
**Rubber, raw natural — Colour index
test**

Caoutchouc naturel brut — Essai d'indice de couleur

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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).

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).

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

For an explanation of 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 www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 45, *Rubber and rubber products*, Subcommittee SC 3, *Raw materials (including latex) for use in the rubber industry*.

This fifth edition cancels and replaces the fourth edition (ISO 4660:2011), which has been technically revised. The main changes compared to the previous edition are as follows:

- a colour spectrophotometer has been added as an alternative method to determine colour index in [Clauses 1, 4](#) and in [5.8](#);
- the thickness of the material from the punch, in [5.4](#), has been specified to be 3,4 mm ± 0,2 mm;
- the weight of the test portion, in [6.1](#), has been specified to be 20 g ± 5 g;
- the number of pass for test piece preparation, in [6.1](#), has been specified to be two passes;
- the thickness of the final sheet from the mill, in [6.1](#), has been specified to be 1,7 mm ± 0,1 mm;
- the calibration for colour spectrophotometer has been added in [6.2](#);
- the procedure for colour determination using colour spectrophotometer has been added in [6.3.2](#);
- Method B using the colour spectrophotometer has been stated in [Clause 1](#) as the preferred method.

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.

Rubber, raw natural — Colour index test

WARNING — Persons using this document should be familiar with normal laboratory practice. This document does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user to establish appropriate safety and health practices.

1 Scope

This document specifies two methods to determine the colour of raw natural rubber according to a standard colour scale:

- Method A: colour matching against standard coloured glasses;
- Method B: colour determination using colour spectrophotometer.

In case of dispute, the preferred method is Method B.

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 2393, *Rubber test mixes — Preparation, mixing and vulcanization — Equipment and procedures*

3 Terms and definitions

No terms and definitions are listed in this document.

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

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

4 Principle

The raw rubber is prepared in the form of a moulded disc of specified thickness.

For Method A, the colour of this disc is compared and matched as closely as possible with that of standard glasses. Colour matching is carried out under diffuse daylight illumination against a matt white background, preferably by use of a comparator which suitably locates and shrouds the test piece and standard glass.

For Method B, the colour of the test piece is compared and matched automatically using a colour spectrophotometer.

[Annex A](#) gives additional information on comparison study between Method A and Method B.

5 Apparatus

The usual laboratory apparatus and, in particular, the following.

5.1 Laboratory mill, conforming to the requirements of ISO 2393.

5.2 Mould, of stainless steel or aluminium, $1,6 \text{ mm} \pm 0,05 \text{ mm}$ thick, having cavities approximately 14 mm in diameter with two mould covers of similar material, 1 mm to 2 mm thick. A suitable mould is illustrated in [Figure 1](#).

5.3 Platen press, capable of applying a pressure of not less than 3,5 MPa over the platen surfaces and maintaining platen temperatures of $150 \text{ }^{\circ}\text{C} \pm 3 \text{ }^{\circ}\text{C}$. Platens with lateral dimensions of $200 \text{ mm} \times 200 \text{ mm}$ are suitable.

