ISO 16111:2018 (E)

Transportable gas storage devices — Hydrogen absorbed in reversible metal hydride

Contents

Foreword

Introduction

1 Scope

2 Normative references

3 Terms and definitions

4 Service conditions

4.1 Pressures
4.1.1 Maximum developed pressure (MDP)
4.1.2 Rated charging pressure (RCP)
4.1.3 Stress level at MDP
4.2 Rated capacity
4.3 Temperature ranges
4.3.1 Operating temperature range
4.3.2 Service temperature range
4.4 Environmental conditions
4.5 Service life
4.6 Hydrogen quality
4.7 Special service conditions

5 Design considerations

5.1 General
5.2 Material selection
5.2.1 General
5.2.2 External surfaces
5.2.3 Compatibility
5.2.4 Temperature
5.3 Shell design
5.3.1 Shells with internal volume greater than 120 ml
5.3.2 Shells with internal volume of 120 ml or less
5.4 Design strength
5.5 Overpressure and fire protection
5.5.1 General
5.5.2 PRD activation pressure
5.5.3 PRD activation temperature
5.6 Loading of hydrogen absorbing alloy
5.7 Shut-off valves
5.7.1 General
5.7.2 MH assemblies with internal volume greater than 120 ml
5.7.3 MH assemblies with internal volume of 120 ml or less
5.7.4 Integral shut-off valve protection
5.7.5 Removable shut-off valve protection
5.8 Actively cooled MH assemblies
5.9 Particulate containment

6 Inspection and testing

6.1 General
6.2 Type/qualification tests
6.2.1 General

6.2.2 Fire test
6.2.2.1 General
6.2.2.2 Sample preparation
6.2.2.3 Data monitoring and recording
6.2.2.4 Test set-up, fire source and test method
6.2.2.5 Acceptance criteria
6.2.3 Initial burst tests for MH assemblies with an internal volume of 120 ml or less
6.2.4 Drop or impact test
6.2.4.1 General requirements
6.2.4.1.1 MH assembly with mass of 25 kg or less
6.2.4.1.2 MH assembly with mass greater than 25 kg
6.2.4.2 Sample preparation MH assembly with mass of 25 kg or less
6.2.4.3 Drop test procedure
6.2.4.4 Acceptance criteria for MH assembly with mass of 25 kg or less
6.2.4.4.1 General
6.2.4.4.2 MH assemblies with internal volume greater than 120 ml
6.2.4.4.3 MH assemblies with internal volume of 120 ml or less
6.2.4.5 Blunt impact test for MH assembly with mass greater than 25 kg
6.2.4.6 Blunt impact test procedure
6.2.4.7 Acceptance criteria for MH assemblies with mass greater than 25 kg
6.2.5 Leak test
6.2.5.1 Test procedure
6.2.5.2 Acceptance criteria
6.2.5.2.1 MH assemblies with internal volume greater than 120 ml
6.2.5.2.2 MH assemblies with internal volume of 120 ml or less
6.2.6 Hydrogen cycling and strain measurement test
6.2.6.1 General
6.2.6.2 Test set-up
6.2.6.3 Test method
6.2.6.4 Acceptance criteria
6.2.7 Shut-off valve impact test
6.2.7.1 General
6.2.7.2 Sample preparation
6.2.7.3 Test procedure
6.2.7.4 Acceptance criteria
6.2.8 Thermal cycling test
6.2.8.1 General
6.2.8.2 Test set-up
6.2.8.3 Test procedure
6.2.8.4 Acceptance criteria
6.2.9 Type test reports
6.3 Batch tests
6.3.1 General requirements
6.3.2 Burst test for shell-batch
6.3.3 MDP Test for hydride-batch
6.4 Routine tests and inspections
6.4.1 Routine tests
6.4.2 Certificates of manufacture

7 Marking, labelling, and documentation

7.1 Marking
7.2 Labelling
7.2.1 General
7.2.2 Hazards associated with the solid materials
7.2.3 Labelling concerning removable valve protection
7.2.4 Temperature warning labelling

8 Documentation accompanying the product

8.1 Safety data sheets
8.2 User's or operating manual
8.2.1 General
8.2.2 Initial fill and refill procedures
8.2.2.1 Inspection prior to initial filling and refilling
8.2.2.2 Charging specifications

8.2.2.3 Equipment
8.2.2.4 Inspections and checks after initial filling and refilling
8.2.2.5 Periodic inspection and testing

Annex A (informative) Material compatibility for hydrogen service

A.1 Material compatibility for hydrogen service
A.2 Metals and metallic materials
A.3 Polymers, elastomers and other non-metallic materials
A.4 Other references
A.4.1 International Organization for Standardization (www.iso.org)
A.4.2 American Institute of Aeronautics and Astronautics (www.aiaa.org)
A.4.3 American Petroleum Institute (www.api.org)
A.4.4 American Society for Testing and Materials (www.astm.org)
A.4.5 American Society of Mechanical Engineers (www.asme.org)
A.4.6 American Welding Society (www.aws.org)
A.4.7 ASM International (www.asminternational.org) and Society of Automotive Engineers (www.sae.org)
A.4.8 National Association of Corrosion Engineers (www.nace.org)

Annex B (normative) Environmental tests

B.1 Exposure to fluids
B.1.1 General
B.1.2 Preconditioning
B.1.2.1 Preconditioning apparatus
B.1.2.2 Preconditioning procedure
B.1.2.2.1 Preconditioning for the immersion test
B.1.2.2.2 Preconditioning for the other fluid exposure test
B.1.3 Test conditions
B.1.3.1 Immersion test
B.1.3.2 Other fluid exposure
B.1.3.3 Pressure cycle
B.1.3.4 High and low temperature exposure
B.1.4 Test procedure
B.2 Salt water immersion test
B.2.1 General
B.2.2 Set-up
B.2.3 Immersion period
B.2.4 Drying period
B.2.5 Duration of test and acceptance criteria

Annex C (informative) Type approval certificate

Annex D (informative) Acceptance certificate

Page count: 43