BRITISH STANDARD

BS 6693-2: 1986

Diffusible hydrogen —

Part 2: Method for determination of hydrogen in manual metal-arc weld metal

UDC 621.791.753:621.791.042.4:546.11 – 13.06

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Welding Standards Committee (WEE/-) to Technical Committee WEE/39, upon which the following bodies were represented:

British Association for Brazing and Soldering
British Railways Board
British Shipbuilders
British Steel Industry
British Steel Industry (Wire Section)
Electricity Supply Industry in England and Wales
Engineering Equipment and Materials Users' Association
Process Plant Association
Society of Motor Manufacturers and Traders Limited
Water-tube Boilermakers' Association
Welding Institute
Welding Manufacturers' Association (BEAMA Ltd.)
Coopted member

This British Standard, having been prepared under the direction of the Welding Standards Committee, was published under the authority of the Board of BSI and comes into effect on
31 March 1986

The following BSI references relate to the work on this standard:
Committee reference WEE/39
Draft for comment 82/70403 DC

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Amendments issued since publication

Amd. No.	Date of issue	Comments

Contents

Foreword

This British Standard has been prepared under the direction of the Welding Standards Committee and is being published in separate Parts covering different methods of determining diffusible hydrogen.

This Part of BS 6693 was first published as Appendix A of BS 2493:1985. It was intended to use this method for the revision of BS 639 but it was realized that this could cause some confusion as the method given in BS 639 is called up in other standards. It was therefore decided to issue the BS 639:1976 method as BS 6693-1 and the revised method to be issued as BS 6693-2.

It has been assumed in the drafting of this British Standard that the execution of its provisions is entrusted to appropriately qualified and experienced people.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 6, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

This Part of BS 6693 describes a method for the determination of hydrogen in manual metal-arc weld metal and where collection of hydrogen is continued until there is no increase in volume on successive days.

NOTE The titles of the publications referred to in this standard are listed on the inside back cover.

2 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 collected over mercury by a volumetric method.

3 Materials and apparatus

3.1 *Parent plate material*. The test piece assembly shall be prepared from a semi-killed grade of steel containing not more than 0.20 % C and not more than 0.05 % S. Prior to use the test piece shall be degassed at 650 °C for 1 h in a suitable atmosphere to prevent oxidation.

3.2 *Electrodes*. The electrode to be tested shall be of 4 mm core wire diameter, or of 3.2 mm diameter in the case of an electrode having a nominal efficiency higher than 130 %. For classification purposes the electrode shall be dried just before use at the lowest temperature and for the lowest time recommended by the manufacturer to achieve a hydrogen level not exceeding 15 mL per 100 g of deposited weld metal. For other purposes the manufacturer's instructions shall be followed.

3.3 *Welding fixture*. A copper jig, as shown in Figure 1, shall be used for the alignment and clamping of the test piece assembly.

3.4 *Apparatus for determination of diffusible hydrogen*. Examples of gas burettes for the measurement of extracted gas are shown in Figure 2 and Figure 3. Burettes of other designs may be employed, provided that the following requirements are fulfilled.

a) Clean mercury shall be used as the confining liquid.

b) It shall be possible to maintain the sample under vacuum for a brief period, as specified under **4.3**, to remove any trace of wash liquid or moisture trapped on the fractured surface of the sample.

NOTE In burettes consisting of a single limb, this may be achieved through manipulation of the mercury level and the stopcock, any contaminants released during the brief period of surface degassing being swept out of the burette before the measurements.

c) The volume of collected gas shall be determined using a cathetometer to measure the length of gas column in the standard bore limb to an accuracy of 0.1 mm.

4 Procedure

4.1 Test piece assembly

Triplicate sets of test pieces having a cross section of 10 mm × 15 mm shall be used for each type of electrode to be tested. A bead of 100 mm overall length shall be deposited along the centreline of each test piece assembly. An unused electrode shall be used for each weld. The test piece assembly shown in Figure 1 consists of run-on and run-off pieces, and a central sample section of 30 mm length. Triplicate determinations shall be made using the entire length of this centre section. The test piece dimensions shown in Figure 1 shall be maintained within the limits of ± 0.25 mm. 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. The faces of the cross sections shall be machined to ensure good contact between adjacent pieces.

