TECHNICAL REPORT

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Anodized aluminium and aluminium alloys — Accelerated test of weather fastness of coloured anodic oxide coatings using cyclic artificial light and pollution gas

Aluminium et alliages d'aluminium anodisés — Essai accéléré de résistance aux intempéries des couches anodiques colorées par exposition cyclique à la lumière artificielle et à un gaz polluant

Reference number
ISO/TR 11728:1993(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.

The main task of technical committees is to prepare International Standards, but in exceptional circumstances a technical committee may propose the publication of a Technical Report of one of the following types:

— type 1, when the required support cannot be obtained for the publication of an International Standard, despite repeated efforts;

— type 2, when the subject is still under technical development or where for any other reason there is the future but not immediate possibility of an agreement on an International Standard;

— type 3, 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).

Technical Reports of types 1 and 2 are subject to review within three years of publication, to decide whether they can be transformed into International Standards. Technical Reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.

ISO/TR 11728, which is a Technical Report of type 2, was prepared by Technical Committee ISO/TC 79, *Light metals and their alloys*, Sub-Committee SC 2, *Anodized aluminium.*

Two methods of evaluating the weathering property of materials in International Standards exist; one is the outdoor exposure test and the other is the accelerated artificial test. However, there is no International Standard which describes the relation between them or explains why current weathering test methods have been separated into two methods; one is

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a test method for the degradation due to light of organic materials and the other is a test method for the corrosion of inorganic materials.

However, outdoor deterioration the other actually occurs in an environment combining light degradation and corrosion, so that a combined test including both factors should be considered.

For reference, a Japanese standard (JIS-H-8602:1992, *Coatings combined with anodic oxidation and organic finishing on aluminium and aluminium alloys*) has already adopted a test combining the open-flame (sunshine) carbon arc test and the CASS test.

This Technical Report intends to provide the most reliable accelerated test method that simulates the outdoor exposure test and can estimate the service life of a material. It is based on the study, which was conducted by ISO/TC 79/SC 2/WG 7 member bodies for about seven years, for planning and executing the accelerated tests and the outdoor exposure. This study was carried out at three sites for five years, from August 1984 to August 1989, and significant results were obtained.

From this point of view, it was considered preferable to publish, in the form of a Technical Report, a new technique for assessing the weather fastness of coloured anodized oxidation coatings.

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Anodized aluminium and aluminium alloys — Accelerated test of weather fastness of coloured anodic oxide coatings using cyclic artificial light and pollution gas

1 Scope

This Technical Report describes an accelerated test method for assessing the weather fastness, using artificial light and pollution gas, of coloured anodic oxide coatings on aluminium and its alloys.

It specifies the apparatus and procedure to be used in conducting a cyclic test of the light exposure to a xenon arc or an open-flame carbon arc, and of the exposure to sulfur dioxide at a specified concentration under specified conditions of temperature and relative humidity. This test is used to evaluate the weather resistance of coloured anodic oxide coatings under atmospheric conditions, but it does not specify the type of test specimen and the exposure period.

WARNING — The gas used for this test is so hazardous that care must be taken when handling it.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Technical Report. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this Technical Report are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 2135:1984, *Anodizing of aluminium and its alloys — Accelerated test of light fastness of coloured anodic oxide coatings using artificial light.*

ISO 7668:1986, *Anodized aluminium and aluminium alloys — Measurement of specular reflectance and specular gloss at angles of 20 degrees, 45 degrees, 60 degrees or 85 degrees.*

ISO/TR 8125:1984, *Anodizing of aluminium and its alloys — Determination of colour and colour difference of coloured anodic coatings.*

ISO 8993:1989, *Anodized aluminium and aluminium alloys — Rating system for the evaluation of pitting corrosion — Chart method.*

CIE Publication No. 85:1989, *Solar spectral irradiance.*

3 Principle

Exposure of anodized samples to cyclic artificial light and a pollution gas atmosphere, and regular observation of any change in colour and gloss, and generation of corrosion.

4 Apparatus

4.1 Light exposure test

4.1.1 Light source

Use of either of the two items of equipment described in 4.1.1.1 and 4.1.1.2 is recommended.

4.1.1.1 Xenon-arc type

Quartz jacketed xenon long-arc lamps emit radiation in a range which extends from below 270 nm in the ultraviolet through the visible spectrum and into the infrared.

