requires the use of two or three liquids of known surface energy, respectively. In such cases, the values calculated for the components of surface energy will be related to the liquids chosen for the analysis[1]. This is not covered in this document.

The test method described in this document is sometimes known as 'static' or even 'sessile drop', since on many surfaces the droplet remains static and in equilibrium with the paper surface and air. Yet on paper and board surfaces the droplet often changes its dimensions with time, due to sorption and wetting phenomena. This has led some instrument manufacturers and researchers to describe the automated optical technique outlined in this document as measurement of the 'dynamic' contact angle.

This document does not use the term 'dynamic' because this nomenclature confuses a measurement changing with respect to time with one that changes due to a plane of shear. For example, the Willhelmy plate method of contact angle measurement, which measures the force required to push a solid material into and then pull it out from a liquid reservoir, is a true 'dynamic' method[2].

Similarly, this document does not cover the situation where a droplet is placed on a horizontal surface that is subsequently tilted so that gravity causes the droplet to assume an asymmetric shape, then to commence movement.

Paper and board — Measurement of water contact angle by optical methods

1 Scope

This document specifies the method for optical assessment of the contact angle between water and the surface of paper and board, where the process of droplet formation, application to planar substrates or measurement of the droplet shape in contact with the solid is performed by automated equipment.

The limits of measurement are determined by the capabilities of the instrumentation used. The instrumental capabilities defined by this document use a digital image capturing system operating at a minimum of 50 frames per second and needs the ability to perform the first measurement after no more than 20 ms to 40 ms contact between the droplet and substrate.

The test method is applicable to most kinds of paper or board however it cannot be applicable to structured materials.

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 186, *Paper and board — Sampling to determine average quality*

ISO 187, *Paper, board and pulps — Standard atmosphere for conditioning and testing and procedure for monitoring the atmosphere and conditioning of samples*

ISO 13530, *Water quality – Guidance on analytical quality control for chemical and physicochemical water analysis*

3 Terms and references

For the purposes of this document, the following terms and definitions apply:

3.1
baseline
line of contact between the water droplet and paper or board surface, determined by optical means and taken as the plane from which the contact angle is measured

Note 1 to entry: Precise measurement of contact angle requires precise assessment of the baseline. For the optical system to achieve the best estimate of the baseline, it may be necessary to tilt the camera so that it views the droplet slightly from above, at a shallow angle (typically 0-3° relative to the horizontal), rather than directly from the side (0°). Experience shows this small change in viewing angle does not affect the measured contact angle value but can enhance detection of the baseline[3].

3.2
contact angle
Θ
angle to a *baseline* (3.1), formed by means of a tangent on the droplet contour through one of the three-phase points at the specified contact time

Note 1 to entry: The contact angle is expressed in degrees (°).