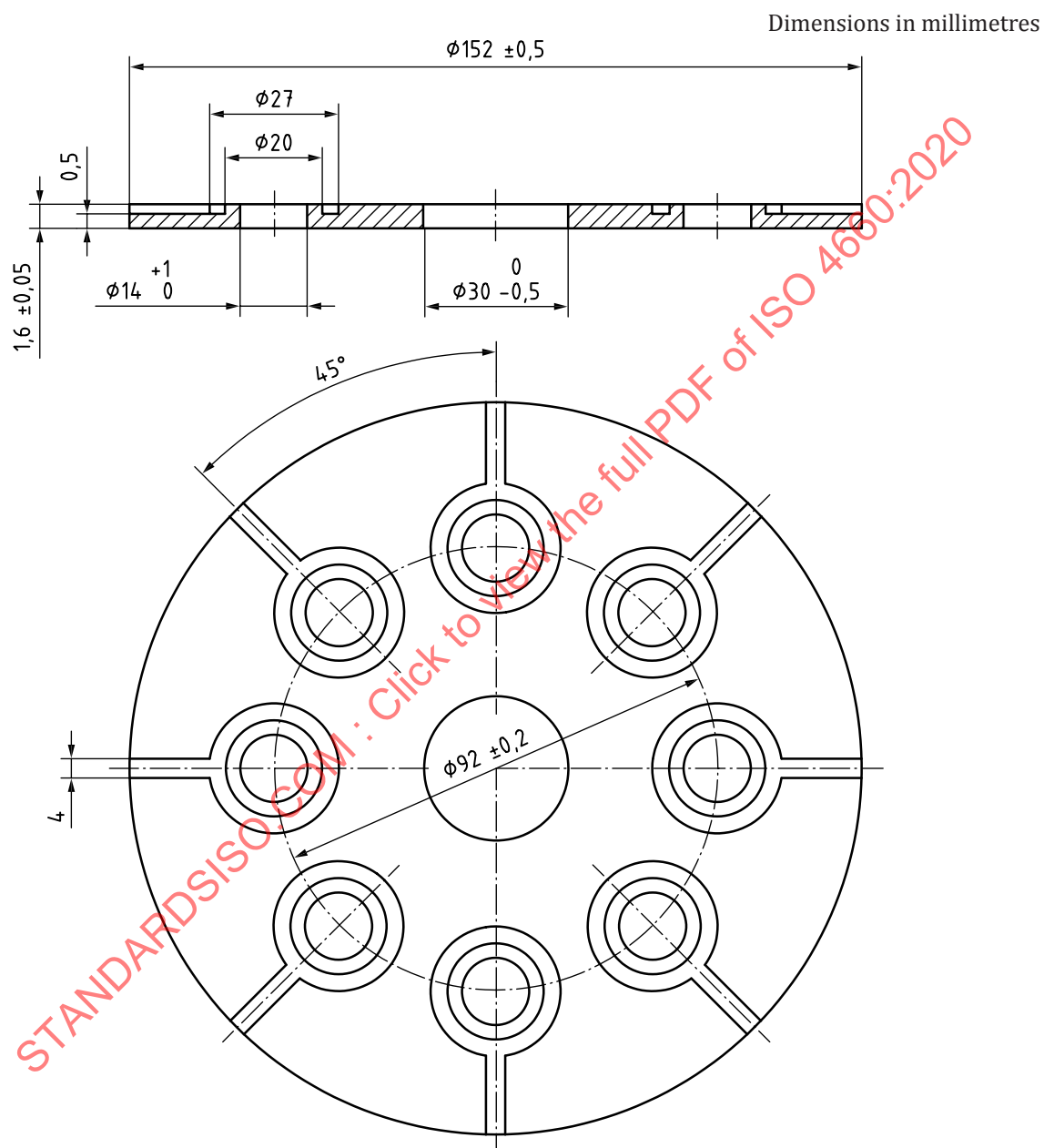


Figure 1 — Mould for colour index test

5.4 Punch, for preparation of the test pieces.

The purpose of the punch is to produce test pieces of approximately constant volume quickly and without difficulty. The punch shall consist of a flat-ended cylindrical anvil and a coaxial tubular knife