The radiant energy should be filtered to provide a spectral power distribution that closely approximates that of terrestrial daylight, as described in CIE Publication No. 85. (See table 1.)

Table 1 — Relative spectral irradiance for artificial weathering

Wave length nm	Relative spectral irradiance %
280 to 800	100[1)]
< 280 > 280 to 320 > 320 to 360 > 360 to 400	0 1,0 ± 0,2 4,0 ± 0,5 6,0 ± 1,0

1) The spectral irradiance between > 280 nm (or > 300 nm) and 800 nm is defined as 100 %.

When using xenon arcs and filters, their characteristics are subject to due to ageing and they shall therefore be replaced at appropriate intervals. Furthermore, they are subject to changes due to the accumulation of dirt and they shall therefore be cleaned at appropriate intervals.

The spectral irradiance in the band-pass 280 nm to 800 nm shall preferably be 550 W/m^2 at the test specimen face. However, when desired and agreed upon by all the parties concerned, another irradiance may be specified for the same or different spectral band-pass. In any case, those values shall be stated in the test report.

The irradiance on the test specimen area shall not vary by more than + 10 % at any specimen position.

4.1.1.2 Open-flame carbon arc

The performances or the specifications of the light source and the glass filter are shown in table 2.

Type 1 glass was specified in most test methods based upon historical precedence. Types 2 and 3 may be used by mutual agreement between the concerned parties.

Type 1 filter transmits small amounts of radiant energy below the wavelength of daylight that could be very efficient in producing photochemical reactions. Type 2 filter will remove this short wavelength energy that is not normally present in daylight. Type 3 filter is representative of single strength window glass.

4.1.2 Test enclosure

The radiant source(s) shall be located, with respect to the specimens, so that the irradiance at the specimen face complies with 4.1.1.

Should any ozone be generated from operation of the lamp, it shall be isolated from the test specimens and operating personel. If it is in an air stream, it shall be vented directly outside the building.

4.1.3 Black-panel thermometer

The operating temperature shall be determined by maintaining the specified temperature of a black-panel thermometer consisting of a stainless steel panel coated on its exposed surface with a non-selectively absorbing black coating, the spectral reflectance of which shall not exceed 10 % throughout the wavelength region 400 nm to 2 500 nm. The normal dimensions of the panel shall be 70 mm × 150 mm × 1 mm thick.

Table 2 — Performance and use of glass filter

Type	Type 1[1)] %	Type 2[2)] %	Type 3[3)] %
Spectral transmittance prior to use	255 nm : 1 302 nm : 68 375 nm to 700 nm : 90	275 nm : 2 320 nm : 75 400 nm to 700 nm : 65	295 nm : 1 320 nm : 40 400 nm to 700 nm : 90

1) Corex D is an example of a suitable glass available commercially.

This information is given for the convenience of users of this Technical Report and does not constitute an endorsement by ISO of the glass named. Equivalent glass products may be used if they can be shown to lead to the same results.

2) Pyrex 7740 is an example of a suitable glass available commercially.

This information is given for the convenience of users of this Technical Report and does not constitute an endorsement by ISO of the glass named. Equivalent glass products may be used if they can be shown to lead to the same results.

3) Heat resistant glass.

The temperature of the panel shall be determined by either a black-coated stem-type bimetallic dial thermometer or a resistance bulb thermometer, which is centrally positioned and firmly attached to the exposed surface of the black panel.

The black panel shall be mounted on the specimen frame with the coated surface facing the lamp.

The control of the black-panel temperature should preferably be accomplished by air flowing over the specimen at a controlled temperature.

4.1.4 Relative humidity

The relative humidity of the air passing over the test specimens may be controlled at an agreed value, if necessary, and measured by suitable instruments inserted into the test space and shielded from the lamp radiation.

4.1.5 Specimen holders

When it is necessary to support specimens for mounting on the specimen frame, use specimen holders that are made from inert materials which will not interact with the test specimen to influence test results. The specimen holder should not cover any part of the specimen that may critically influence the test result. Unless a specimen backing is specified, the specimen holder shall expose the back of the specimen to the air. Non-oxidizing aluminium alloy and stainless steel have been found to be satisfactory materials. Brass, steel or copper shall not be used.

4.1.6 Radiation meter (optional)

If it is mutually agreed upon by the concerned parties, the irradiance E and the radiant exposure H on the surfaces of the test panels in the test chamber should be measured using a radiation meter with a photoelectronic receptor. The receptor should receive the radiation in a solid angle of 2 sr and evaluate it according to the cosine.

