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**Technical conditions of pressurized water electrolysis
system for hydrogen production**

压力型水电解制氢系统技术条件

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Technical conditions of pressurized water electrolysis system for hydrogen production

1 Scope

This Standard specifies the terms and definitions, classification and designation, technical requirements, test and detection, marking, and packaging of pressurized alkaline water electrolysis system for hydrogen production and proton exchange membrane (PEM) water electrolysis system for hydrogen production.

This Standard applies to pressurized alkaline water electrolysis and pressurized PEM water electrolysis systems for hydrogen production, whose working pressure is greater than or equal to 0.3 MPa and less than or equal to 5.0 MPa.

2 Normative references

The following documents are indispensable for the application of this document. For the dated references, only the editions with the dates indicated are applicable to this document. For the undated references, the latest edition (including all the amendments) are applicable to this document.

GB/T 150 (all parts) Pressure vessels

GB/T 151 Heat exchanger

GB/T 629 Chemical reagent - Sodium hydroxide

GB/T 1972 Disc spring

GB/T 2306 Chemical reagent - Potassium hydroxide

GB/T 2829 Sampling procedures and tables for periodic inspection by attributes (apply to inspection of process stability)

GB/T 3634.2 Hydrogen - Part 2: Pore hydrogen, high pure hydrogen and ultrapure hydrogen

GB 3836.1 Explosive atmospheres - Part 1: Equipment - General requirements

GB 3836.14 Electrical apparatus for explosive gas atmospheres - Part 14:

GB/T 37563 Safety requirements for pressurized water electrolysis system for hydrogen production

GB 50030 Code for design of oxygen station

GB 50058 Code for design of electrical installations in explosive atmospheres

GB 50177 Design code for hydrogen station

HG 20202 Code for construction and acceptance of degreasing project

JB/T 4711 Coating and packing for pressure vessels transport

TSG 21 Supervision Regulation on Safety Technology for Stationary Pressure Vessel

3 Terms and definitions

The terms and definitions defined in GB/T 19774 and GB/T 24499 and the following ones apply to this document.

3.1

Pressure

The force acting vertically on a unit surface area of a vessel. In this Standard, unless otherwise noted, pressure refers to gauge pressure.

3.2

Pressurized water electrolysis system for hydrogen production

A water electrolysis system for hydrogen production composed of a water electrolyzer with a specified pressure and its auxiliary equipment, pipelines and accessories, and enclosure, etc.

3.3

Alkaline water electrolysis system for hydrogen production

A water electrolysis system for hydrogen production composed of alkaline water electrolyzer and its auxiliary equipment, pipelines and accessories, and enclosure, etc.

3.4

- b) It shall meet the requirements of various mechanical properties; and under working conditions, maintain stable mechanical properties.
- c) The chemical composition and metallographic structure of the selected materials shall not cause or avoid hydrogen embrittlement.
- d) The chemical composition and metallographic structure of the selected materials shall not cause stress corrosion, cracking or oxygen corrosion during operation.

5.2.1.4 The autoignition temperature of materials in contact with oxygen under any conditions shall be 50 °C higher than the maximum acceptable operating temperature.

5.2.2 Water electrolyzer

5.2.2.1 The water electrolyzer is the main equipment of the water electrolysis system for hydrogen production. Its performance parameters will determine the technical performance of the water electrolysis hydrogen production.

The performance parameters and structural design of the water electrolyzer shall be based on the basic requirements of reducing the power consumption per unit of hydrogen, reducing the manufacturing cost, and extending the service life. The structural form of the water electrolyzer, the structure, coating and material of the electrolysis cell and diaphragm shall be selected reasonably.

5.2.2.2 The hydrogen production capacity, purity, and impurity content of the water electrolyzer shall be negotiated and determined in accordance with the manufacturer's enterprise standards and the user's requirements.

5.2.2.3 The electrode material, coating or catalyst of the electrolysis cell of the water electrolyzer shall be determined according to factors such as the electrolyzer type/working parameters.

If a bipolar structure is used, the electrode is required to have good volume conductivity. At the same time, the diaphragm shall be able to block the gas exchange between the positive and negative compartments, to ensure the purity of hydrogen and oxygen.

Titanium plate should be used as the plate substrate of the "electrolysis cell" in the PEM water electrolyzer. Metal platinum can be used as a catalyst on the negative electrode side. A ruthenium-iridium alloy or their oxide or mixture can be used as a catalyst on the positive electrode side.

