TC 28

International Standard ISO 2160

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Petroleum products — Corrosiveness to copper — Copper strip test

Produits pétroliers — Action corrosive sur le cuivre — Essai à la lame de cuivre

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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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 2160 was prepared by Technical Committee ISO/TC 28, *Petroleum products and lubricants*.

ISO 2160 was first published in 1972. This second edition cancels and replaces the first edition, of which it constitutes a technical revision.

Petroleum products — Corrosiveness to copper — Copper strip test

1 Scope and field of application

This International Standard specifies a method for the determination of the corrosive tendencies towards copper of petroleum products such as aviation gasoline, aviation turbine fuel, automotive gasoline, natural gasoline or other hydrocarbons having a Reid vapour pressure no greater than 124 kPa (1,24 bar), white spirits, cleaners (Stoddard) solvent, kerosene, diesel fuel, distillate heating oil, lubricating oil and certain other petroleum products.[1)]

CAUTION — Some products, particularly natural gasoline, may have a much higher vapour pressure than would normally be characteristic of automotive or aviation gasolines. For this reason, extreme caution must be exercised to assure that the test bomb containing natural gasoline or other products of high vapour pressure is not placed in the 100 °C bath. Samples having Reid vapour pressures in excess of 124 kPa (1,24 bar) may develop sufficient pressure at 100 °C to cause rupture of the test bomb. For any sample having a Reid vapour pressure above 124 kPa (1,24 bar), use ISO 6251, *Liquefied petroleum gases — Corrosiveness to copper — Copper strip test.*

2 Principle

A polished copper strip is immersed in a given quantity of sample and heated at a temperature and for a time specified for the material being tested. At the end of this period, the copper strip is removed, washed, and compared with corrosion standards.

3 Reagents and materials

3.1 Wash solvent

Any volatile, sulphur-free hydrocarbon solvent may be used, provided that it shows no tarnish when tested at 50 °C. Knock test grade *iso*-octane is a suitable solvent and shall be used in case of dispute. Details of the essential requirements of Knock test *iso*-octane are given in the annex.

3.2 Copper strip

Copper strips 12,5 mm wide, 1,5 to 3,0 mm thick, 75 mm long, cut from smooth-surfaced, hard-temper, cold-finished, electrolytic type copper of more than 99,9 % purity; electrical busbar stock is generally suitable.

The strips may be used repeatedly but shall be discarded when they show pitting or deep scratches that cannot be removed, or when the surfaces become deformed on handling.

3.3 Polishing materials

Silicon-carbide abrasive paper of varying degrees of fineness including 65 µm (240 grit) paper or cloth, also supply of 105 µm (150 mesh) silicon-carbide powder, and pharmaceutical grade absorbent cotton (cotton wool).

4 Apparatus

4.1 Test bomb, constructed of stainless steel according to the dimensions shown in figure 1, and capable of withstanding a test pressure of 700 kPa (7 bar) gauge. Alternative designs for the bomb cap and synthetic rubber gasket may be used, provided that the internal dimensions of the bomb are the same as those shown in figure 1.

