# TECHNICAL REPORT

# ISO/TR 25477

First edition
2008-09-15

## Paper, board and pulps — Basic guidelines for image analysis measurements

*Papier, carton et pâtes — Lignes directrices de base pour les mesurages en analyse d'image*

Reference number
ISO/TR 25477:2008(E)

# 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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

In exceptional circumstances, when a technical committee has collected data of a different kind from that which is normally published as an International Standard (“state of the art”, for example), it may decide by a simple majority vote of its participating members to publish a Technical Report. A Technical Report is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.

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.

ISO/TR 25477 was prepared by Technical Committee ISO/TC 6, *Paper, board and pulps*, Subcommittee SC 5, *Test methods and quality specifications for pulps*.

# Introduction

Image analysis systems have been available to the pulp and paper industry since the mid-nineteen seventies. There have been many publications dealing with applications ranging from dirt counting to print quality measurements. The image analysis equipment has evolved from complicated and expensive research-class devices and now covers a large number of camera-based two-dimensional charge-coupled diode arrays (CCDs), along with an increasing number of systems based on “page scanners” that use linear CCDs and scanning mirror systems to build up the scanned image in the computer. This Technical Report attempts to provide an overview of some of the important issues, but it is not intended as an all-encompassing guide to this complex field. Anyone new to the field of image analysis should refer to the published literature for more detailed guidance on specific measurement applications.

# Paper, board and pulps — Basic guidelines for image analysis measurements

## 1 Scope

This Technical Report provides guidance on using image analysis to measure various visual properties of pulp, paper, board and the corresponding products that have been printed or coated. This Technical Report is based on TAPPI TIP 0804-09.

## 2 Basic guidelines

### 2.1 General

The following basic guidelines are recommended for image analysis measurements.

### 2.2 Documentation

Every image analysis method should be thoroughly documented to ensure reproducibility of all steps, ranging from sample preparation and equipment and lighting set-up through to the final data collection and analysis steps.

### 2.3 Sample preparation

The apparent simplicity of image analysis measurements may lead users to ignore the possible impact of effects arising from variable sample preparation or from sample ageing effects that introduce significant changes into the measurement. Ensure that samples and reference samples are prepared in a repeatable manner and are stable. Sample preparation is often identified as the greatest source of error in image analysis measurements.

### 2.4 Lighting

Lighting differences can drastically alter image analysis measurements. Differences can arise from numerous sources, including intensity, angular incidence, light source temperature and variable light intensity when an image analyser is subject to ambient light variations. Even the light reflected from an operator's clothing can influence the measurement. Diffuse light is the preferred illumination for paper and paperboard surfaces. Ensure that the wavelength spectrum of the illuminant is consistent with the spectral response of the detector. Camera response shall be linear and with no autogain. Care shall be taken when selecting a light source to detect coloured features. A brown dot will have a much lower contrast in a red light than in a blue light. Choose a light source that does not vary in spectral emission with changing voltage. Many CCD cameras are extremely sensitive to near-infrared light, which can result in greater image contrast relative to visible light. A broadband green filter or a filter that excludes near-infrared light may be installed in front of the detector. It is best to locate image analysis equipment in a windowless room.

## 2.5 Calibration

Almost all image analysis systems are delivered with some form of calibration standard that allows the conversion of measurements into meaningful units. However, these standards might not be suitable for all applications and they are often difficult to confirm in relation to primary standards. When possible, buy a calibration standard that is traceable to a primary standard.

NOTE Image analysis is broadly used in the pulp and paper industry. Calibration methods will vary and depend on the specific application. Some typical applications are listed in Clause 4.

## 2.6 Reference samples

Due to the complexity of the overall system set-up for some applications, it is often advisable to retain one or more reference samples whenever this is possible. The reference sample is measured as a quick check to confirm that the current set-up produces results within acceptable tolerances. The reference sample shall be stable and also permit repeat scans with acceptable precision. It is advisable to ensure that a number of system operators obtain the same result and that the method is operator-independent.

