INTERNATIONAL STANDARD ISO 3690

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

Welding — Determination of hydrogen in deposited weld metal arising from the use of covered electrodes for welding mild and low alloy steels

Soudage — Détermination de l'hydrogène dans le métal fondu en provenance des électrodes enrobées pour le soudage des aciers non alliés ou faiblement alliés

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FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO Member Bodies). The work of developing International Standards is carried out through ISO Technical Committees. Every Member Body interested in a subject for which a Technical Committee has been set up 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.

International Standard ISO 3690 was drawn up by Technical Committee ISO/TC 44, *Welding*, and was circulated to the Member Bodies in March 1975.

It has been approved by the Member Bodies of the following countries :

Australia	India	Romania
Austria	Ireland	Spain
Brazil	Israel	Sweden
Bulgaria	Italy	Switzerland
Canada	Netherlands	Turkey
Czechoslovakia	New Zealand	United Kingdom
Finland	Norway	Yugoslavia
France	Poland	
Germany	Portugal	

The Member Bodies of the following countries expressed disapproval of the document on technical grounds :

Belgium
Japan
U.S.A.

Printed in Switzerland

Welding — Determination of hydrogen in deposited weld metal arising from the use of covered electrodes for welding mild and low alloy steels

1 SCOPE

This International Standard specifies a method for determining the content of diffusible hydrogen in deposited weld metal arising from the use of covered electrodes for welding mild and low alloy steels.

2 FIELD OF APPLICATION

This International Standard is applicable to the verification of the content of hydrogen corresponding to the symbol H in ISO 2560 when mercury is used to determine diffusible hydrogen. In addition, the same method of welding and sampling can be applied for the determination of the total hydrogen value.

3 REFERENCES

ISO/R 630, *Structural steels.*

ISO 2560, *Covered electrodes for manual arc welding of mild steel and low allow steel — Code of symbols for identification.*

4 PRINCIPLE

The electrode to be tested is used to deposit a single weld bead which is rapidly quenched. Both the welding and quenching procedures are carefully controlled. The specimen so produced is maintained at room temperature for a sufficient time to release its content of diffusible hydrogen, which is measured by volumetric methods and reported on unit mass of deposited or fused weld metal.

The total hydrogen content is defined for the present purposes as the sum of the diffusible and residual contents, the latter being determined by hot extraction at 650 °C under vacuum or in a carrier gas.

5 MATERIALS REQUIRED FOR TEST

5.1 Parent plate material

The test piece assembly shall be prepared from a grade of steel conforming to ISO/R 630 Fe 37 B (non-rimming quality) or equivalent. Prior to use in a determination of total hydrogen content, the test piece shall be degassed under conditions equivalent to those employed in the subsequent hot extraction.

5.2 Electrodes

Electrodes to be tested according to the present procedure shall be of 4 mm core wire diameter, or of 3,15 mm diameter in the case of electrodes of a metal recovery higher than 130 %.

The electrodes to be tested shall be dried at 125 °C for 2 h if no directions for drying are supplied by the manufacturer. This drying procedure is not to be applied to electrodes containing more than 5 % by mass of cellulose in their coatings. If the electrode is claimed to be a hydrogen-controlled brand, the drying temperature shall be 250 °C for 2 h; if the maker recommends a pre-drying treatment in practical application of the electrodes, this procedure shall be followed.

5.3 Welding fixture

A copper jig, as shown in figure 1, allows alignment and clamping of the test piece assembly.

6 APPARATUS

Apparatus for determination of diffusible hydrogen

An example of a gas burette for the measurement of cold extracted gas is shown in figure 2. Burettes of other design may be employed, provided that the following requirements are fulfilled :

1) mercury is used as the confining liquid;

2) it is possible to maintain the sample under vacuum for a brief period as specified in 7.1.4 to remove any trace of foreign gases trapped on the fractured surfaces of the sample; in burettes consisting of a single limb, this may be achieved through manipulation of the mercury level and the stopcock which has been verified for gas tightness, any gas released during the brief period of surface degassing being swept out of the burette before the measurements;

3) all necessary provisions are made to measure the volume of the collected gas with an accuracy of at least 0,05 ml under conditions of normal temperature and pressure.