4.2 Test tubes, 25 mm × 150 mm, as liners for the test bomb, to hold the samples.

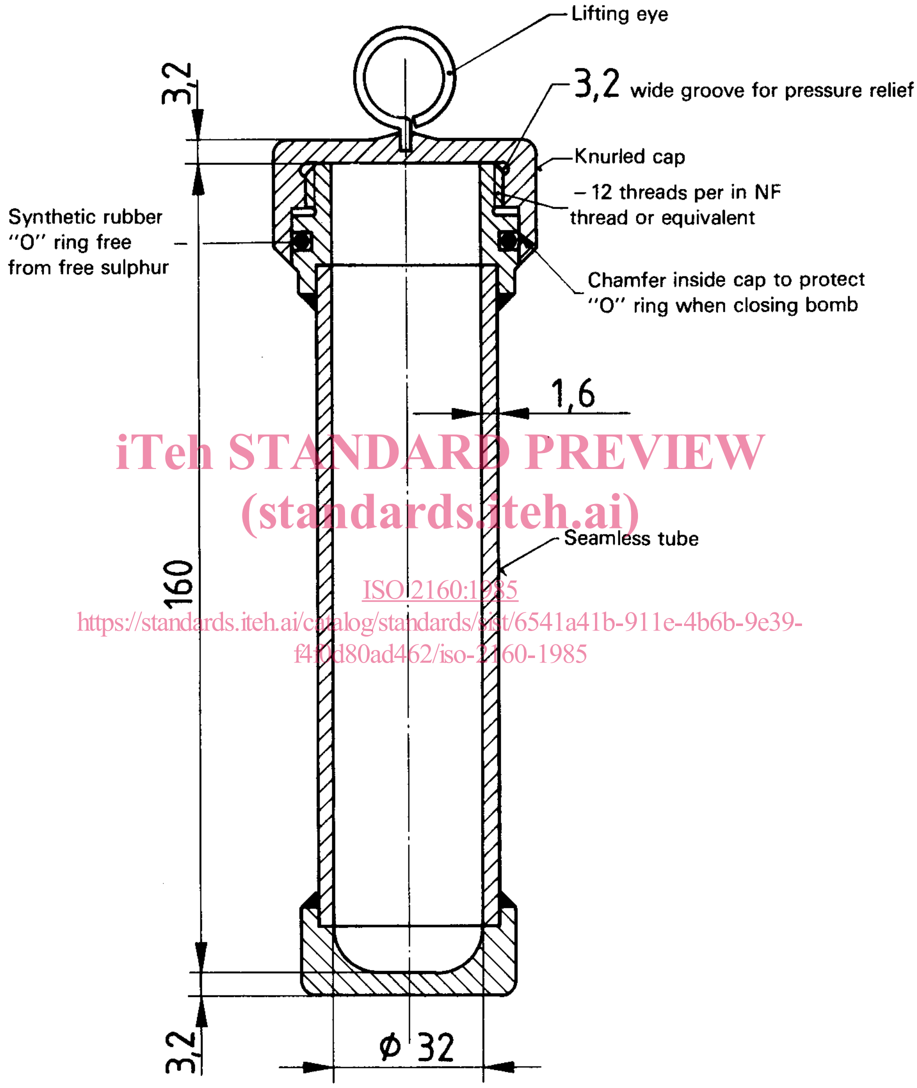
NOTE — The capacity of some thin wall test tubes is such that the sample does not completely cover the copper strip. Such tubes should not be used.

4.3 Water or other liquid baths, capable of being maintained at the specified test temperatures to within ± 1 °C. The normally specified temperatures for the different products are given in section 8.1.2 through 8.1.6. The bath shall have suitable supports to hold the test bomb in a vertical position. The bath shall be deep enough so that the entire bomb will be submerged during the test.

NOTE — Light has been found to have considerable influence on test results. Therefore, the bath should be made of a non-transparent material.

1) A different method of evaluating corrosive tendencies of electrical insulating oils is given in IEC Publication 296, *Specification for new insulating oils for transformers and switchgear.*

Dimensions in millimetres



Material: stainless steel
Welded construction
Maximum test pressure, gauge 700 kPa (7 bar)

Figure 1 — Test bomb for the copper strip corrosion test

4.4 Water or oil bath, or **aluminium block,** capable of being maintained at the specified test temperatures to within ± 1 °C. The normally specified temperatures for the different products are given in section 8.1.2 through 8.1.6. The bath shall have suitable supports to hold the test tube (4.2) upright and submerged to a depth of about 100 mm.

NOTE — Light has been found to have considerable influence on test results. Therefore, the bath should be made of a non-transparent material.

4.5 Polishing vice or holder, for holding copper strips firmly without marring the edges while polishing. Any convenient type of holder may be used provided that the strip is held tightly and that the surface of the strip being polished is supported above the surface of the holder. A suitable apparatus is illustrated in figure 2.

4.6 Viewing test tubes, flat, as shown in figure 3, for protecting corroded strips during close inspection or during storage.