## 2.7 Pixel resolution

At the heart of every image analyser is a linear or two-dimensional detector array of picture elements (pixels). The optical image is converted into an array of pixels, each with an individual intensity in a computer memory. The resolution and accuracy of image analysis measurements are determined by the number of pixels that make up a discrete feature in an image. Electronic coupling between detector pixels can cause the effective resolution of the detector to be much lower than might be expected from pixel spacing. If it is essential to obtain high resolution of feature size or shape, then the feature magnification level shall be set at an appropriate level.

## 2.8 Optical resolution

The quality of image analysis measurements is limited by the optical limitations of the viewing system that feeds the image to the detector. The possible effects are potentially numerous and complex: alignment, flatness of field, chromatic aberration, etc. In general, finer detail will be resolved with high-quality lenses, shorter wavelength light, and lenses with higher numerical apertures (and shorter working distances). When practical considerations require working a longer distance from the portion of test and stopping down the lens to get greater depth of focus, detail on the scale of a few micrometers may be degraded and no amount of empty magnification will recover it. Beginners to image analysis should take some time to learn about their specific optical systems and applications before finalizing their image analysis methods. A minimum of four pixels is suggested for the smallest feature to be measured and, if using white light sources, the resolution should not exceed 1 µm per pixel. Zoom lenses should be avoided.

## 2.9 Grey level resolution

The grey level, GL, is the intensity number assigned to each pixel where a lower number corresponds to a darker pixel. A resolution scale with a minimum of 256 GL is recommended (8-bit sensor). A range of 256 GL contributes 0,5 % digitizing uncertainty to the total intensity uncertainty. If electronic noise is on the order of 0,5 %, then digitizing to even 4 000 GL will not improve the grey level resolution. The image analyser operator shall record what the 0 GL and 255 GL values relate to with respect to a light and dark standard. The operator shall also note the detection threshold, in terms of GL, that was used to detect features. It shall be understood that the real limitation in resolving image features lies in the limited GL range that may exist in some samples. Again, sensor response shall be linear and without autogain.

 

## 3 Image analysis versus visual perception

Image analysis systems are capable of producing measurements that are precise to one percent or better. These systems can, in fact, measure in a reliable manner sample quality differences that are much too fine to be discerned by the human eye. In applications where image analysis results are likely to be compared with visual evaluations, it is important to clarify what represents a minimum significant difference as far as the observers are concerned. In general, one shall devise means to ensure that what the image analyser is detecting corresponds to the reality of what the operator wishes to measure.

## 4 Typical applications of image analysis technique

The following are areas to which the image analysis technique applies:

— estimation of dirt and shives (ISO 5350-1, ISO 5350-2 and ISO 5350-4);

— estimation of stickies and plastics (ISO 15360-2);

— fibre length methods (ISO 16065-1 and ISO 16065-2);

— coarseness of pulps (ISO 23713).

# Bibliography

[1] ISO 5350-1, *Pulps — Estimation of dirt and shives — Part 1: Inspection of laboratory sheets by transmitted light*

[2] ISO 5350-2, *Pulps — Estimation of dirt and shives — Part 2: Inspection of mill sheeted pulp by transmitted light*

[3] ISO 5350-4, *Pulps — Estimation of dirt and shives — Part 4: Instrumental inspection by reflected light using Equivalent Black Area (EBA) method*

[4] ISO 15360-2, *Recycled pulps — Estimation of Stickies and Plastics — Part 2: Image analysis method*

[5] ISO 16065-1, *Pulps — Determination of fibre length by automated optical analysis — Part 1: Polarized light method*

[6] ISO 16065-2, *Pulps — Determination of fibre length by automated optical analysis — Part 2: Unpolarized light method*

[7] ISO 23713, *Pulps — Determination of fibre coarseness by automated optical analysis — Polarized light method*

[8] TIP 0804-09, *Basic Guidelines for Image Analysis Measurements*, Technical Information Paper, TAPPI, 2001

 

ICS 85.040; 85.060

Price based on 4 pages