7 PREPARATION OF TEST SPECIMEN

7.1 Test piece assembly

Duplicate sets of test pieces having a cross-section of 10 mm × 15 mm shall be used for each type of electrode to be tested. Beads of 100 mm overall length shall be deposited along the centre line of the test piece assembly. No burning-off prior to the testing is allowed.

The test piece assembly shown in figure 1 consists of run-on and run-off pieces, and a central sample section of 30 mm total length. Duplicate determinations shall be made using the entire length of this section. It may be divided into four specimens each of 7,5 mm length as indicated in figure 1, or two specimens each of 15 mm, or one specimen of 15 mm and two specimens of 7,5 mm. Three optional combinations are recommended :

1) Nos. 1 and 4 (2 × 7,5 mm) analysed jointly.

Nos. 2 and 3 (2 × 7,5 mm) analysed jointly.

2) Nos. 1 and 4 (2 × 7,5 mm) analysed jointly.

Central specimen (15 mm) analysed separately.

3) Two specimens (15 mm each) analysed separately.

The test piece dimensions specified in figure 1 shall be maintained within the limits ± 0,25 mm; however, each set comprising run-on and run-off pieces and the central section shall be finished in one operation of grinding so as to ensure a uniform width, and the surfaces of the cross-sections shall be machined to ensure good contact between adjacent pieces.

The central specimens shall be marked and weighed to the nearest 10 mg.

7.2 Welding

The temperature of the jig shall be 25 ± 5 °C prior to testing. The welding current shall be 15 A less than the maximum stated by the manufacturer, the machine setting being controlled within a tolerance of ± 5 A. The speed of welding shall be adjusted to an electrode consumption between 1,2 and 1,3 cm per centimetre of bead length. The time spent in the deposition shall be noted.

Three seconds after extinction of the arc, the jig is released and the test piece assembly is quenched in iced water and subsequently in alcohol or acetone saturated with solid carbon dioxide. The sample pieces are wire brushed and broken apart while cold. Using brief intermittent periods of cooling, the intervals spent outside the cooling bath in these operations shall not exceed 10 s each. The samples may now be stored at the temperature of solid carbon dioxide for a period up to 3 days before analysis.

8 TEST PROCEDURE

8.1 Preparation of specimen for analysis

When transferring the samples to the gas burette, a shield of dry nitrogen shall be applied, to avoid condensation of atmospheric humidity. The sequence of operations and the time spent in each of these shall be as follows :

1) Wash in alcohol for a period of 3 to 5 s.

2) Wash in pure ether for a period of 3 to 5 s.

3) Dry in a blast of dry nitrogen supplied from a nozzle, particular attention being paid to the fractured faces of the specimen. This operation shall be accomplished in not less than 20 s and not more than 22 s.

4) Maintaining a blanket of dry nitrogen, transfer the sample to the outer limb of the burette, where the sample is held in position clear of the mercury surface by a magnet. Evacuate the outer limb of the burette to a pressure of approximately 0,1 mmHg.[1] The time spent in these operations shall be not less than 20 s and not more than 25 s.

5) Transfer the sample through the mercury air-lock to its final position in the measuring limb of the burette. This operation shall be accomplished within 5 s.

The total time spent in transferring the sample until the measurements commence shall thus not exceed 60 s.

8.2 Analytical procedure (diffusible hydrogen)

The sample is maintained under reduced pressure at 25 ± 5 °C for a period of 72 h before the final volume is measured; the precise temperature and pressure of the hydrogen shall be recorded. The samples are removed from the apparatus, thoroughly brushed to remove any oxide skin, and weighed to the nearest 10 mg. The gain in mass corresponds to the mass of deposited metal. In order to determine the mass of deposited weld metal, the bead cross-section shall be measured and the gain in mass multiplied by the average ratio

$$\frac{\text{deposited weld metal area}}{\text{deposit area}}$$

determined on two faces of the specimen. These measurements are made after hot extraction if the residual hydrogen content is also to be assessed.

9 CALCULATIONS AND EXPRESSION OF RESULTS

The volume measured after 72 h is converted to volume at 0 °C and 760 mmHg.[1] This volume, divided by one-hundredth of the gain in mass, is the diffusible hydrogen content, in millilitres per 100 g of deposited metal[2].