4.7 Thermometers, total immersion, for indicating the required test temperature with the smallest graduations of 1 °C or less. No more than 25 mm of the mercury thread shall extend above the surface of the bath at the test temperature. The ASTM 12 C (12 F) or IP 64 C (64 F) thermometers are suitable.

5 Corrosion standards

The corrosion standards[1] for this test consist of full-colour reproductions, printed on aluminium sheets by a 4-colour process, of typical test strips representing increasing degrees of tarnish and corrosion (see the table). The reproductions are encased for protection in plastics in the form of a plaque. Directions for their use are given on the reverse side of each plaque.

The plastics-encased corrosion standards shall be protected from light to avoid the possibility of fading. They shall be inspected for fading by comparing two different plaques, one of which has been carefully protected from light (new). Both sets shall be observed in diffused daylight (or equivalent), first from a point directly above and then from an angle of 45°. If any evidence of fading is observed, particularly at the left-hand end of the plaque, it is suggested that the plaque be discarded.

Alternatively, a 20 mm opaque strip (masking tape) shall be placed across the top of the colour portion of the plaque when initially purchased. At intervals, the opaque strip shall be removed and an examination made for any evidence of fading of the exposed portion. If any fading has occurred, it is suggested that the corrosion standard be replaced.

If the surface of the plastics cover shows excessive scratching, it is suggested that the corrosion standard be replaced.

Table — Classification of corrosion standards

Classification	Designation	Description*
Freshly polished strip	—	**
1	Slight tarnish	a Light orange, almost the same as a freshly polished strip
		b Dark orange
2	Moderate tarnish	a Claret red
		b Lavender
		c Multicoloured with lavender blue and/or silver overlaid on claret red
		d Silvery
		e Brassy or gold
3	Dark tarnish	a Magenta overcast on brassy strip
		b Multicoloured with red and green showing (peacock), but no grey
4	Corrosion	a Transparent black, dark grey or brown with peacock green barely showing
		b Graphite or lustreless black
		c Glossy or jet black

* The corrosion standard is made up of strips characteristic of these descriptions.

** The freshly polished strip is included in the series only as an indication of the appearance of a properly polished strip before a test run. It is not possible to duplicate this appearance after a test with a completely noncorrosive sample.

6 Preparation of test strips

6.1 Surface preparation

Remove all surface blemishes from all six sides of a copper strip (3.2) with silicon-carbide paper (3.3) of such degrees of fineness as are needed to achieve the desired results efficiently. Finish with 65 µm (240 grit) silicon-carbide paper or cloth, removing all marks that may have been made by other grades of paper used previously. Immerse the copper strip in wash solvent (3.1) from which it may be withdrawn immediately for final polishing or in which it may be stored for future use.

As a practical manual procedure for surface preparation, place a sheet of the abrasive paper on a flat surface, moisten it with kerosine or wash solvent (3.1) and rub the copper strip against the paper with a rotary motion, protecting the strip from contact with the fingers with an ashless filter paper. Alternatively,

1) Available from the Headquarters of the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103, USA.

