

Transportable gas cylinders — Compatibility of cylinder and valve materials with gas contents —

Part 4: Test methods for selecting metallic materials resistant to hydrogen embrittlement

The European Standard EN ISO 11114-4:2005 has the status of a
British Standard

ICS 23.020.30

National foreword

This British Standard was published by BSI. It is the UK implementation of EN ISO 11114-4:2005.

The UK participation in its preparation was entrusted by Technical Committee PVE/3, Gas containers, to Subcommittee PVE/3/1, Valve fittings for gas containers.

A list of organizations represented on PVE/3/1 can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 April 2007

© BSI 2007

ISBN 978 0 580 50518 8

Amendments issued since publication

Amd. No.	Date	Comments

English Version

Transportable gas cylinders - Compatibility of cylinder and valve materials with gas contents - Part 4: Test methods for selecting metallic materials resistant to hydrogen embrittlement (ISO 11114-4:2005)

Bouteilles à gaz transportables - Compatibilité des matériaux des bouteilles et des robinets avec les contenus gazeux - Partie 4: Méthodes d'essai pour le choix de matériaux métalliques résistants à la fragilisation par l'hydrogène (ISO 11114-4:2005)

Ortsbewegliche Gasflaschen - Verträglichkeit von Werkstoffen für Gasflaschen und Ventile mit den in Berührung kommenden Gasen - Teil 4: Prüfverfahren zur Auswahl von metallischen Werkstoffen, die gegen Wasserstoffversprödung unempfindlich sind (ISO 11114-4:2005)

This European Standard was approved by CEN on 22 July 2005.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.



EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

Foreword

This document (EN ISO 11114-4:2005) has been prepared by Technical Committee ISO/TC 58 "Gas cylinders" in collaboration with Technical Committee CEN/TC 23 "Transportable gas cylinders", the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by February 2006, and conflicting national standards shall be withdrawn at the latest by February 2006.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

Endorsement notice

The text of ISO 11114-4:2005 has been approved by CEN as EN ISO 11114-4:2005 without any modifications, except as stated in normative annex NA.

NOTE Normative references to International Standards are listed in Annex ZA (normative).

INTERNATIONAL STANDARD

ISO
11114-4

First edition
2005-08-01

Transportable gas cylinders — Compatibility of cylinder and valve materials with gas contents —

Part 4: Test methods for selecting metallic materials resistant to hydrogen embrittlement

*Bouteilles à gaz transportables — Compatibilité des matériaux des
bouteilles et des robinets avec les contenus gazeux —*

*Partie 4: Méthodes d'essai pour le choix de matériaux métalliques
résistants à la fragilisation par l'hydrogène*



Reference number
ISO 11114-4:2005(E)

AVA Documents
Document Sharing Hub

Contents

Page

Foreword.....	iv
Introduction	v
1 Scope	1
2 Normative references	1
3 Terms, definitions and symbols	2
3.1 Terms and definitions.....	2
3.2 Symbols	3
4 General requirements.....	3
5 Test methods.....	4
5.1 Disc test (method A).....	4
5.2 Fracture mechanic test (method B)	9
5.3 Test method to determine the resistance to hydrogen assisted cracking of steel cylinders (method C)	13
5.4 Tensile tests	16
Annex NA (normative) Specific European requirements.....	17
Annex ZA (normative) Normative references to international publications with their relevant European publications	18

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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 11114-4 was prepared by Technical Committee ISO/TC 58, *Gas cylinders*.

ISO 11114 consists of the following parts, under the general title *Transportable gas cylinders — Compatibility of cylinder and valve materials with gas contents*:

- *Part 1: Metallic materials*
- *Part 2: Non-metallic materials*
- *Part 3: Autogenous ignition test in oxygen atmosphere*
- *Part 4: Test methods for selecting metallic materials resistant to hydrogen embrittlement*

Introduction

It is widely recognised that compressed hydrogen and some hydrogen bearing gases can have an embrittling effect on metallic materials, especially steels. This embrittling effect has resulted in the failure of hydrogen cylinders (including some bursts) that has led gas cylinder users and manufacturers to adopt specific measures.

The adoption of these measures has eliminated all known failures of hydrogen cylinders from this embrittlement phenomenon.

The basic recommendation was to minimise the stresses in the cylinder wall (see ISO 11114-1) and eliminate harmful defects.

This tensile strength limit of 950 MPa was developed for quenched and tempered gas cylinders of 34 Cr Mo 4 type steels using steelmaking practices, chemistry and manufacturing techniques typical of those used during the early 1980s and successfully used for filling pressures up to 300 bar. This practice has been in widescale use up to the current time. Other higher pressures, although at lower tensile strength limits, have also been used.

In recent years, improvements in steelmaking, e.g. by reducing the sulphur and phosphorus contents, have indicated the possibility of increasing the tensile strength limit of 950 MPa for embrittling gas service, as a result of improvements in the fracture toughness of the material.

Experimental work has shown that the relevant parameters affecting hydrogen embrittlement are the following:

- a) microstructure resulting from the combination of the chemistry and the heat treatment;
- b) mechanical properties of the material;
- c) applied wall stress;
- d) internal surface imperfections resulting in local stress concentrations;
- e) characteristics of the gas contained (composition, quality, pressure, etc.).

When developing this part of ISO 11114 only the material aspects, a) and b) above, were considered. Other essential features, c) and d), are covered by the relevant parts of ISO 9809.

This part of ISO 11114 specifies test methods to identify steels which, when combined with the cylinder manufacturing requirements specified in ISO 9809 (all parts), will result in cylinders suitable for use in embrittling gas service.

However, some low alloy steels other than 34 Cr Mo 4 may require tensile strength lower than 950 MPa to be suitable for the manufacture of gas cylinders for embrittling gas service.

These tests have been developed following an extensive world-wide programme which incorporated laboratory and full scale tests.