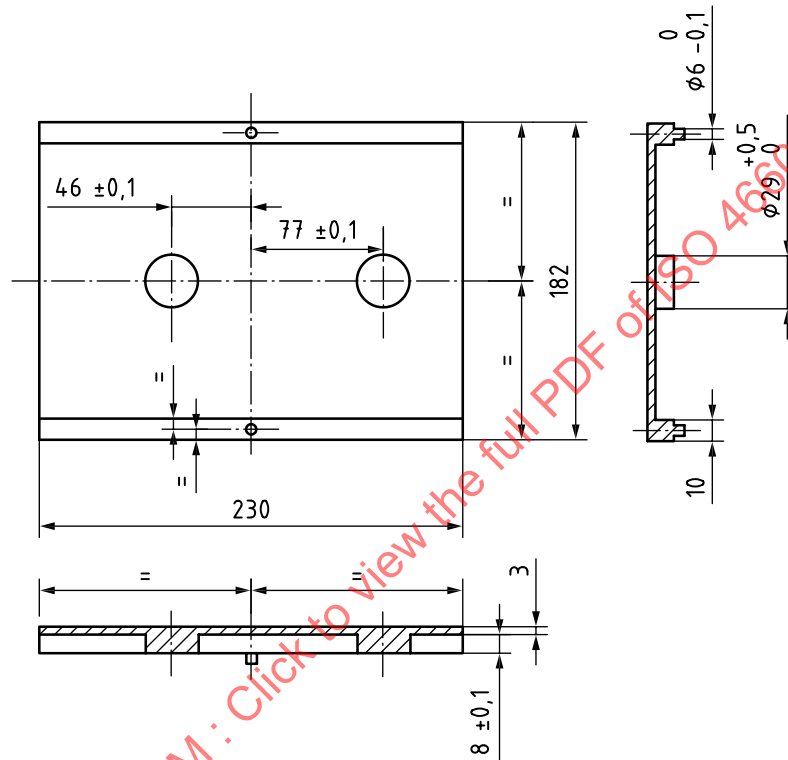
moving independently of one another; a single action of the handle shall compress a portion of the material to a thickness of $3,4 \text{ mm} \pm 0,2 \text{ mm}$ and shall cut a disc of approximately 13 mm diameter.

NOTE This is identical with the test piece punch described in ISO 2007.

