

Method of measurement of hydrogen permeation and the determination of hydrogen uptake and transport in metals by an electrochemical technique

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- AEA Technology
- Aluminium Federation
- British Gas plc
- British Iron and Steel Producers Association
- British Non-Ferrous Metals Federation
- Department of Transport (Transport Research Laboratory)
- Electricity Association
- Institute of Corrosion
- Ministry of Defence
- Society of Chemical Industry
- Welding Institute

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Foreword

This British Standard has been prepared by Technical Committee ISE/NFE/8.

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 10, an inside back cover and a back cover.

Method of measurement

1 Scope

This British Standard specifies a laboratory method for the measurement of hydrogen permeation and for the determination of hydrogen atom uptake and transport in metals using an electrochemical technique.

The standard gives a method for evaluating hydrogen uptake in metals based on measurement of steady-state hydrogen flux.

It also gives a method for determining an effective diffusivity of hydrogen atoms in a metal and for distinguishing reversible and irreversible trapping.

This standard gives requirements for the preparation of specimens, control and monitoring of the environmental variables, test procedures and analysis of results.

This standard may be applied in principle to all metals for which hydrogen permeation is measurable and the method can be used to rank the relative aggressivity of different environments in terms of the hydrogen uptake of the exposed metal.

2 Informative references

This British Standard refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on the inside back cover, but reference should be made to the latest editions.

3 Definitions and symbols

3.1 Definitions

For the purposes of this British Standard, the following definitions apply.

3.1.1 charging

Method of introducing atomic hydrogen into the metal by exposure to aqueous environment under galvanostatic control (constant charging current), potentiostatic control (constant electrode potential), free corrosion, or by gaseous exposure.

3.1.2 charging cell

Compartment in which hydrogen atoms are generated on the sample surface. This includes both aqueous and gaseous charging.

3.1.3 decay current

Decay of the hydrogen atom oxidation current, after attainment of steady-state, following a decrease in charging current.

3.1.4 Fick's second law

Second order differential equation describing the concentration of atomic hydrogen in the sample as a function of position and time. The equation is of the form $\partial C(x, t)/\partial t = D_1 \partial^2 C(x, t)/\partial x^2$ for lattice diffusion in one dimension where diffusivity is independent of concentration.

3.1.5 hydrogen flux

Amount of hydrogen passing through the metal sample per unit area per unit time.

3.1.6 hydrogen uptake

Atomic hydrogen absorbed into the metal as a result of charging.

3.1.7 irreversible trap

Microstructural site at which the residence time for a hydrogen atom is infinite or extremely long compared to the time-scale for permeation testing at the relevant temperature.

3.1.8 mobile hydrogen atoms

Hydrogen atoms in interstitial sites in the lattice (lattice sites) and reversible trap sites.

3.1.9 oxidation cell

Compartment in which hydrogen atoms exiting from the metal sample are oxidized.

3.1.10 permeation current

Current measured in oxidation cell associated with oxidation of hydrogen atoms.

3.1.11 permeation flux

Hydrogen flux exiting the test sample in the oxidation cell.

3.1.12 permeation transient

Variation of the permeation current with time from commencement of charging to the attainment of steady-state, or modification of charging conditions.

3.1.13 recombination poison

Chemical within the test environment in the charging cell which enhances hydrogen absorption by retarding the recombination of hydrogen atoms on the metal surface.

3.1.14 reversible trap

Microstructural site at which the residence time for a hydrogen atom is greater than that for the lattice site but is small in relation to the time to attain steady-state permeation.

3.2 Symbols

For the purposes of this British Standard the following symbols apply.

A	Exposed area of sample in the oxidation cell
$C(x, t)$	Lattice concentration of hydrogen as a function of position and time
C_0	Sub-surface concentration of atomic hydrogen in interstitial lattice sites on the charging side of the sample
C_{0R}	Summation of the sub-surface concentration of hydrogen in interstitial lattice sites and reversible trap sites on the charging side of the sample