The measuring instrument is to be calibrated according to the relative spectral distribution of the carbon arc over the wavelength interval specified by the spectral response of the detector. The calibration is to be rechecked after an operation period of 1 year, at the latest. The photoelectronic receptor is preferably mounted on a support for a test panel, in such a way that it receives the same radiation as a flat test panel surface on the same support.

The used irradiance E is to be stated in the test report.

4.2 Gas (SO_2) corrosion test

The equipment required for this test shall be constituted of a test chamber equipped with controls of gas concentration, temperature and humidity, sample supports, a gas cylinder suitable for the selected method, a gas quantitative dilution apparatus, and an exhaust air treatment apparatus. Furthermore, the test equipment shall meet the following conditions.

a) It is made from materials which have no effect on the corrosion resistance of the gas employed, and are corrosion-proof themselves.

b) No drop of solution accumulated on the ceiling of the test chamber shall fall on the specimens being tested.

c) It is equipped with a fan capable of foreing the air upwards in the chamber, at a rate of 0,1 m/s to 0,5 m/s, near the surface of test specimen.

d) It maintains the concentration of a gas within a specified range, with a gas detector built into the chamber.

e) The volume of the test chamber is optional, if the specified test condition is obtained.

f) The test equipment shall be constructed so that polluted gas does not leak during the test.

A schematic diagram of typical apparatus is shown in figure 1.

5 Test specimen

5.1 Preparation

5.1.1 Sampling

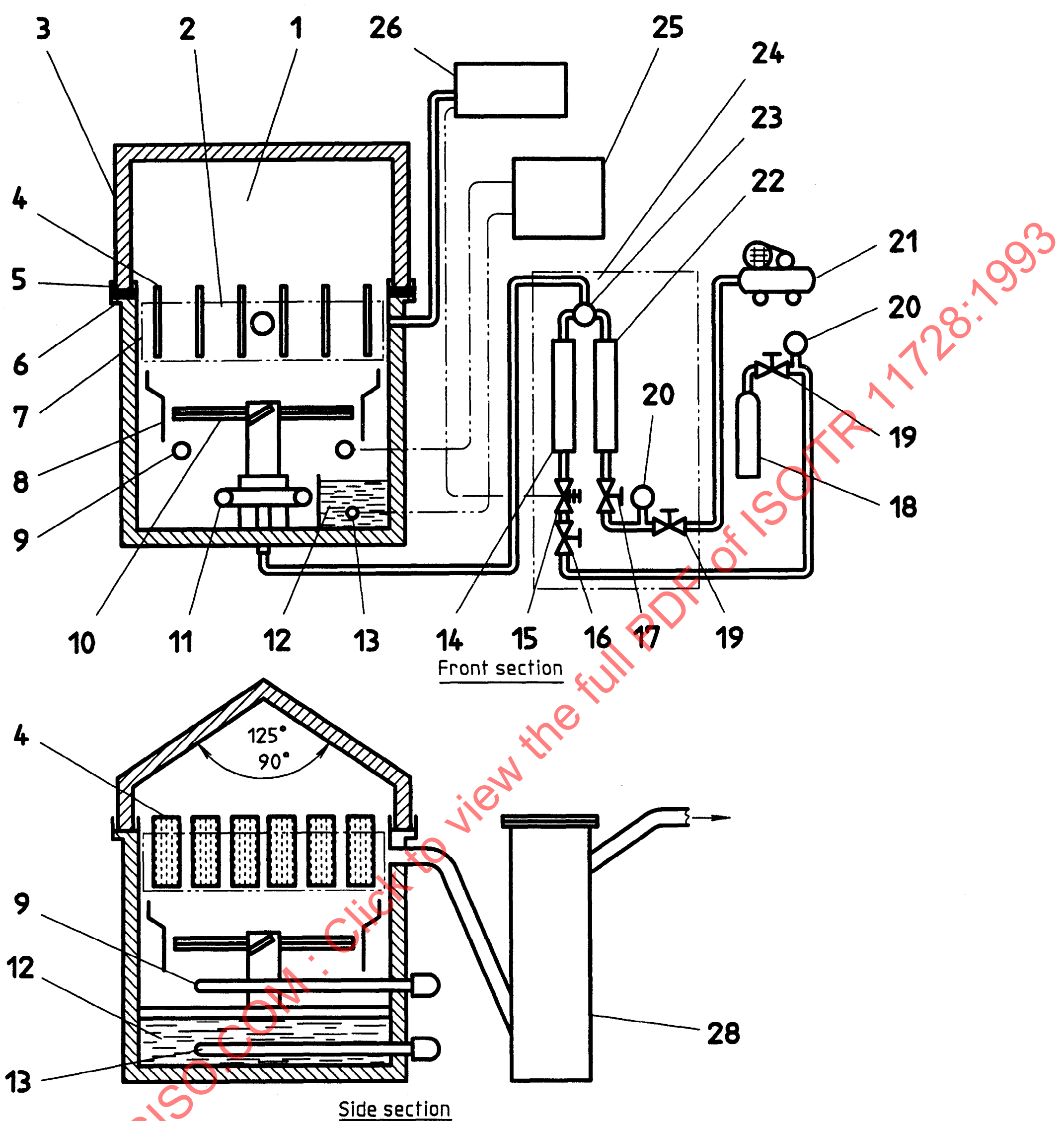
A test specimen shall be taken from the significant surface of the product or prepared so as to represent the product.

