INTERNATIONAL STANDARD

ISO 22734-2

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Hydrogen generators using water electrolysis process —

Part 2: Residential applications

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

Partie 2: Applications résidentielles

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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 22734-2 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*

Introduction

The technology in this part of ISO 22734 is as follows.

In a hydrogen generator 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 H_2O, twice the volume of hydrogen is produced compared with 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, monitoring equipment and controls are contained within an enclosure. Gas compression and feed water conditioning and auxiliary equipment may also be included.

Hydrogen generators using water electrolysis process —

Part 2:
Residential applications

1 Scope

This part of ISO 22734 defines the construction, safety and performance requirements of packaged hydrogen gas generation appliances, herein referred to as hydrogen generators, using electrochemical reactions to electrolyse water to produce hydrogen.

This part of ISO 22734 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 residential use in sheltered areas, such as car-ports, garages, utility rooms and similar areas of a residence. This part of ISO 22734 includes cord-connected equipment for outdoor and garage use only.

Portable generators as well as hydrogen generators that can also be used to generate electricity, such as reversible fuel cells, are excluded from the scope of this part of ISO 22734.

Hydrogen generators that also supply oxygen as a product are excluded from the scope of this part of ISO 22734.

This part of ISO 22734 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 1182, *Reaction to fire tests for products — Non-combustibility test*

ISO 3746, *Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Survey method using an enveloping measurement surface over a reflecting plane*

ISO 3864-2, *Graphical symbols — Safety colours and safety signs — Part 2: Design principles for product safety labels*

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 4126-6, *Safety devices for protection against excessive pressure — Part 6: Application, selection and installation of bursting disc safety devices*

ISO 7000, *Graphical symbols for use on equipment — Index and synopsis*

ISO 7010, *Graphical symbols — Safety colours and safety signs — Registered safety signs*

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

ISO 9614-1, *Acoustics — Determination of sound power levels of noise sources using sound intensity — Part 1: Measurement at discrete points*

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*

ISO 10286, *Gas cylinders — Terminology*

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 and tubes*

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 and tubes with non-metallic and non-load-sharing metal liners*

ISO 12100, *Safety of machinery — General principles for design — Risk assessment and risk reduction*

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

ISO 13857, *Safety of machinery — Safety distances to prevent hazard zones being reached by upper and lower limbs*

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

ISO 14687 (all parts), *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 16111, *Transportable gas storage devices — Hydrogen absorbed in reversible metal hydride*

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

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

ISO 22734-1, *Hydrogen generators using water electrolysis process — Part 1: Industrial and commercial applications*

ISO 26142, *Hydrogen detection apparatus — Stationary applications*

IEC 60034-1, *Rotating electrical machines — Part 1: Rating and performance*

IEC 60068-2-18:2010, *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 60079-10-1, *Explosive atmospheres — Part 10-1: Classification of areas — Explosive gas atmospheres*

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 converters*

IEC 60204-1:2005, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements*

IEC/TR 60269-5, *Low-voltage fuses — Part 5: Guidance for the application of low-voltage fuses*

IEC 60335-1:2010, *Household and similar electrical appliances — Safety — Part 1: General requirements*

IEC 60335-2-41, *Household and similar electrical appliances — Safety — Part 2-41: Particular requirements for pumps*

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 60335-2-80, *Household and similar electrical appliances — Safety — Part 2-80: Particular requirements for fans*

IEC 60364-4-43, *Low-voltage electrical installations — Part 4-43: Protection for safety — Protection against overcurrent*

IEC 60364-6:2006, *Low-voltage electrical installations — Part 6: Verification*

IEC 60417, *Graphical symbols for use on equipment*

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*

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, conductor terminations and conductors*

IEC 60364-6:2006, *Low-voltage electrical installations — Part 6: Verification*

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

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 60730-1:2010, *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*

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)*

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, *Information technology equipment — Safety — Part 1: General requirements*

IEC 61000 (applicable parts), *Electromagnetic compatibility (EMC)*

IEC 61010-1:2010, *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 61204-1, *Low-Voltage Power Supply Devices, D.C. Output — Part 1: Performance Characteristics*

IEC 61508, *Functional safety of electrical/electronic/programmable electronic safety-related systems*

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

IEC 61558-1, *Safety of power transformers, power supplies, reactors and similar products — Part 1: General requirements and tests*

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*

IEC 61672-1, *Electroacoustics — Sound level meters — Part 1: Specifications*

IEC 61672-2, *Electroacoustics — Sound level meters — Part 2: Pattern evaluation tests*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 22734-1 and the following apply.

3.1
accessible part
part or surface that can be touched by means of test probe B of IEC 61032, and if the part or surface is made of metal, any conductive part connected to it

3.2
all-pole disconnection
disconnection of all supply conductors by a single initiating action

NOTE For three-phase hydrogen generators, the neutral conductor is not considered to be a supply conductor.