The central specimen shall be marked on the opposite side to that used for welding and weighed to the nearest 10 mg.

4.2 Welding

The temperature of the jig shall be ambient ± 5 °C prior to testing. The welding current shall be the maximum stated by the manufacturer less 15 A, the machine setting being controlled within a tolerance of ± 5 A. The run out length shall be 20 ± 2 per 25 mm length of the electrode. The time spent in the deposition shall be noted.

After extinction of the arc and without any delay, the jig shall be released and the test piece assembly shall be quenched in iced water and quickly transferred to a container of alcohol or acetone saturated with solid carbon dioxide, or of liquid nitrogen. The central sample piece shall be cleaned by vigorous brushing using a wire brush in good condition, with brief intermittent periods of cooling, or the sample shall be cleaned by shot blasting; the intervals spent outside the cooling bath during this operation shall not exceed 15 s. The test piece assembly shall now be broken apart and the sample stored in solid carbon dioxide or liquid nitrogen until required for analysis.

4.3 Preparation of sample for analysis

The sample shall be removed from the storage coolant and raised to room temperature by immersion in acetone. Following a rapid rinse with a jet of acetone and drying in a jet of air, it shall be transferred to the open limb of the burette. This open limb shall then be closed with the glass two-way vacuum stopcock and evacuated. Acetone and traces of condensed water evaporate off the surface of the sample and are removed with the evacuated air. The sample shall then be pulled under the surface of the mercury, using a magnet, and transferred to a position where it floats in the closed limb allowing evolved diffusible hydrogen to be collected in the standard bore tube. The whole procedure described in this paragraph shall be done as quickly as possible, taking not more than 2 min.

4.4 Analytical procedure

The sample shall be maintained under reduced pressure at room temperature until readings on successive days show no increase in hydrogen. The barometric pressure shall be recorded. The sample shall be removed from the apparatus and weighed to the nearest 10 mg.

5 Calculation and expression of results

The volume V_h (in mL) at s.t.p. of diffusible hydrogen per 100 g of deposited weld metal shall be calculated from the following formula[1)]:

$$V_h = \frac{V_g\,(B-H)}{760} \times \frac{273}{(273+T)} \times \frac{100}{(M_2-M_1)}$$

where

V_g is the volume of gas in the burette (in mL);

B is the barometric pressure (in mmHg)[a];

H is the head of mercury at which V_g is measured (in mmHg);

T is the room temperature (in °C);