5.5 Transparent polyester or cellulose film, approximately 0,025 mm thick.

5.6 Comparator, as illustrated in [Figure 2](#) or as available commercially.

Dimensions in millimetres



a) Base plate

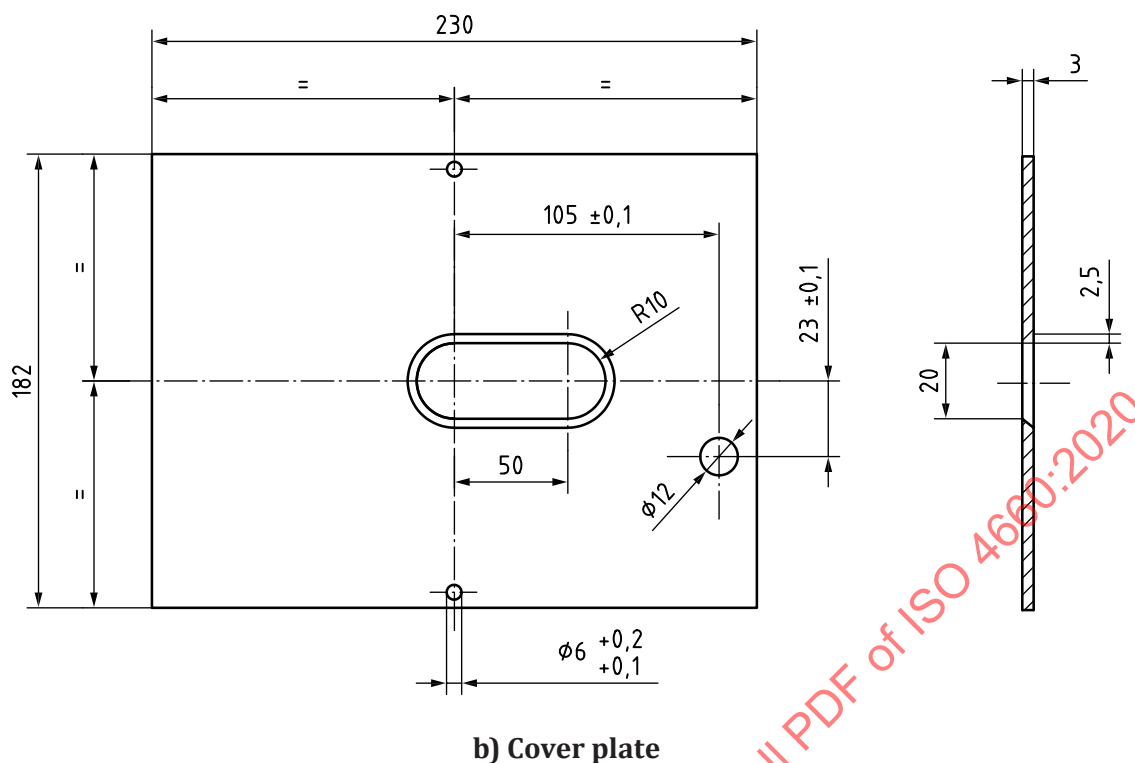


Figure 2 — Comparator for use with commercial Lovibond Comparator discs

5.7 Standard coloured glasses, conforming to the requirements of [Table 1](#) (colour index scale: 1 to 5 units in half-unit steps and 5 to 16 units in unit steps)¹⁾. The standard glasses are produced according to the intensity of amber colour to provide a colour index scale in which the higher index values correspond to darker colours.

Table 1 — Calibration table for standard glasses

Colour index	CIE ^a chromaticity coordinates using standard illuminant B ^b		
	<i>x</i>	<i>y</i>	<i>z</i>
1	0,357 7	0,368 6	0,275 2
1,5	0,362 9	0,372 8	0,265 5
2	0,367 2	0,377 0	0,255 8
2,5	0,373 8	0,380 4	0,245 8
3	0,377 6	0,385 5	0,236 9
3,5	0,384 2	0,389 6	0,226 2
4	0,388 0	0,393 5	0,218 5
4,5	0,392 5	0,397 9	0,211 0
5	0,396 5	0,400 3	0,203 2
6	0,405 0	0,408 9	0,186 1
7	0,414 1	0,412 4	0,173 6

^a Commission Internationale de l'Éclairage (International Commission on Illumination).

^b Standard illuminant B corresponds to the yellower phases of daylight (colour temperature 4 870 K).

1) These glasses are also referred to as Lovibond Comparator discs, 4/19A in 1 to 5 units and 4/19B in 5 to 16 units. They are supplied by Tintometer Limited, Lovibond House, Sun Rise Way Amesbury SP4 7GR, United Kingdom. Tel: +44(0)1980664800, Fax: +44(0) 1980625412. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of the product named.

Table 1 (continued)

Colour index	CIE ^a chromaticity coordinates using standard illuminant B ^b		
	<i>x</i>	<i>y</i>	<i>z</i>
8	0,412 6	0,418 6	0,159 8
9	0,430 2	0,423 0	0,146 9
10	0,437 1	0,425 9	0,137 0
11	0,443 9	0,427 0	0,129 0
12	0,449 1	0,430 8	0,120 0
13	0,454 2	0,432 9	0,113 0
14	0,461 0	0,435 0	0,104 0
15	0,466 2	0,436 1	0,097 7
16	0,471 0	0,438 9	0,090 0
^a Commission Internationale de l'Éclairage (International Commission on Illumination).			
^b Standard illuminant B corresponds to the yellower phases of daylight (colour temperature 4 870 K).			

5.8 Colour spectrophotometer, automated colour measurement instruments that can measure the intensity of wavelengths in a spectrum of light compared with the intensity of light from a standard source (illuminant D65).

6 Procedure

6.1 Test piece preparation

Clean the mill (5.1) thoroughly and then proceed as follows:

Take a test portion of about 20 g ± 5 g from the homogenized piece and pass twice (doubling the sheet between passes) between the mill rolls, at room temperature and with the distance between the rolls adjusted so that the final sheet thickness is 1,7 mm ± 0,1 mm. Immediately double the sheet, which shall be uniform in texture and free from holes, and lightly press the two halves together by hand, avoiding the formation of air bubbles. From the doubled sheet (thickness of 3,4 mm ± 0,2 mm) cut two pellets with the test piece punch (5.4) and press them lightly together.

Press this test piece in the mould (5.2) between two sheets of polyester or cellulose film (5.5), with mould covers superimposed, at a pressure of not less than 3,5 MPa for 5 min ± 0,2 min at 150 °C ± 3 °C. Retain the test piece in the mould, with the transparent cover films attached, for testing. The moulded test piece shall be 1,6 mm ± 0,1 mm thick, excluding cover films, and shall be free from extraneous contaminants.

