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**Paints and varnishes — Determination
of resistance to liquids —**

**Part 1:
Immersion in liquids other than water**

*Peintures et vernis — Détermination de la résistance aux liquides —
Partie 1: Immersion dans des liquides autres que l'eau*



Reference number
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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).

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For an explanation on 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 the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 35, *Paints and varnishes*, SC 9, *General test methods for paints and varnishes*.

This third edition cancels and replaces the second edition (ISO 2812-1:2007), of which it constitutes a minor revision. The changes compared to the previous edition are as follows: the CAS numbers have been added to the reagents listed in [Annex A](#) and a terms and definitions clause has been added.

A list of all parts in the ISO 2812 series can be found on the ISO website.

Paints and varnishes — Determination of resistance to liquids —

Part 1: Immersion in liquids other than water

1 Scope

This document specifies general methods for determining the resistance of an individual-layer or multi-layer system of coating materials to the effects of liquids, other than water, or paste-like products (included implicitly in test liquids mentioned in the text).

These methods enable the testers to determine the effects of the test liquid on the coating and, if necessary, to assess the damage to the substrate.

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 1513, *Paints and varnishes — Examination and preparation of test samples*

ISO 1514, *Paints and varnishes — Standard panels for testing*

ISO 2808, *Paints and varnishes — Determination of film thickness*

ISO 3270, *Paints and varnishes and their raw materials — Temperatures and humidities for conditioning and testing*

ISO 3696, *Water for analytical laboratory use — Specification and test methods*

ISO 4618, *Paints and varnishes — Terms and definitions*

ISO 4628-1, *Paints and varnishes — Evaluation of degradation of coatings — Designation of quantity and size of defects, and of intensity of uniform changes in appearance — Part 1: General introduction and designation system*

ISO 4628-2, *Paints and varnishes — Evaluation of degradation of coatings — Designation of quantity and size of defects, and of intensity of uniform changes in appearance — Part 2: Assessment of degree of blistering*

ISO 15528, *Paints, varnishes and raw materials for paints and varnishes — Sampling*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 4618 apply.

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

A coated test panel is exposed to a test liquid by immersion in the test liquid. The effects of the exposures are assessed in accordance with agreed criteria.

5 Apparatus

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

5.1 Vessel, made of inert material, capable of holding the test liquid and test panels.

5.2 Heating cabinet, with artificial ventilation, for carrying out the test at higher temperatures (up to 40 °C to within ± 3 °C).

WARNING — To protect against explosion or fire, products containing volatile flammable liquids should be handled with care.

6 Test liquids

One or more test liquids, as agreed between interested parties, shall be used. Examples of test liquids are given in [Annex A](#).

7 Sampling

Take a representative sample of the coating material to be tested, in accordance with ISO 15528.

Pretest each sample in accordance with ISO 1513 and prepare it for further testing.

8 Test pieces

8.1 Shape and material

8.1.1 Panels

Unless otherwise agreed, use test panels conforming to the requirements of ISO 1514, with dimensions of approximately 150 mm × 100 mm and a thickness of 0,7 mm to 1,0 mm.

8.1.2 Rods

The rod shall be made of steel. One end of a rod shall be rounded, with a radius approximately equal to the radius of the rod.

NOTE 1 Rods with a length of 150 mm and a diameter of 15 mm are suitable.

NOTE 2 Rods are used to eliminate edge effects.

8.2 Preparation and coating

8.2.1 Test panels

Prepare each test panel as described in ISO 1514 and then coat it by the specified application method with the product or system under test. Dry (or stove) and age (if applicable) each coated test panel for the specified time under specified conditions.

For Methods A and B, both sides should preferably be coated and the edges protected. It should be agreed whether the reverse side of the panel will be protected with a sufficiently resistant coating, or whether both sides of the panel will be coated with the coating material under test.