3.3
built-in hydrogen generator
fixed hydrogen generator intended to be installed in a cabinet, in a prepared recess in a wall or in a similar location

3.4
fixed hydrogen generator
hydrogen generator that is intended to be used while fastened to a support or while secured in a specific location

NOTE Adhesives are not recognized as a means for fastening a fixed hydrogen generator to a support.

3.5
hazard
potential source of harm

3.6
mechanical ventilation
replacement of air inside an enclosure with fresh air accomplished by a mechanical device (such as a fan) to prevent or eliminate hazardous concentrations of hydrogen

3.7
natural ventilation
replacement of air inside an enclosure with fresh air accomplished exclusively by a natural draft caused, for example, by the effects of wind, temperature gradients or buoyancy effects, to prevent or eliminate hazardous concentrations of hydrogen

3.8
normal condition
condition in which all means for protection against hazards are intact

3.9
normal use
operation, including stand-by, according to the instructions for use or for the obvious intended purpose

NOTE In most cases, normal use also implies normal condition, because the instructions for use will warn against using the hydrogen generator when it is not in normal condition.

3.10
permanently connected
electrically connected to a supply by means of a permanent connection, which can be detached only by the use of a tool

3.11
portable hydrogen generator
hydrogen generator that is intended to be moved while in operation or a hydrogen generator other than a fixed hydrogen generator having a mass less than 18 kg

3.12
residential
relating to the use of hydrogen generators by laymen in private households (non-commercial and non-industrial use)

3.13
single fault condition
condition in which one means for protection against hazard is defective or one fault is present which could cause a hazard

NOTE If a single fault condition results unavoidably in another single fault condition, the two failures are considered as one single fault condition.

3.14
supply cord
flexible cord, for supply purposes, that is fixed to the hydrogen generator

3.15
tool
external device, including keys and coins, used to aid a person to perform a mechanical function

4 Operating conditions

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, amps or watts (W or VA) and hertz.

4.1.2 Other utilities

The manufacturer shall specify any other utilities required.

4.2 Feed water specifications

The manufacturer shall define the specifications for the feed water to be used in the hydrogen generator.

4.3 Ambient environment

The manufacturer shall specify the physical environment conditions for which the hydrogen generator is designed. These shall include indoor or outdoor operation, the ambient temperature range, and the barometric and humidity specifications.

4.4 Purge gas

Where the use of purge gas is required, the manufacturer shall specify the type of purge gas and its specifications.

4.5 Oxygen venting

4.5.1 General

The manufacturer shall specify if oxygen is to be vented indoors or outdoors. If oxygen is to be vented indoors, the manufacturer shall specify if oxygen is to be vented directly out of the enclosure or within the enclosure.

4.5.2 Oxygen vented indoors

If oxygen is vented indoors, it shall not be vented directly through tubing from the enclosure in a way that could allow the oxygen to be collected.

To preclude the formation of a hazardous enriched-oxygen atmosphere within the enclosure, oxygen purposely vented inside the enclosure shall be diluted to a volume fraction of oxygen in air of less than 23,5 % before being exhausted from the enclosure by a ventilation air stream. Classified electrical equipment that could come in contact with enriched-oxygen mixtures shall be evaluated for suitability under the possible conditions (see also 6.1.3 and 6.2.1).

The design of the ventilation shall dilute the oxygen concentration such that any gas flow exiting the enclosure to the surrounding environment will not create a hazardous condition. Where mechanical ventilation is used to dilute oxygen levels, means of detecting insufficient air ventilation shall be provided and cause the hydrogen generator to shut down.

In addition, the room to which the hydrogen generator ventilates its air/gas mixture shall be sufficiently ventilated to dilute the oxygen concentration in air below a volume fraction of 23,5 %. Room ventilation requirements shall be provided in the installation instructions as required by 12.3.3 and a label warning about the presence of oxygen and hydrogen shall be affixed as required by 11.4.

NOTE Pressure-relief devices that vent indoors are to be considered when determining ventilation requirements.

4.5.3 Oxygen vented outdoors

If oxygen is vented outdoors, it shall be vented out of the enclosure to an outdoor location in a way that will not create a hazardous condition. The installation instructions shall provide full details describing acceptable methods as required by 12.3.3.

4.6 Hydrogen venting

4.6.1 General

Hydrogen shall be vented in a manner that will not create a hazardous condition in accordance with 4.6.2 and 4.6.3.

4.6.2 Hydrogen vented outdoors

Means shall be provided to connect a vent line to the hydrogen generator. Vent lines may be designed according to ISO/TR 15916, or other similar standards.