5.2.2.4 PEM water electrolyzer uses proton exchange membrane as electrolyte. The proton exchange membrane shall have sufficient chemical stability and

- a) The enclosure shall have sufficient strength, rigidity and durability, to ensure the safety of all equipment and pipelines. The enclosure shall also bear the stress and vibration of the hydrogen production system in the process of transportation, installation and operation.
- b) The enclosure shall be made of corrosion-resistant materials, such as stainless steel plate or nickel-plated steel plate. Its thickness shall not be less than 0.6 mm.
- c) The insulating material of the enclosure shall be fixed by mechanical or other appropriate methods. It shall be prevented from any form of movement and destruction.
- d) The inner surface of the enclosure shall be flat and free of hydrogen gathering space. An exhaust port shall be set on the top. If there are multiple spaces where hydrogen can accumulate, multiple exhaust ports shall be provided; or vent holes shall be provided in the relevant "space".
- e) At locations that are convenient for inspection and maintenance, the enclosure shall be provided with inspection ports and maintenance ports. The inspection ports shall be equipped with windows or cover plates.
- f) A fixed hydrogen detection alarm shall be installed in the enclosure. Its technical performance shall meet the requirements of GB 12358 and GB 16808. The hydrogen detection alarm monitors the hydrogen concentration in the air. When reaching 0.4% (volume fraction), it shall give an alarm and turn on the accident fan.

5.2.4.4 The enclosure shall be equipped with pipelines and accessories for discharging the oxygen/hydrogen generated by water electrolysis to designated outdoor areas. For small equipment, the gas can also be discharged into the room. But at this time, an oxygen-enriched monitoring system or a hydrogen alarm system shall be installed in the room.

5.2.5 Hydrogen tank

5.2.5.1 According to the characteristics of hydrogen use and users' requirements for hydrogen, the hydrogen production system shall be equipped with corresponding hydrogen tanks.

5.2.5.2 The storage capacity of the hydrogen tank shall be determined according to parameters such as hydrogen production, characteristics of hydrogen used, and hydrogen pressure.

5.2.6 Oxygen tank

equipped with two independent overpressure interlock protection devices, to ensure the safe operation of the system.

5.2.9.2 The gas, discharged in the enclosure of the hydrogen production system, shall be led to a designated outdoor area for discharge.

5.2.9.3 The set pressure of the safety valve in the pressure relief device is 1.05 times to 1.1 times the working pressure. The safety valve shall meet the relevant requirements of GB/T 12241.

5.3 Pipelines and accessories

5.3.1 General requirements

5.3.1.1 The material selection of the hydrogen pipelines and accessories of the water electrolysis system for hydrogen production shall meet the relevant requirements of GB 50177. Oxygen pipelines and accessories shall meet the requirements of GB 50030.

5.3.1.2 The setting of the pipeline support shall meet the requirements of GB 50177. Welding shall not be used between the support and the single equipment.

5.3.2 Arrangement of pipeline accessories

5.3.2.1 The arrangement of pipeline accessories shall meet the requirements of the process flow chart with control points for the water electrolysis system for hydrogen production. And it shall facilitate the operation, installation and maintenance of the water electrolysis system for hydrogen production.

5.3.2.2 For pipe sections with thermal expansion and cold contraction, during arrangement, the flexible calculation and thermal compensation requirements shall be combined to make proper arrangements.

5.3.2.3 The arrangement of pipelines and accessories shall be neat and orderly; reduce unnecessary crossing. It shall pay proper attention to aesthetics.

5.3.3 Gas pipelines

5.3.3.1 The gas pipelines should be made of seamless steel pipes.

5.3.3.2 The setting of hydrogen pipelines and accessories shall comply with the relevant regulations of GB 50177.

5.3.3.3 The setting of oxygen pipelines and accessories shall comply with the relevant regulations of GB 50030.

5.4.1.4 The electrical facilities of the hydrogen production environment shall be divided into zones 1 and 2 in accordance with the provisions of GB 50177. The explosion-proof grade of electrical equipment in the explosion-hazardous area shall be Class II, Level C, Group T1. And it shall meet the requirements of GB 3836.1 and GB/T 34542.1.

5.4.1.5 The safety interlock signal of the hydrogen production system shall cut off the DC power supply.

5.4.1.6 The electrolysis room shall be equipped with an emergency power-off button for the DC power supply. The button should be located in a place that is convenient for operation.