8.2.2 Test rods

Prepare each test rod as specified and then coat it by the specified application method with the product or system under test. Dry (or stove) and age (if applicable) each coated test rod for the specified time under specified conditions.

8.3 Coating thickness

Determine the dry film thickness of the coating, in micrometres, using one of the non-destructive methods specified in ISO 2808.

9 Procedure

9.1 Conditioning of the test panels or rods

Immediately before testing, condition the test panels or rods for at least 16 h under standard conditions as specified in ISO 3270, i.e. (23 ± 2) °C and (50 ± 5) % relative humidity.

9.2 Test liquids with high electrical conductivity

If liquids with high electrical conductivity are used, with the resultant possibility of significant electrolytic effects, only one test piece should be immersed in the test fluid. If several test pieces are immersed in a vessel, these test pieces shall be identical. Moreover, the test liquid shall not be affected by the test pieces.

The test pieces shall be at least 30 mm from the vessel walls and, if several test pieces are immersed in the same vessel, at least 30 mm from one another. The test pieces shall be electrically isolated from their holders.

9.3 Determination

9.3.1 Method A — Single-phase liquid

Perform the test in duplicate.

Pour a sufficient quantity of test liquid into a suitable vessel (5.1) to immerse the test panel or test rod to the required depth.

NOTE 1 Examples of test liquids are given in Annex A.

Stand or hang the test piece in an approximately vertical position in the vessel, so that it is half-immersed in the test liquid.

NOTE 2 Immersion depths other than half-immersion can be used by agreement.

If several test pieces are loaded in the vessel at the same time, make sure that they are spaced at least 5 mm apart or, in the case of highly conductive test liquids, 30 mm apart (see 9.2).

Cover the vessel for the duration of the test, in order to minimize liquid loss due to evaporation or splashing.

If agreed, shake or stir the liquid.

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If agreed, compensate for any loss of liquid by adding test liquid, or water conforming to the requirements of grade 3 of ISO 3696 at specified intervals, in order to keep the initial volume or initial concentration constant.

If agreed, the test may be performed at a higher temperature. The vessel and the test liquid shall already be heated to the specified test temperature in a heating cabinet (5.2) before immersing the test piece. The test temperature shall be maintained with an accuracy of ± 3 °C (see 5.2). The vessel shall only be removed from the cabinet for a short time in order to immerse the test pieces.

The test duration shall be agreed between the interested parties and should reflect the end use of the coating.

9.3.2 Method B — Two-phase liquid

Perform the test in duplicate.

Stand or hang the coated test piece in an approximately vertical position in the vessel. Test panels (see 8.1.1) shall have the 100 mm side horizontal.

Saturate each of the two test liquids with the other immediately before use.

Carefully pour the test liquid having the higher density down the wall of the vessel, until it covers approximately 40 % of the test piece (panel or rod). Make sure that the test piece is not wetted above this level.

Add the second liquid in the same manner, until it covers a further 40 % of the test piece. Cover the vessel and leave it to stand without stirring.

If an intermediate evaluation has been agreed, take the test piece out of the liquid at the appropriate time, remove any remaining liquid from its surface, examine the test piece and re-immerses it in the liquid.

NOTE In case there is a possibility of contamination by the upper liquid of the lower part of the test panels and/or the lower liquid, perform replicate tests for any intermediate assessments.

The test duration shall be agreed between the interested parties and should reflect the end use of the coating.

10 Evaluation

After the test period has expired, wipe the test piece with a cloth. Clean off any dried residue of aqueous test liquids under running water, and clean off the dried residue of any other test liquids with a solvent that does not attack the coating.

Evaluate only the area which has been in direct contact with the test liquid.

Immediately assess the test piece for blistering as specified in ISO 4628-2. Rate any visible alterations as specified in ISO 4628-1.

Unless otherwise agreed, allow the test piece to equilibrate in a dry condition for 24 h, and reassess the exposed area.

Further tests on the exposed and non-exposed areas of the test piece may be performed (e.g. cross-cut test, hardness test).