Dimensions in millimetres

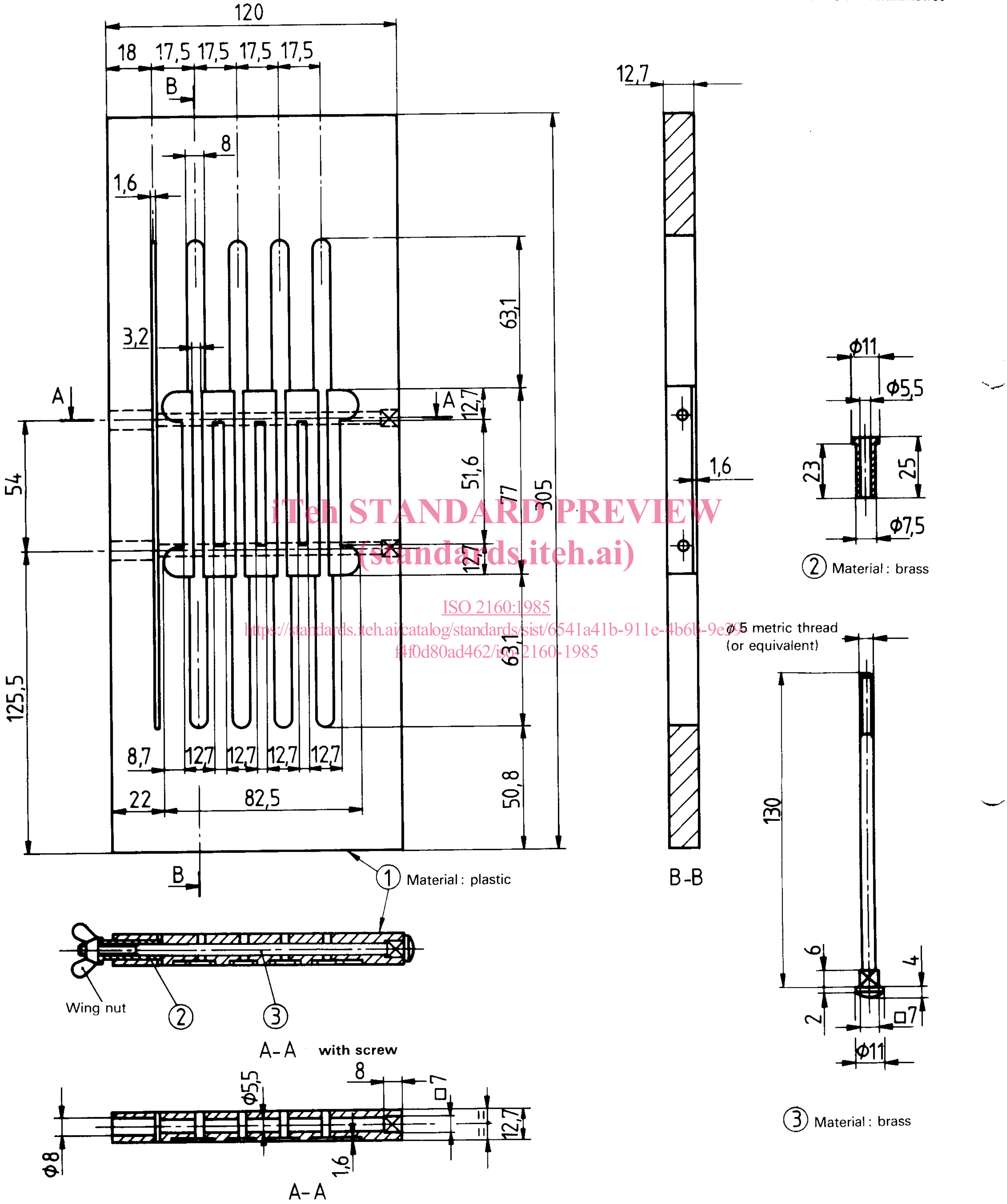
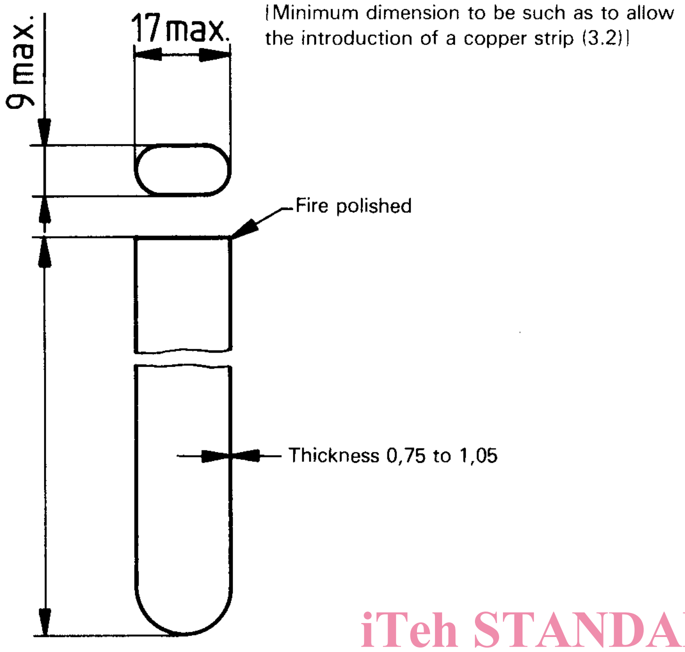


Figure 2 — Multistrip vice

Dimensions in millimetres



The tubes shall be free of striae or similar defects.