4.6.3 Hydrogen vented indoors

Hydrogen gas may be vented indoors if it is diluted to a volume fraction of hydrogen in air of less than 1 % before exiting the enclosure.

In addition, the room to which the generator ventilates its air/gas mixture shall be sufficiently ventilated to preclude formation of a hydrogen-air mixture exceeding a volume fraction of 1 % except in dilution volume. Room ventilation requirements shall be provided in the manual as required by 12.3.3 and a label warning about the presence of hydrogen shall be affixed as required by 11.4.

4.7 Delivery of hydrogen

The manufacturer shall specify the hydrogen production rate, the hydrogen output pressure, temperature, and the quality of the hydrogen produced by the hydrogen generator as in ISO 14687.

5 Mechanical equipment

5.1 General requirements

All hydrogen generator parts and all substances used in the hydrogen generator shall be

— suitable for the range of temperatures and pressures to which the hydrogen generator is subjected during expected usage,

— resistant to the reactions, processes and other conditions to which the hydrogen generator is exposed during expected usage,

— suitable for their intended use, and

— used within their rating and in accordance with the manufacturer's instructions.

The hydrogen generator shall be designed to withstand expected shock and vibration loads, as well as the specified ambient temperature range during transportation to the installation site and use. Means shall be provided to facilitate safe handling of the hydrogen generator during lifting, moving and positioning operations. The hydrogen generator shall be designed to remain stable when subjected to normal operational forces imposed by users or by the environment during the installation or use.

The design of the hydrogen generator shall take into account the requirements specified in ISO 12100.

All parts of hydrogen generators, which are set or adjusted at the stage of manufacture and which should not be manipulated by the user or the installer, shall be appropriately protected.

Manual controls shall be clearly marked and designed to prevent inadvertent adjustment or activation.

All parts shall be adequately protected from climatic and environmental conditions anticipated by the operating conditions such as seismic-zone rating, snow, rain and wind loading.

All parts shall be of such construction as to be secure against displacement, distortion, warping or other damage that could affect their functionality.

All parts that may be contacted during normal usage, adjustment or servicing shall be free from sharp projections or edges.

All parts that require regular or routine maintenance or servicing, such as inspection, lubrication, cleaning, replacement or similar function, shall be accessible and protected from unauthorized access with the use of a special key or tool. All parts that are serviced by the residential user shall be accessible without exposing the user to any hazards.

Moving parts and parts containing liquid shall be designed and mounted in such a way that in all foreseeable modes of operation, the ejection of parts and liquid and the hazardous injection of liquid are prevented.

Where hazardous fluids are contained in the piping, precautions shall be taken in the design of the sampling and take-off points to ensure safety in accordance with the manufacturer's failure mode and effects analysis (FMEA). Where hazardous fluids are contained in the piping, the sampling and take-off points shall be clearly identified with cautionary symbols and protected from unauthorized access.

An FMEA pertaining to potential modes of failure and drift values for each safety-critical part shall be conducted (see 6.2.4.1).

The hydrogen generator or parts of it where persons are intended to move about or stand shall be designed and constructed to prevent persons slipping, tripping or falling on or off these parts.

5.2 General materials requirements

Materials employed in the hydrogen generator shall be suitable for their purpose.

All internal and external parts of the hydrogen generator that are directly exposed to moisture, ion transport medium, process gas streams of hydrogen or oxygen, as well as parts used to seal or interconnect the same, shall have the following material attributes during the manufacturer's rated service life:

a) retain mechanical stability with respect to strength (fatigue properties, endurance limit, creep strength) when exposed to the full range of operating conditions specified in Clause 4;

b) resist the chemical and physical action of the fluids that they contain and resist environmental degradation;

c) be compatible with any other material used in conjunction so as to not have a synergistic and undesirable effect.

When selecting materials and manufacturing methods, due consideration shall be given to the following:

— hydrogen embrittlement and hydrogen-assisted corrosion, as indicated in Annex A and in ISO/TR 15916;

— oxygen compatibility;

— corrosion and wear resistance;

— electrical conductivity;

— electrical insulation;

— impact strength;

— aging resistance;

— temperature effects;

— galvanic corrosion;

— erosion, abrasion, corrosion or other chemical attack;

— resistance to ultraviolet (UV) radiation.

The auto-ignition temperature of any materials that may come into contact with oxygen during operation shall have ignition temperatures in pure oyxgen atmosphere at the maximum operating pressure at least 50 °C greater than the maximum temperature to which they are exposed during operation.

Process piping and vessels carrying oxygen shall be cleaned in accordance with IEC/TR 60877.

5.3 Enclosures

5.3.1 Minimum strength

The supporting structure and the enclosure shall have the strength, rigidity, durability, resistance to corrosion and the other physical properties to support and protect all the components and piping, and withstand