
**Hydrogen generators using water
electrolysis process —**

**Part 1:
Industrial and commercial applications**

Générateurs d'hydrogène utilisant le procédé de l'électrolyse de l'eau —

Partie 1: Applications industrielles et commerciales

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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 22734-1 was prepared by Technical Committee ISO/TC 197, *Hydrogen technologies*.

ISO 22734 consists of the following parts, under the general title *Hydrogen generators using water electrolysis process*:

— *Part 1: Industrial and commercial applications*

— *Part 2: Residential applications*

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0 Introduction

0.1 Electrolysis Technology

In an electrolyser cell, electricity causes dissociation of water into hydrogen and oxygen molecules. An electric current is passed between two electrodes separated by a conductive electrolyte or “ion transport medium”, producing hydrogen at the negative electrode (cathode) and oxygen at the positive electrode (anode). As water is H₂O, twice the volume of hydrogen is produced over oxygen. Hydrogen gas produced using electrolysis technology can be utilized immediately or stored for later use.

The cell(s), and electrical, gas processing, ventilation, cooling and monitoring equipment and controls are contained within the hydrogen generator enclosure. Gas compression and feed water conditioning and auxiliary equipment may also be included.

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Hydrogen generators using water electrolysis process —

Part 1: Industrial and commercial applications

1 Scope

This International Standard defines the construction, safety and performance requirements of packaged or factory matched hydrogen gas generation appliances, herein referred to as hydrogen generators, using electrochemical reactions to electrolyse water to produce hydrogen and oxygen gas.

This International Standard is applicable to hydrogen generators that use the following types of ion transport medium:

- Group of aqueous bases;
- Solid polymeric materials with acidic function group additions such as acid proton exchange membrane (PEM).

This part of ISO 22734 is applicable to hydrogen generators intended for indoor and outdoor commercial and industrial use (non-residential use). Hydrogen generators that can also be used to generate electricity such as reversible fuel cells are excluded from the scope of this International Standard.

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This International Standard is intended to be used for certification purposes.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 834-1, *Fire-resistance tests — Elements of building construction — Part 1: General requirements*

ISO 1182, *Reaction to fire tests for building products — Non-combustibility test*

ISO 3864 (all parts), *Graphical symbols — Safety colours and safety signs*

ISO 4126-1, *Safety devices for protection against excessive pressure — Part 1: Safety valves*

ISO 4126-2, *Safety devices for protection against excessive pressure — Part 2: Bursting disc safety devices*

ISO 4706, *Refillable welded steel gas cylinders*

ISO 7866, *Gas cylinders — Refillable seamless aluminium alloy gas cylinders — Design, construction and testing*

ISO 9300, *Measurement of gas flow by means of critical flow Venturi nozzles*

ISO 9809-1, *Gas cylinders — Refillable seamless steel gas cylinders — Design, construction and testing — Part 1: Quenched and tempered steel cylinders with tensile strength less than 1 100 MPa*

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ISO 9809-2, *Gas cylinders — Refillable seamless steel gas cylinders — Design, construction and testing — Part 2: Quenched and tempered steel cylinders with tensile strength greater than or equal to 1 100 MPa*

ISO 9809-3, *Gas cylinders — Refillable seamless steel gas cylinders — Design, construction and testing — Part 3: Normalized steel cylinders*

ISO 9951, *Measurement of gas flow in closed conduits — Turbine meters*

ISO 10790, *Measurement of fluid flow in closed conduits — Guidance to the selection, installation and use of Coriolis meters (mass flow, density and volume flow measurements)*

ISO 11119-1, *Gas cylinders of composite construction — Specification and test methods — Part 1: Hoop wrapped composite gas cylinders*

ISO 11119-2, *Gas cylinders of composite construction — Specification and test methods — Part 2: Fully wrapped fibre reinforced composite gas cylinders with load-sharing metal liners*

ISO 11119-3, *Gas cylinders of composite construction — Specification and test methods — Part 3: Fully wrapped fibre reinforced composite gas cylinders with non-load-sharing metallic or non-metallic liners*

ISO 12100-2, *Safety of machinery — Basic concepts, general principles for design — Part 2: Technical principles*