6.2 Calibration

The colour spectrophotometer shall be calibrated against the manufacturer's instructions. Different colour spectrophotometer may have different method of calibration.

6.3 Colour determination

6.3.1 Method A — Colour matching against standard coloured glasses

Compare the test piece with standard coloured glasses (5.7). Carry out the colour matching under diffuse daylight illumination against a matt white background, viewing in a direction normal to the major surface of the test piece. Take the colour index of the test piece as that of the glass giving the closest colour match.

If the comparator shown in [Figure 2](#) is used, first place a sheet of white paper (with holes to accommodate the projections) on the base plate. Then fit the disc of standard glasses and the filled mould (with transparent cover films attached) over the projections and place the cover plate in position. Carry out the colour matching.

6.3.2 Method B — Colour spectrophotometer

Input the colour index for each standard coloured glass ([5.7](#)) into the colour spectrophotometer. Observe the colour value of each standard colour glasses using the colour spectrophotometer.

Place the test piece on a flat surface against a matt white background. The test piece shall be properly positioned in the middle of the colour spectrophotometer's receiver for accurate reading. Record the colour index given by colour spectrophotometer.

7 Expression of results

Report the colour index of the test piece to the nearest half-unit for index values 1 to 5 and to the nearest unit for higher values (>5).

Very occasionally, the colour of the test piece cannot be matched owing to the presence of strong yellow, green or grey tints. In this case, report that the colour index cannot be determined, stating the reason, e.g. "green tint too strong".

8 Precision and bias

No statement is made about the precision and bias of this test method for measuring colour of raw natural rubber, since the results merely state whether there is conformance to the criteria for the parameter in terms of an index using a comparative standard.

9 Test report

The test report shall include the following:

- a) a reference to this document, i.e. ISO 4660:2020;
- b) all details necessary for the identification of the sample;
- c) the results and the units in which they have been expressed;
- d) any unusual features noted during the determination;
- e) any operation not included in this document or other international standards to which reference is made, plus any operation regarded as optional;
- f) the date of the test.

Annex A (informative)

Comparison study for colour determination method

A.1 Background

Currently, colour matching against standard colour glasses are widely used. This method is dependent on the human eye to compare the colour of the sample with that of the standard colour glasses. For this reason, the readings produced are not consistent.

Colour determination using colour spectrophotometer is a method to define the colour space with numerical coordinates. The value can be recorded such as RGB, Lab, xyz, CMYK. The value is recorded digitally, it is fast and accurate.

In colour determination, delta E (ΔE) is a metric unit for measurement in colour differences. Values of Delta E range from 0 to 100. [Table A.1](#) shows the perception of colour differences.

Table A.1 — Perception of colour differences

Delta E (ΔE)	Perception
$\leq 1,0$	Very small, imperceptible for human eyes
1,0 - 2,0	Small, perceptible through close observation by trained eye
2,0 - 3,5	Medium, perceptible through close observation by untrained eye
3,5 - 5,0	Clear
$> 5,0$	Marked

SOURCE: <http://zschuessler.github.io/DeltaE/learn/>

A study was conducted to provide an alternative method for colour determination of raw rubber. The comparative study was conducted on four samples of light-colour natural rubber grades; namely SMR L (1), SMR L (2), SMR CV60 and TSR CV70. Readings were taken by both methods A and B for eight replicates on two different days. Readings were recorded in Lovibond index value and in CIE colour space ($L^*a^*b^*$).

Results obtained by both methods were compared and the colour differences (delta E) were calculated.

A.2 Results

Results obtained from the study is shown in [Table A.2](#). Identical results were obtained by both methods for SMR L (1) and SMR L (2). However, results for SMR CV60 and TSR CV70 showed slight differences. The readings obtained were consistent on the second day of the study.

Table A.2 — Colour index reading and delta E (ΔE)

Material	Colour determination		
	Standard colour glasses	Colour spectrophotometer	ΔE
SMR L (1)	4,5	4,5	0,00
SMR L (2)	4,5	4,5	0,00
SMR CV60	5,0	4,5	0,94
TSR CV70	6,0	7,0	0,25