Figure 3 — Viewing test tube

the surface of the copper strip may be prepared by use of motor-driven machines using appropriate grades of dry paper or cloth.

NOTE — If kerosene is used to moisten the abrasive paper, it should have a low sulfur content. It is preferable to use a sulfur-free wash solvent and, as indicated in 3.1, knock grade *iso*-octane shall be used in case of dispute.

6.2 Final polishing

Remove a strip from the wash solvent. Holding it in the fingers, protected with ashless filter paper, polish first the ends and then the sides with the 105 µm (150 mesh) silicon-carbide powder (3.3) picked up from a clean glass plate with a pad of absorbent cotton moistened with a drop of wash solvent. Wipe vigorously with fresh pads of absorbent cotton and subsequently handle only with stainless steel forceps; **do not touch with the fingers.** Clamp in a vice (4.5) and polish the main surfaces with silicon-carbide powder on absorbent cotton. Rub in the direction of the long axis of the copper strip, carrying the stroke beyond the end of the strip before reversing the direction. Clean all metal dust from the strip by rubbing vigorously with clean pads of absorbent cotton until a fresh pad remains unsoiled. When the strip is clean, immediately immerse it in the prepared sample.

NOTE — It is important to polish the whole surface of the strip uniformly to obtain a uniformly stained strip. If the edges show wear (surface elliptical), they will be likely to show more corrosion than the centre of the strip. The use of a vice will facilitate uniform polishing.

7 Sampling and samples

7.1 It is particularly important that all types of test samples which should pass a low-tarnish strip classification be collected in clean, dark glass bottles, plastic bottles or other suitable containers that will not affect the corrosive properties of the product. Avoid the use of tinplate containers for the collection of samples, since experience has shown that they may contribute to the corrosiveness of the sample.

7.2 Fill the containers as completely as possible and close them immediately after taking the test sample. Take care during sampling to protect the test samples from exposure to direct sunlight or even diffused daylight. Carry out the test as soon as possible after receipt at the laboratory, and immediately after opening the container.

7.3 If suspended water (haze) is observed in the test sample, dry by filtering a sufficient volume of the test sample through a medium rapid qualitative filter into a clean, dry test tube (4.2). Carry out this operation in a darkened room or under a light-protected shield.

NOTE — Contact of the copper strip with water before, during, or after the completion of the test run will cause staining, making it difficult to evaluate the strips.

8 Procedure

8.1 Test conditions

8.1.1 General

Those product classes to which given procedural variations are intended to be applied are listed below. Some product classes, being quite broad, may be tested by more than one set of conditions; in such cases, the copper strip quality requirement for a given product shall be limited to a single set of conditions.

8.1.2 Aviation gasoline and aviation turbine fuel

Place a 30 ml test portion, completely clear and free of any suspended or entrained water (see 7.3), into a chemically clean, dry test tube (4.2) and within 1 min after completing the final polishing, slide the copper strip into the test portion in the tube. Carefully slide the test tube into the test bomb (4.1) and screw the lid on tight. Completely immerse the test bomb in the water bath (4.3) at 100 ± 1 °C. After 2 h ± 5 min in the bath, withdraw the bomb and immerse for a few minutes in tap water. Open the bomb, withdraw the test tube and examine the strip as described in 8.2.

8.1.3 Natural gasoline

Carry out the test as described in 8.1.2, but at a temperature of 40 °C and for 3 h ± 5 min. (See Caution statement to clause 1.)