ISO 12499, *Industrial fans — Mechanical safety of fans — Guarding*

ISO 13709, *Centrifugal pumps for petroleum, petrochemical and natural gas industries*

ISO 13850, *Safety of machinery — Emergency stop — Principles for design*

ISO 13852, *Safety of machinery — Safety distances to prevent danger zones being reached by the upper limbs*

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ISO 13853, *Safety of machinery — Safety distances to prevent danger zones being reached by the lower limbs*

ISO 13854, *Safety of machinery — Minimum gaps to avoid crushing of parts of the human body*

ISO 14121-1, *Safety of machinery — Risk assessment — Part 1: Principles*

ISO 14511, *Measurement of fluid flow in closed conduits — Thermal mass flowmeters*

ISO 14687, *Hydrogen fuel — Product specification*

ISO 14847, *Rotary positive displacement pumps — Technical requirements*

ISO 15534-1, *Ergonomic design for the safety of machinery — Part 1: Principles for determining the dimensions required for openings for whole-body access into machinery*

ISO 15534-2, *Ergonomic design for the safety of machinery — Part 2: Principles for determining the dimensions required for access openings*

ISO 15649, *Petroleum and natural gas industries — Piping*

ISO/TR 15916, *Basic considerations for the safety of hydrogen systems*

ISO 16528-1, *Boilers and pressure vessels — Part 1: Performance requirements*

ISO 17398, *Safety colours and safety signs — Classification, performance and durability of safety signs*

- IEC 60034-1, *Rotating electrical machines — Part 1: Rating and performance*
- IEC 60068-2-18:2000, *Environmental testing — Part 2-18: Tests — Test R and guidance: Water*
- IEC 60079-0, *Explosive atmospheres — Part 0: Equipment — General requirements*
- IEC 60079-2:2007, *Explosive atmospheres — Part 2: Equipment protection by pressurized enclosures "p"*
- IEC 60079-10, *Electrical apparatus for explosive gas atmospheres — Part 10: Classification of hazardous areas*
- IEC 60079-14, *Explosive atmospheres — Part 14: Electrical installations design, selection and erection*
- IEC 60079-29-1, *Explosive atmospheres — Part 29-1: Gas detectors — Performance requirements of detectors for flammable gases*
- IEC 60079-29-2, *Explosive atmospheres — Part 29-2: Gas detectors — Selection, installation, use and maintenance of detectors for flammable gases and oxygen*
- IEC 60079-30-1, *Explosive atmospheres — Part 30-1: Electrical resistance trace heating — General and testing requirements*
- IEC 60146 (all parts), *Semiconductor convertors*
- IEC 60204-1:2005, *Safety of machinery - Electrical equipment of machines — Part 1: General requirements*
- IEC 60335-2-30, *Household and similar electrical appliances — Safety — Part 2-30: Particular requirements for room heaters*
- IEC 60335-2-41, *Household and similar electrical appliances — Safety — Part 2-41: Particular requirements for pumps*
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- IEC 60335-2-51, *Household and similar electrical appliances — Safety — Part 2-51: Particular requirements for stationary circulation pumps for heating and service water installations*
- IEC 60335-2-73, *Household and similar electrical appliances — Safety — Part 2-73: Particular requirements for fixed immersion heaters*
- IEC 60335-2-74, *Household and similar electrical appliances — Safety — Part 2-74: Particular requirements for portable immersion heaters*
- IEC 60335-2-80, *Household and similar electrical appliances — Safety — Part 2-80: Particular requirements for fans*
- IEC 60364-4-43, *Electrical installations of buildings — Part 4-43: Protection for safety — Protection against overcurrent*
- IEC 60364-6:2006, *Low-voltage electrical installations — Part 6: Verification*
- IEC 60439-1, *Low-voltage switchgear and controlgear assemblies — Part 1: Type-tested and partially type-tested assemblies*
- IEC 60439-2, *Low-voltage switchgear and controlgear assemblies — Part 2: Particular requirements for busbar trunking systems (busways)*
- IEC 60439-3, *Low-voltage switchgear and controlgear assemblies — Part 3: Particular requirements for low-voltage switchgear and controlgear assemblies intended to be installed in places where unskilled persons have access for their use — Distribution boards*