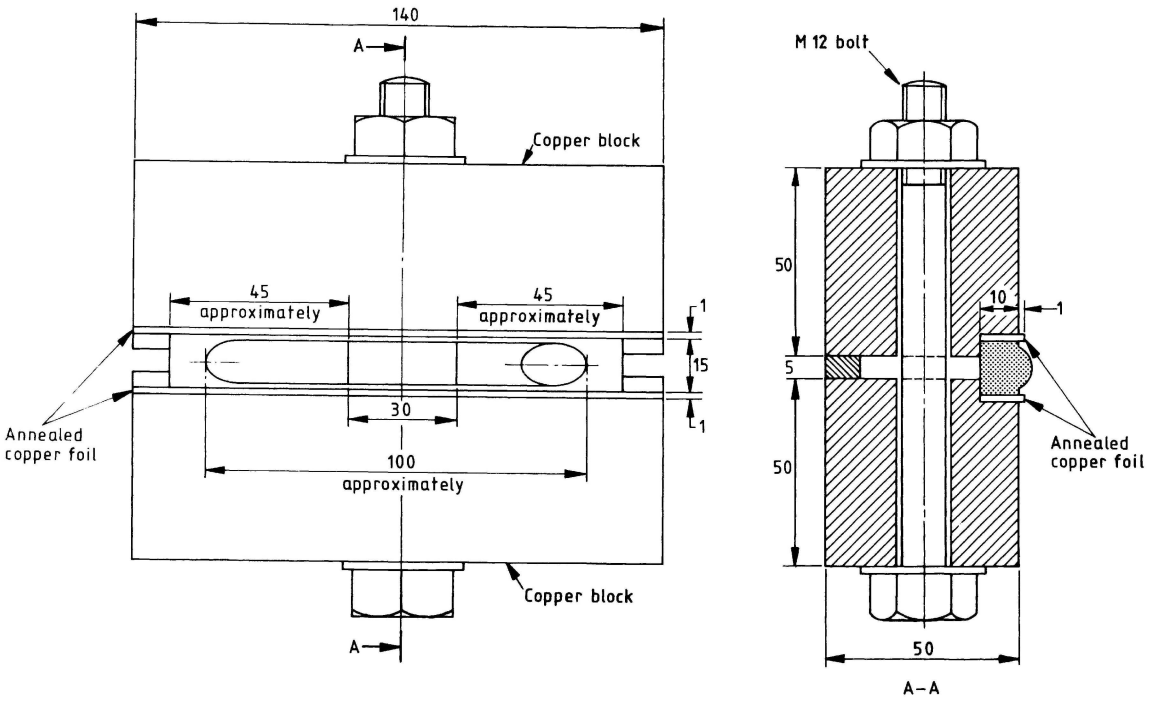
M_2 is the mass of the sample after removal from apparatus (in g);

M_1 is the mass of the sample before deposition of the weld (in g).

[a] 1 mmHg = 133.322 Pa (approximately).

For the purposes of this standard, the average value of the hydrogen contents of triplicate welds shall be used.

[1)] To convert to parts per million, multiply by 0.9.



All dimensions are in millimetres.

Figure 1 — Test piece assembly for hydrogen sampling of weld deposits

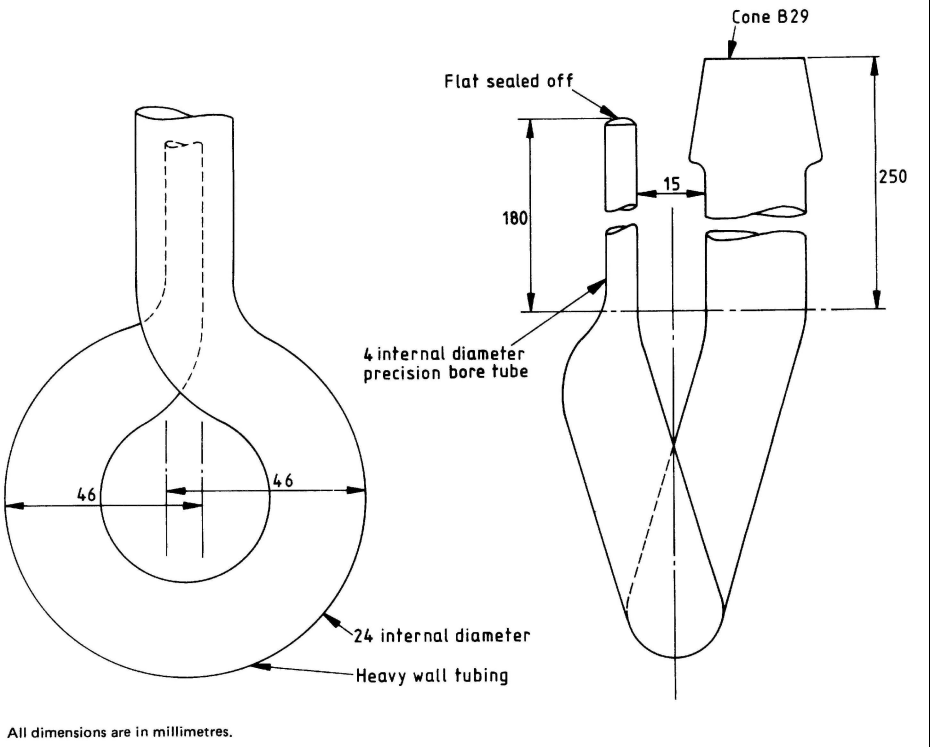
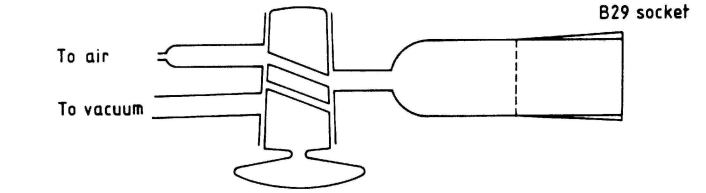
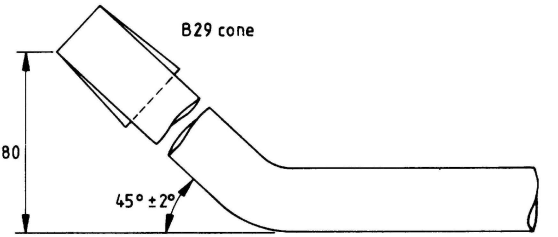