5.1.2 Shape and size of test specimen

The size of the sample shall be at least 100 mm × 50 mm, preferably 150 mm × 70 mm. However, other sizes may be used upon agreement between the concerned parties.

5.2 Treatment before test

The test specimens shall be thoroughly cleaned before testing. The cleaning method shall depend on the nature of the surface and the contaminants, and shall not include the use of any abrasive or solvent which may attack the surface.



1 Test chamber
2 Exhaust port
3 Lid
4 Test specimens
5 Water-shield
6 Packing
7 Sample support
8 Air deflecter
9 Chamber heater
10 Fan
11 Gas injection
12 Humidifier
13 Humidifier heater
14 Gas flowmeter
15 Magnet valve
16 Gas-flow control valve
17 Air-flow control valve
18 Gas cylinder
19 Pressure reducing valve
20 Pressure gauge
21 Air supply
22 Air flowmeter
23 Air-gas mixer for gas dilution
24 Gas quantitative dilution apparatus
25 Temperature and humidity control unit
26 Gas concentration control and monitor unit
27 Gas sampling port
28 Exhaust air treatment apparatus

Figure 1 — Typical apparatus for gas corrosion test

6 Procedure

6.1 Exposure conditions

At first, exposure the samples to sulfur dioxide in the corrosion test apparatus under the conditions given in table 3 for 24 h, and then expose them in the light exposure apparatus under the conditions given in table 4 for 500 h continuously. Repeat this procedure three times.

Table 3 — Exposure conditions for sulfur dioxide gas test

Item	Condition
SO_2 concentration	25 ppm ± 5 ppm
Temperature	40 °C ± 1 °C
Relative humidity	80 % ± 5 %

6.2 Extension of exposure duration

The duration of the exposure cycle may be changed by agreement between the parties concerned.

7 Assessment

The results may be assessed using one or more of the following items

a) Colour difference of the samples. This is measured as ΔE^*_{ab} units with a spectral geometry 8/d, according to the CIE L*a*b* scale described in ISO/TR 8125.

NOTE 1 Experience showed that during the measurement procedure it was advisable to measure the samples when wet instead of in the normal dry state, by wetting the surface of samples with distilled water. This is because the results obtained when the samples are wet closely approximate those evaluated by visual observation.

b) Specular gloss. This may be measured for 20°, 45°, 60° and 85° angles according to ISO 7668.

c) Other optical properties of the surface, for example glossiness.

d) Appearance, for example corrosion defect, dirt (see ISO 8993).

8 Test report

The test report shall include the following information:

a) a reference to this Technical Report;

b) the type and identification of the product tested;

c) the type of light exposure apparatus used (xenon arc or open-flame carbon arc);

d) the results of the test;

e) any deviation from the procedure specified;

f) the date of the test;

g) any operation not specified in this Technical Report, or any optional operation which may have influenced the results.

Table 4 — Exposure conditions for light exposure test

Item	Xenon arc	Open-flame carbon arc
Irradiance at sample plane	550 W/m^2 ± 50 W/m^2 for 280 nm to 800 nm	340 W/m^2 ± 60 W/m^2 for 300 nm to 700 nm
Black panel temperature	63 °C ± 5 °C	63 °C ± 3 °C
Relative humidity	50 % ± 5 %	50 % ± 5 %