

ISO

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

ISO RECOMMENDATION R 878

PLASTICS

DETERMINATION OF RESISTANCE OF PLASTICS
TO COLOUR CHANGE UPON EXPOSURE TO LIGHT
OF THE ENCLOSED CARBON ARC

1st EDITION
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BRIEF HISTORY

The ISO Recommendation R 878, *Plastics – Determination of resistance of plastics to colour change upon exposure to light of the enclosed carbon arc*, was drawn up by Technical Committee ISO/TC 61, *Plastics*, the Secretariat of which is held by the United States of America Standards Institute (USASI).

Work on this question led, in 1963, to the adoption of a Draft ISO Recommendation.

In August 1964, this Draft ISO Recommendation (No. 758) was circulated to all the ISO Member Bodies for enquiry. It was approved, subject to a few modifications of an editorial nature, by the following Member Bodies :

Argentina	Hungary	Romania
Austria	India	South Africa, Rep. of
Belgium	Israel	Switzerland
Canada	Japan	Turkey
Czechoslovakia	Korea, Rep. of	U.A.R.
Finland	Netherlands	United Kingdom
France	New Zealand	U.S.A.
Germany	Poland	U.S.S.R.

Two Member Bodies opposed the approval of the Draft :

Italy
Sweden

The Draft ISO Recommendation was then submitted by correspondence to the ISO Council, which decided, in December 1968, to accept it as an ISO RECOMMENDATION.

PLASTICS

DETERMINATION OF RESISTANCE OF PLASTICS
TO COLOUR CHANGE UPON EXPOSURE TO LIGHT
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1. SCOPE

This ISO Recommendation describes a procedure for assessing the resistance of plastics to colour change upon exposure to light of an enclosed carbon arc.

2. PRINCIPLE OF METHOD

- 2.1 Specimens of the plastics material to be tested are exposed to light, together with pieces of the dyed wool standards specified in ISO Recommendation R 105/1, *Tests for colour fastness of textiles (First series)*, Part 11 : "Colour fastness to light : Daylight". These standards vary in colour fastness to light, No. 8 being the most stable and No. 1 the least stable.

After specified exposure, the degree of contrast between exposed and unexposed portions of the test specimens is compared with that of the dyed wool standards, and the fastness number obtained from the number of the standard which shows a degree of contrast similar to that of the test specimen.

Provision is also made in this ISO Recommendation for the use of other standards and other means of measurement. Related methods are described in the following ISO Recommendations :

ISO Recommendation R 877, *Determination of resistance of plastics to colour change upon exposure to daylight;*

ISO Recommendation R 879, *Determination of resistance of plastics to colour change upon exposure to light of a xenon lamp.*

- 2.2 The quality and intensity of solar radiation at the earth's surface vary with climate, location and time. Consequently, uniform, reproducible exposure ordinarily is not achieved under natural conditions. Laboratory sources of radiation vary among themselves, with ambient conditions and with usage. These variations should be recognized both in measuring the effects of exposure on plastics and in interpreting the results of such measurements. The use of dyed wool standards as a reference provides a means for minimizing the effects of these variables. The carbon arc apparatus permits controlled and rapid evaluation of the resistance of plastics to radiation rich in ultra-violet energy. While radiation may affect other properties of plastics, this method pertains only to its effect on colour.

3. APPARATUS

3.1 Radiation source

The source of light is provided by an enclosed single or twin carbon arc lamp with automatic carbon feed and controls to maintain a current of 15 to 17 A at a potential of 125 to 145 V (r.m.s.) for each arc. The pure carbon electrodes are of the solid or cored type, or both, 13 mm in diameter and of proper length.

3.2 Globe

Each arc is enclosed in a bell-shaped globe made of heat-resistant glass having a lower transmission cut-off at 275 nm and a transmittance of at least 91 % at 370 nm and in the visible region of the spectrum. The globe should fit securely, it should be clean and free of chips or cracks, and it should be so maintained at each change of electrodes. It is discarded whenever noticeable discoloration (as compared with an unused globe) occurs, or in any event after 2000 hours of use.