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IEC 60439-5, *Low-voltage switchgear and controlgear assemblies — Part 5: Particular requirements for assemblies for power distribution in public networks*

IEC 60445, *Basic and safety principles for man-machine interface, marking and identification — Identification of equipment terminals and conductor terminations*

IEC 60446, *Basic and safety principles for man-machine interface, marking and identification — Identification of conductors by colours or alphanumerics*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 60534 (all parts), *Industrial-process control valves*

IEC 60695-11-10, *Fire hazard testing — Part 11-10: Test flames — 50 W horizontal and vertical flame test methods*

IEC 60695-11-20, *Fire hazard testing — Part 11-20: Test flames — 500 W flame test methods*

IEC 60730-1:2007, *Automatic electrical controls for household and similar use — Part 1: General requirements*

IEC 60747 (all parts), *Semiconductor devices — Discrete devices*

IEC/TR 60877, *Procedures for ensuring the cleanliness of industrial-process measurement and control equipment in oxygen service*

IEC 60947-2, *Low-voltage switchgear and controlgear — Part 2: Circuit-breakers*

IEC 60947-3, *Low-voltage switchgear and controlgear — Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units*

IEC 60947-4-1, *Low-voltage switchgear and controlgear — Part 4-1: Contactors and motor-starters — Electromechanical contactors and motor-starters*

IEC 60947-4-2, *Low-voltage switchgear and controlgear — Part 4-2: Contactors and motor-starters — AC semiconductor motor controllers and starters*

IEC 60947-4-3, *Low-voltage switchgear and controlgear — Part 4-3: Contactors and motor-starters — AC semiconductor controllers and contactors for non-motor loads*

IEC 60947-5-1, *Low-voltage switchgear and controlgear — Part 5-1: Control circuit devices and switching elements — Electromechanical control circuit devices*

IEC 60947-5-2, *Low-voltage switchgear and controlgear — Part 5-2: Control circuit devices and switching elements — Proximity switches*

IEC 60947-5-3, *Low-voltage switchgear and controlgear — Part 5-3: Control circuit devices and switching elements — Requirements for proximity devices with defined behaviour under fault conditions (PDF)*

IEC 60947-5-5, *Low-voltage switchgear and controlgear — Part 5-5: Control circuit devices and switching elements — Electrical emergency stop device with mechanical latching function*

IEC 60947-6-1, *Low-voltage switchgear and controlgear — Part 6-1: Multiple function equipment — Transfer switching equipment*

IEC 60947-6-2, *Low-voltage switchgear and controlgear — Part 6-2: Multiple function equipment — Control and protective switching devices (or equipment) (CPS)*

IEC 60947-7-1, *Low-voltage switchgear and controlgear — Part 7-1: Ancillary equipment — Terminal blocks for copper conductors*

IEC 60947-7-2, *Low-voltage switchgear and controlgear — Part 7-2: Ancillary equipment — Protective conductor terminal blocks for copper conductors*

IEC 60950-1:2005/Cor. 1:2006, *Information technology equipment — Safety — Part 1: General requirements*

IEC 61010-1:2001/Cor. 1:2002/Cor. 2:2003, *Safety requirements for electrical equipment for measurement, control, and laboratory use — Part 1: General requirements*

IEC 61069-7, *Industrial-process measurement and control — Evaluation of system properties for the purpose of system assessment — Part 7: Assessment of system safety*

IEC 61131-1, *Programmable controllers — Part 1: General information*

IEC 61131-2, *Programmable controllers — Part 2: Equipment requirements and tests*

IEC 61204, *Low-voltage power supply devices, d.c. output — Performance characteristics*

IEC 61204-6, *Low-voltage power supplies, d.c. output — Part 6: Requirements for low-voltage power supplies of assessed performance*

IEC/TR 61459, *Coordination between fuses and contactors/motor-starters — Application guide*

IEC 61508-1, *Functional safety of electrical/electronic/programmable electronic safety-related systems — Part 1: General requirements*

IEC 61508-2, *Functional safety of electrical/electronic/programmable electronic safety-related systems — Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems*

IEC 61508-3, *Functional safety of electrical/electronic/programmable electronic safety-related systems — Part 3: Software requirements*

IEC 61511-1, *Functional safety — Safety instrumented systems for the process industry sector — Part 1: Framework, definitions, system, hardware and software requirements*