If the substrate of the test piece is to be examined for visible alterations, remove the coating in conformity with the specified procedure.

If the results of the evaluation of the duplicate determinations differ significantly, repeat the determination, again in duplicate.

Report the results of all determinations, including any repeat determinations.

11 Precision

No details are currently available for the repeatability limit (r) and reproducibility limit (R).

12 Test report

The test report shall contain at least the following information:

- a) all information necessary for identification of the coating examined, including the manufacturer, trade name, batch number, etc.;
- b) a reference to this document (i.e. ISO 2812-1);
- c) details of the test panels and rods, including:
 - 1) the material (including thickness) and surface pretreatment of the substrate;
 - 2) the application method for applying the sample coating to the substrate, including the drying time and drying conditions for all layers; where applicable, ageing conditions before the test;
 - 3) the dry film thickness of the coating, in micrometres, including the measuring method chosen in ISO 2808;
- d) the method used (A or B), including:
 - 1) the specification of the test liquids;
 - 2) the duration of the test;
 - 3) the immersion depth of the test piece in the test liquid;
 - 4) the temperature;
- e) the results of the test as specified in [Clause 10](#);
- f) the name of the person who conducted the test;
- g) any deviations from the procedure specified;
- h) any unusual features (anomalies) observed during the test;
- i) the date of the test.

Annex A (informative)

Examples of test liquids

A.1 General

A range of fuels and chemicals that are typically used as test substances for automotive coatings is given in A.2 and A.3. Other test liquids may be used for testing both automotive and other coatings.

Use only analytical-grade chemicals.

A.2 Fuels and operating fluids for the automotive industry

A.2.1 FAM test substance, conforming to the requirements of DIN 51604-1, DIN 51604-2 or DIN 51604-3.

A.2.2 Diesel fuel, conforming to the requirements of EN 590.

A.2.3 Premium gasoline, conforming to the requirements of EN 228.

A.2.4 Bio-diesel, conforming to the requirements of EN 14214.

A.2.5 Engine oil.

A.2.6 Hypoid gearbox oil.

A.2.7 Hydraulic oil.

A.2.8 Automatic transmission oil.

A.2.9 Brake fluid.

A.2.10 Radiator anti-freeze.

A.2.11 Body sealing compound.

A.2.12 Cavity sealing compound.

A.2.13 Windscreen-washer fluid.

A.2.14 Cold cleaner.

A.3 Laboratory chemicals

A.3.1 Ethanol, CAS-No 64-17-5.

A.3.2 Isopropanol, CAS-No 67-63-0.

A.3.3 Sodium hydroxide solution, with a mass fraction of 5 % sodium hydroxide, CAS-No 1310-73-2.

A.3.4 Hydrochloric acid solution, with a mass fraction of 10 % hydrochloric acid, CAS-No 7647-01-0.

A.3.5 Sulfurous acid solution, with a mass fraction of 6 % sulfurous acid, CAS-No 7782-99-2.

A.3.6 Sulfuric acid solution, with a mass fraction of 10 % sulfuric acid, CAS-No 7664-93-9.

A.3.7 Sulfuric acid solution, with a mass fraction of 36 % sulfuric acid, CAS-No 7664-93-9.

Bibliography

- [1] EN 228, *Automotive fuels — Unleaded petrol — Requirements and test methods*
- [2] EN 590, *Automotive fuels — Diesel — Requirements and test methods*
- [3] EN 14214, *Liquid petroleum products — Fatty acid methyl esters (FAME) for use in diesel engines and heating applications — Requirements and test methods*
- [4] DIN 51604-1, *FAM testing fluid for polymer materials; composition and requirements*
- [5] DIN 51604-2, *Methanolic FAM testing fluid for polymer materials; composition and requirements*
- [6] DIN 51604-3, *Methanolic lower layer FAM testing fluid for polymer materials; composition and requirements*

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