3.3 Test chamber

3.3.1 Ventilation control. Clean air is circulated through the test chamber and over the test specimens and standards, to prevent excessive rise in temperature.

The air velocity or air temperature may be adjusted to control the temperature. If wet and dry bulb thermometers are used to measure relative humidity in the test chamber, the air velocity at this point should be not less than 3 m per second.

3.3.2 Temperature measurement. Temperature is measured by a black panel thermometer (see Note below) or mercury thermometer with a blackened bulb, mounted in the position normally occupied by the test specimen.

The black panel temperature should not exceed 55 °C.

NOTE. — The black panel thermometer consists of a 0.9 ± 0.1 mm thick steel panel, of a size to fill completely one specimen holder and finished with a black glossy enamel having good resistance to light. The panel is provided with means for measuring its temperature at the centre. A thermocouple or bimetallic thermometer making intimate contact with the panel is suitable.

3.3.3 Relative humidity measurement and control. Relative humidity may be determined by means of wet and dry bulb thermometers mounted on the specimen holder, but shielded from the radiation. If means for control are available, relative humidity is adjusted to the value specified for the material. In a test chamber not equipped for such adjustment, the relative humidity prevailing in it is measured and reported. Materials highly sensitive to humidity should only be tested in a test chamber capable of control.

3.4 Specimen holders

A cylindrical frame between the arc and the shell of the test chamber supports specimen holders which accurately position the test specimens so that they face the arc at a distance of 25.4 cm from the effective centre, with no part more than 6.5 cm above or below the horizontal plane passing through the centre of the source. (For twin arcs, the test specimens are 38 cm from a point midway between the arcs).

3.5 Standards

Blue dyed wool standards No. 1 to No. 8, as specified in ISO Recommendation R 105/I, Part 11, clause 3.1.1.* (See Appendix, section Z.1, of this ISO Recommendation).

3.6 Grey scale

Grey scale for assessing change of colour, as specified in ISO Recommendation R 105/I, Part 2.* (See Appendix, section Z.2, of this ISO Recommendation). In this scale, Grade 1 corresponds to the greatest degree of contrast, and grade 5 to zero contrast (two patterns of identical colour).

* See ISO Recommendation R 105/I, *Tests for colour fastness of textiles (First series)*
Part 2 : "Grey scale for assessing change in colour",
Part 11 : "Colour fastness to light : Daylight".

4. TEST SPECIMEN

- 4.1 The test specimen may conveniently be 60 to 70 mm in length and 20 mm or more in width, according to the dimensions of the specimen holders used.

For film and sheet, the test specimen is cut to size and is of the thickness of the film or sheet.

For moulding materials, a moulded sheet of thickness 3 ± 0.15 mm is prepared and the test specimen cut from this, unless other methods of preparation or other thicknesses are prescribed in the specification for the material.

For materials which may shrink in one direction during the test, the test specimen should be cut with its long dimension at right angles to this direction, since a change in the length of the test specimen may displace the limiting line between exposed and unexposed parts and thus diminish the sharpness of contrast.

- 4.2 One test specimen is used. More may be required for materials which are not of a uniform colour. A further control specimen (or specimens) is required for comparison.

5. PROCEDURE

- 5.1 When a number of specimens are to be tested simultaneously, the test specimens are mounted in the specimen holders facing the source, both above and below the horizontal centre line of the source of radiation.

Each test specimen is mounted so that its back is open to the air and only the minimum area required for holding it touches the holder.

The mounting should not impose appreciable stress on the test specimen.

The test specimens may revolve about the radiation source to ensure even exposure. A suitable rate is from 1 to 5 revolutions per minute. It may also be advisable to interchange test specimens from the upper to the lower row and vice versa during the test, to ensure uniform exposure over their surface. When test specimens are thus exchanged, they must not be inverted in any direction.

When physical characteristics do not permit mounting of the test specimens in the manner described above, they may be otherwise mounted, as deemed necessary. In this event, the method of mounting is agreed between the parties concerned and described in the test report.