IEC 61558 (all parts), *Safety of power transformers, power supplies, reactors and similar products (all applicable parts)*

IEC 61558-2-17, *Safety of power transformers, power supply units and similar — Part 2-17: Particular requirements for transformers for switch mode power supplies*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1

area classification

classification of hazardous areas according to the probability of the existence of an explosive gas-air atmosphere, in order to relate the selection of electrical apparatus for use in the area to the degree of hazard

3.2

classified area

area or space where combustible dust, ignitable fibres, or flammable, volatile liquids, gases, vapours or mixtures are or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures

3.3 commercial
relating to the use of hydrogen generators by laymen in non-manufacturing business facilities such as stores, hotels, office buildings, educational institutes, filling stations, warehouses, and other non-residential locations

3.4 containment system
part of the apparatus containing a flammable substance that may constitute a source of release

3.5 design pressure
pressure value applied to the design of pressure containing components, which represents the pressure at the most severe condition of coincident internal or external pressure and temperature expected during service

NOTE Design pressure is represented in Annex B.

3.6 design temperature
temperature value applied to the design of pressure containing components; the temperature at the most severe condition of coincident pressure expected during service

3.7 dilution
continuous supply of a purge gas at such a rate that the concentration of a flammable substance inside an enclosure is maintained at a value outside the explosive (flammable) limits at any potential ignition source (that is to say, outside the dilution area)

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3.8 dilution volume
area in the vicinity of a source of release where the concentration of flammable substance is not diluted to a level below the lower flammability limit (LFL) [ISO 22734-1:2008](https://standards.iteh.ai/catalog/standards/sist/a046a073-1d7b-4a8c-aa52-3c30a22614c7/iso-22734-1-2008)

NOTE 1 Dilution of oxygen by inert gas may result in a concentration of flammable gas or vapour above the upper flammability limit (UFL).

NOTE 2 Annex C provides information on the flammability limits of hydrogen.

3.9 enclosure
containment and support structure(s) protecting a hydrogen generator from specific environmental and climatic conditions and protecting persons and livestock from incidental contact with the hazardous parts of the hydrogen generator

3.10 enriched oxygen atmosphere
gas that contains a volume fraction of more than 23,5 % oxygen with the remainder of its components being inert

3.11 hazardous condition
condition that may adversely affect safety of the hydrogen generator operation

NOTE Examples of hazardous conditions include having an enriched oxygen atmosphere, a hydrogen concentration exceeding the lower flammability limit, an ignition source in a classified area, an overpressure, an over temperature.

3.12 industrial
relating to the use of hydrogen generators by qualified and experienced personnel in a controlled manufacturing or processing environment

3.13**ion transport medium**

medium that provides ionic transport within the cell

3.14**maximum normal operating pressure**

maximum pressure that can be experienced by the pressure containing components when the hydrogen generator is functioning within its design and control parameters

NOTE Maximum normal operating pressure is represented in Annex B.

3.15**membrane**

material that provides separation between oxygen and hydrogen product gases while allowing ionic transport within the cell

3.16**normal conditions**

conditions to which the volume or other properties of a gas are referred and which are represented by a temperature of 273,15 K (0 °C) and an atmospheric pressure of 101,325 kPa

3.17**normal operating pressure**

pressure that is experienced by the pressure bearing components when the hydrogen generator is functioning within its design and control parameters

3.18**pressure bearing component**

part, which is subject to a minimum positive internal pressure of 50 kPa during normal operating conditions

3.19**purge gas**

gas used to maintain pressurization or to dilute flammable gas or vapour to a concentration well below the lower flammability limit

3.20**purging**

passage of sufficient volume of a purge gas through a pressurized enclosure and its ducts, before the application of voltage to the apparatus to reduce any ignitable (flammable) gas atmosphere to a concentration well below the lower flammability limit

3.21**storage cylinder**

pressure container intended to store product gas

4 Operating conditions and specifications**4.1 Energy consumption****4.1.1 Electrical**

The manufacturer shall specify as outlined in IEC 60204-1 the electrical input rating for the hydrogen generator in volts, amperes or watts (VA or W), and hertz.

4.1.2 Other utilities

The manufacturer shall specify other utilities required.