8.1.4 Diesel fuel, distillate heating oil, automotive gasoline

Place a 30 ml test portion, completely clear and free of any suspended or entrained water (see 7.3), into a chemically clean, dry test tube (4.2) and, within 1 min after completing the final polishing, slide the copper strip into the sample tube. Stopper with a vented cork and place in the bath (4.4) maintained at the required temperature within 1 °C. Water bath (4.4) temperatures used for testing this group of petroleum products may vary. National and other local specifications often require that the test be conducted at 50 ± 1 °C or, alternatively, at 100 ± 1 °C. Protect the contents of the test tube from strong light during the test. After 3 h ± 5 min in the bath, examine the strip as described in 8.2.

NOTE — As the temperature of the bath (4.4) can be at any of several test temperatures, it is important when specifying or referring to this method that the temperature of the test also be included in the specification or reference.

8.1.5 White spirits, cleaners (Stoddard) solvent, kerosene

Carry out the test as described in 8.1.4, but at a temperature of 100 °C.

8.1.6 Lubricating oil

Carry out the test as described in 8.1.4.

Tests may be carried out for varying times and at elevated temperatures other than 100 °C. For the sake of uniformity, it is suggested that even increments of 30 °C, beginning with a temperature of 120 °C, be used.

8.2 Strip examination

Empty the contents of the test tube into a 150 ml tall-form beaker, letting the copper strip slide in gently so as to avoid breaking the beaker. Immediately withdraw the strip with stainless steel forceps and immerse it in the wash solvent (3.1). Withdraw the strip at once, dry with quantitative filter paper (by blotting and not by wiping), and inspect for evidence of tarnishing or corrosion by comparison with the corrosion standards. Hold both the test strip and the standards in such a manner that light reflected from them at an angle of approximately 45° will be observed.

In handling the test strip during the inspection and comparison, the danger of marking or staining can be avoided if it is inserted in a flat tube (4.6) which is stoppered with absorbent cotton.

9 Expression of results

9.1 Express the corrosiveness of the test portion in accordance with one of the classifications for the corrosion standards as listed in the table.

9.2 When a strip is in the obvious transition state between that indicated by any two adjacent standards, judge the sample by the more tarnished standard. Should a strip appear to have a darker orange colour than standard 1b, consider the observed strip as still belonging in classification 1; however, if any evidence of red colour is observed, the observed strip belongs in classification 2.

9.3 A claret red strip in classification 2 can be mistaken for a magenta overcast on brassy strip in classification 3 if the brassy underlay of the latter is completely masked by a magenta overtone. To distinguish between the two, immerse the strip in wash solvent; the former will appear as a dark orange strip, while the latter will not change.

9.4 To distinguish between multicoloured strips in classifications 2 and 3, place the test strip in a test tube (4.2) and bring it to a temperature of 340 ± 30 °C in 4 to 6 min with the tube lying on a hot-plate. Adjust the temperature while observing a high distillation thermometer in a second test tube. If the strip belongs in classification 2, it will assume the colour of a silver and then a gold strip. If the strip belongs in classification 3 it will take on the appearance of a transparent black, etc., as described in classification 4.

9.5 Repeat the test if blemishes are observed due to fingerprints or to spots from any particles or water droplets that may have touched the test strip during the digestion period.

9.6 Repeat the test also if the sharp edges along the flat faces of the strip appear to be in a classification higher than the greater portion of the strip; in this case it is likely that the edges were burnished during polishing.

10 Test report

The test report shall contain at least the following information:

a) the type and identification of the product tested;

b) the temperature of the test;

c) the duration of heating;

d) a reference to this International Standard or to a national standard;

e) the result of the test (see clause 9);

f) any deviation, by agreement or otherwise, from the procedure specified;

g) the date of the test.

Annex

Specification for Knock test grade *iso*-octane

(This annex forms an integral part of the Standard.)

Density at 20 °C, g/ml	0,691 9 ± 0,000 2
Refractive index n_D^{20}	1,391 5 ± 0,000 2
Freezing point, °C	− 107,4 min.
Distillation:	
50 % recovered, °C	99,2
Differential 80 % recovered minus 20 % recovered, °C	0,02 max.