- 5.2 The dyed wool standards are similarly mounted in one of the specimen holders.

The control specimens and a control set of dyed wool standards are stored in the dark in one of the standard laboratory atmospheres (see ISO Recommendation R 291, *Plastics – Standard atmospheres for conditioning and testing*).

- 5.3 **Preliminary assessment of colour fastness.** The test specimens and the dyed wool standards, mounted as described in clauses 5.1 and 5.2, are exposed simultaneously for 24 hours per day. The *standards* are inspected frequently, and when a change in standard 3 can just be perceived, the *test specimens* are inspected and their colour fastness rated by comparing any change in colour (see Note below) with the changes in standards 1, 2 and 3.

The preliminary assessment of colour fastness is the number of the standard which shows a visual contrast between exposed portions of the standard and the control standard similar to that of the specimen. If the change in colour of the test specimen is less than the change in standard 3, no preliminary assessment for it is recorded.

NOTE. – The term *change in colour* includes not only true fading, i.e. destruction of colouring matter, but also changes in hue, depth, brightness, or any combination of these characteristics.

- 5.4 Exposure is then continued as before, until a change in standard 4 can just be perceived. At this point, an opaque cover is fixed in position so that one-third of the exposed portions of the test specimens and standards is protected from the light.

Exposure is continued until a change in standard 6 can just be perceived. Then a second opaque cover is fixed so that an additional one-third of the original exposed portions of the test specimens and standards is also protected from the light.

Exposure is continued until either

- (a) a contrast is produced in standard 7 equal to that of Grade 4 of the grey scale, or
- (b) a contrast equal to that of Grade 3 of the grey scale has been produced on the most resistant test specimen,

whichever occurs first.

NOTE. — If desired, when testing very resistant specimens, exposure may be continued until a contrast is produced in standard 8 equal to that of Grade 4 of the grey scale. If this procedure is used, the fact should be stated in the test report.

- 5.5 **Final assessment of colour fastness.** After the prescribed exposure, the test specimens and the dyed wool standards are removed. The test specimens are cleaned with soap and cold water if necessary, dried and examined indoors, in a good north light,* against a white background in comparison with the dyed wool standards.

The change in colour of the test specimen (see Note to clause 5.3) is compared with the changes which have occurred in the dyed wool standards. The colour fastness to light of the carbon arc of the material under test is the number of the standard which shows a similar visual contrast between exposed and unexposed parts. Test specimens which have not changed in colour when standard 7 shows a change equal to Grade 4 of the grey scale are given a rating of 8.

If the test specimen shows changes approximately half-way between two standards, an appropriate half-rating may be given. For example, a light fastness of 3 to 4 means that the test specimen is not as fast as standard 4, but faster than standard 3.

If different assessments are obtained from the areas which have been given different degrees of exposure, the light fastness is the arithmetic mean of these assessments, to the nearest half-rating.

- 5.6 **Colour fastness rating of test specimen.** If the final assessment of colour fastness, according to clause 5.5, is 4 or higher, and a preliminary assessment in accordance with clause 5.3 has been recorded, the preliminary assessment is reported in brackets. For example, a rating of 6(3) indicates that the test specimen has changed slightly in the test when standard 3 begins to change, but that on continuing exposure the resistance to light is equal to that of standard 6.

- 5.7 **Evaluation and expression of results if operating at one stage only.** It is more expedient and often sufficient, for commercial transactions, to compare the test specimen and standards at only one stage of colour change of the test specimens.

The buyer and seller may then decide to discontinue the test in accordance with one of the two following criteria :

- (a) when one of the wool standards 3, 4 or 6, chosen in advance, shows between the exposed and unexposed portions a contrast equal to Grade 4 of the grey scale; or
- (b) when the test specimen shows between the exposed and unexposed portions a contrast similar to that of a grade of the grey scale selected in advance.

* See ISO Recommendation R 105/1, *Tests for colour fastness of textiles (First series)* :
Part 1 : "General principles of testing", section 12.