1) 1 mmHg = 133,322 N/m².

2) Multiply by 0,9 for conversion to p.p.m.

The diffusible hydrogen content, in millilitres per 100 g of fused metal, is found by dividing the gas volume (STP) under conditions of normal temperature and pressure by one-hundredth of this mass. Each separate content shall be reported, together with the average for each of the two beads tested and the overall average of the four values.

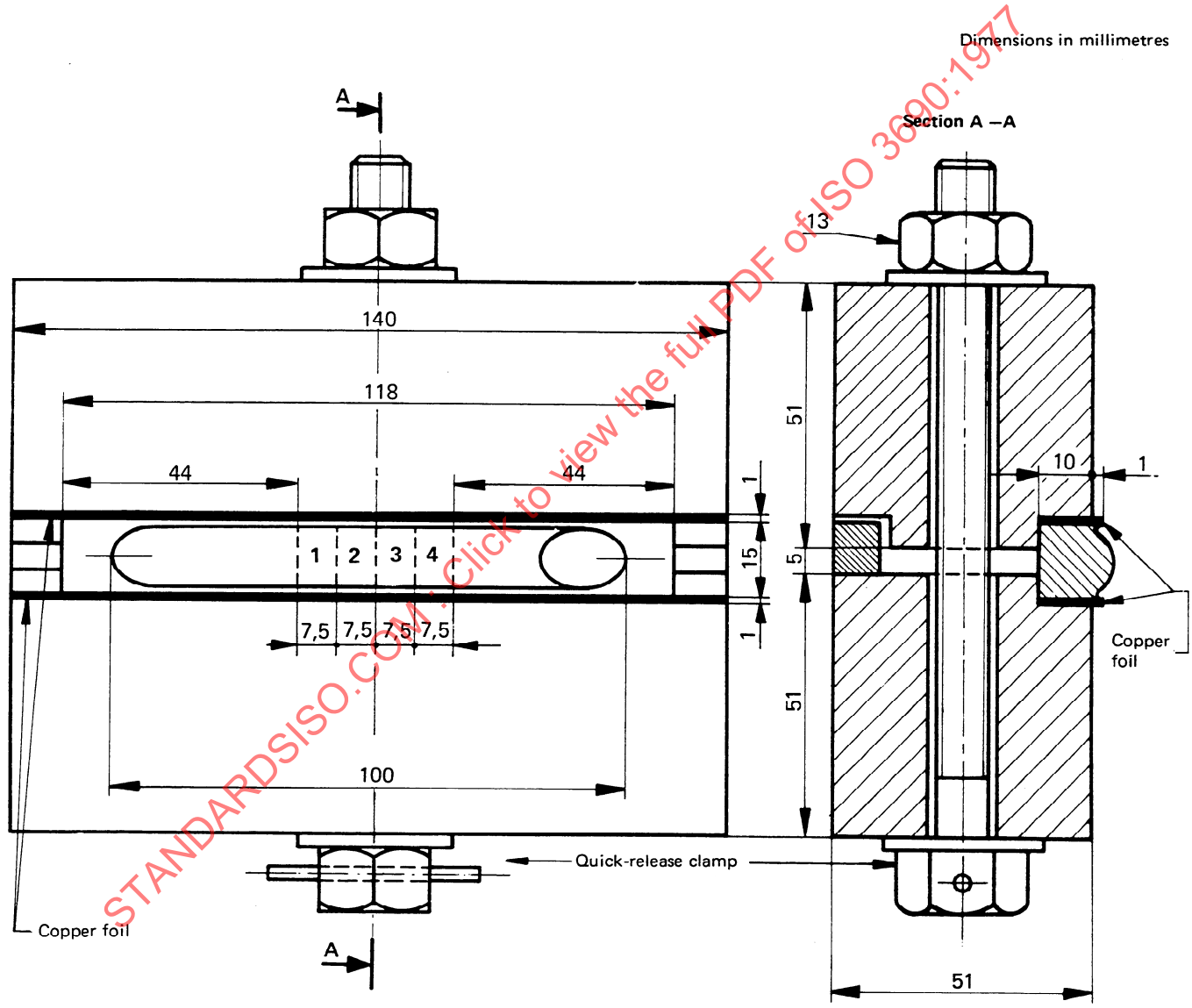

FIGURE 1 — **Test piece assembly for hydrogen sampling of weld deposits**

Dimensions in millimetres

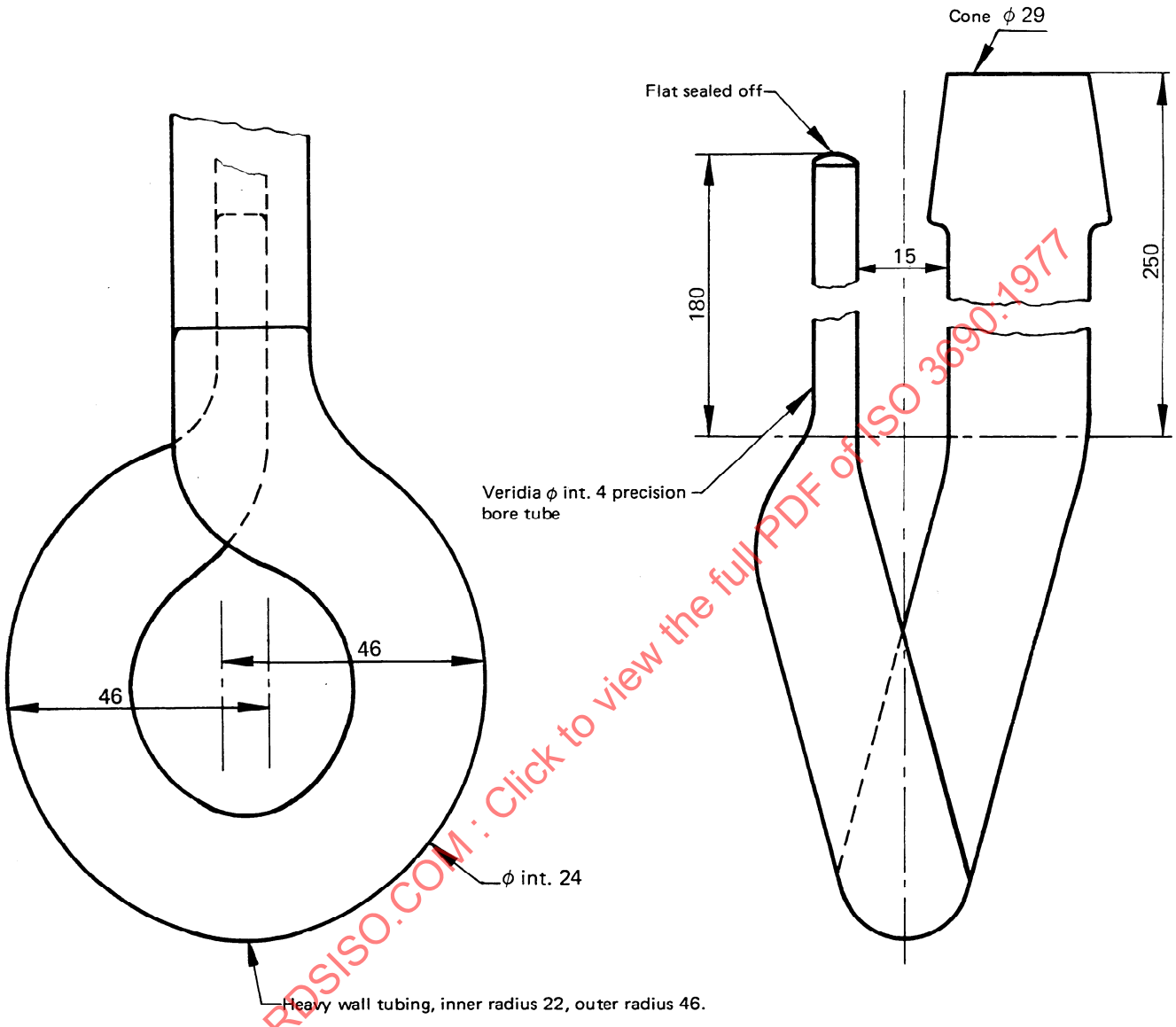

FIGURE 2 — **Diffusible hydrogen collecting apparatus**