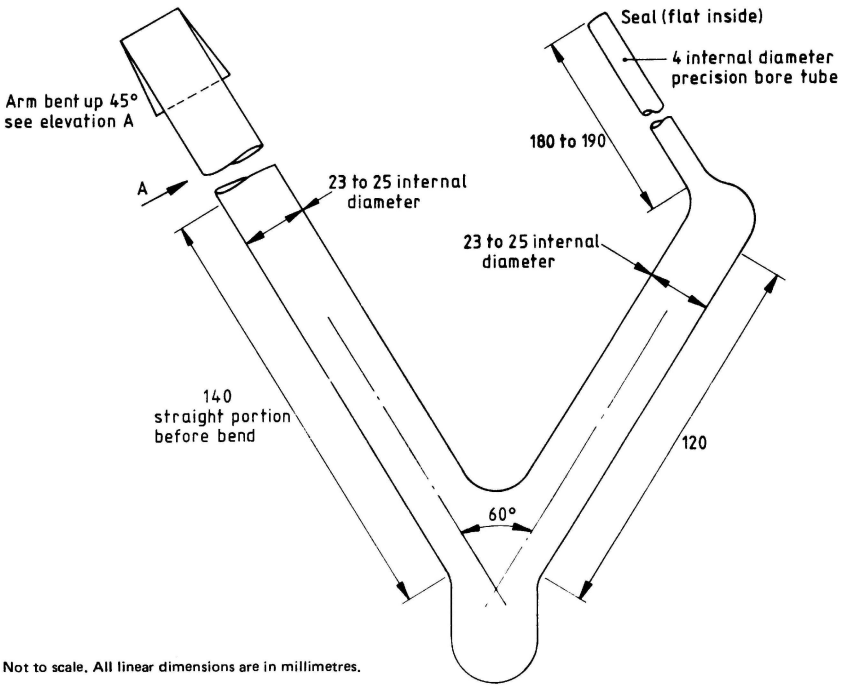
Figure 2 — Diffusible hydrogen collecting apparatus, "O" tube



Two way glass vacuum stopcock



Elevation of side arm in direction A



Not to scale. All linear dimensions are in millimetres.

Figure 3 — Diffusible hydrogen collecting apparatus, "Y" tube

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Publications referred to

BS 639, *Covered electrodes for the manual metal-arc welding of carbon and carbon manganese steels*[2)].
BS 2493, *Specification for low alloy steel electrodes for manual metal-arc welding*[2)].
BS 6693, *Diffusible hydrogen*[2)].
BS 6693-1, *Method for determination of hydrogen in manual metal-arc weld metal using 3 day collection.*

[2)] Referred to in the foreword only.

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