5.4.2 Electrical grounding

5.4.2.1 Before installing the pipeline, the water electrolysis system for hydrogen production shall be checked for grounding resistance. For water electrolyzers connected to the positive and negative poles of the DC power supply at both ends respectively, the resistance to ground is not less than 1 M Ω .

5.4.2.2 The flanges and valve connections of hydrogen equipment and pipelines shall be bridged by metal (copper) connecting wires. The jumper resistance shall be less than 0.03 Ω .

5.4.2.3 For the grounding of electrical installations, a separate grounding trunk line shall be provided. Series connection must not be used.

5.4.2.4 The hydrogen and oxygen vent pipes shall be equipped with anti-static grounding.

5.4.2.5 All lightning protection and anti-static grounding devices shall be tested regularly for grounding resistance; at least once a year.

5.5 Automatic control and monitoring

5.5.1 General requirements

The hardware and software used in the automatic control and monitoring of the water electrolysis system for hydrogen production shall be able to operate normally under the design conditions. And it can promptly alarm and stop when the hydrogen production system fails; and carry out corresponding emergency treatment.

5.5.2 Automatic control and monitoring devices

5.5.2.1 Temperature sensor

After the automatic control and monitoring devices of the water electrolysis system for hydrogen production alarm, the source of the fault shall be checked immediately. And corresponding adjustments shall be made. When one of the following situations occurs, the interlock shutdown shall be started:

- When the purity of hydrogen or oxygen is lower than the design lower limit;
- When the liquid level of the separator is lower than the design lower limit;
- When the system pressure is higher than the design upper limit;
- When the lye/pure water circulation volume is lower than the design lower limit;
- When a power failure occurs;
- When the hydrogen concentration in the monitored air exceeds 1% (volume fraction).

5.6 Assembly and installation

5.6.1 General requirements

5.6.1.1 The assembly and installation of the water electrolysis system for hydrogen production shall be carried out in accordance with the design documents, technical requirements or engineering design documents of the equipment manufacturer.

5.6.1.2 The manufacturer shall provide installation instructions. These instructions mainly include the installation requirements, safety protection, maintenance and repair requirements for the electrolyzer and its auxiliary equipment.

5.6.2 Installation of water electrolyzer

5.6.2.1 According to the specifications and dimensions, the water electrolyzer can be installed in an enclosure type as a whole; or it can be installed separately.

5.6.2.2 After the water electrolyzer is assembled in the manufacturing plant, the airtightness inspection shall be carried out according to the design documents and technical requirements. After being qualified, it is shipped to the site for overall installation.

5.6.2.3 According to the specification, dimension and weight of the water electrolyzer, the hoisting and in-place plan shall be formulated. After making sufficient preparations, install it in place.

electrolysis system for hydrogen production is assembled. It mainly checks the appearance and various related dimensions; checks the accuracy of the connections of various liquid and gas pipelines and electrical circuits, etc.

6.1.2 Test preparation

When testing, the entire hydrogen production system shall be assembled according to the manufacturer's instructions. It shall be ensured that the working conditions of the system equipment in the test and detection are the same as the real working conditions.

6.1.3 Test working conditions

Unless otherwise specified, during test and detection, the entire hydrogen production system shall be in design conditions.

6.1.4 Test conditions

The test and detection shall be carried out in the following environment:

- a) The ambient temperature is 15 °C~35 °C;
- b) The relative humidity is within the manufacturer's requirements and does not exceed 75%;
- c) There shall be no frost, dew, water seepage, rain, solar radiation, etc.
- d) The hydrogen production system shall, during the whole test, be in a state of unobstructed ventilation and exhaust.

6.2 Test

6.2.1 Electrical test

6.2.1.1 Loop impedance test

The impedance measurement test of the fault loop shall be verified in accordance with the loop impedance test of GB/T 16895.23.

6.2.1.2 Voltage test

The electrical insulation strength shall be confirmed in accordance with GB 4793.1. The electrical insulation strength is called the dielectric strength in GB 4793.1. Unless the hydrogen production system does not require excessive humidity pretreatment. At this time, the test voltage shall not be lower than the provisions of GB 5226.1. The maximum test voltage shall be twice the rated power supply voltage of electrical equipment or 1000 V, whichever is greater.

6.2.4 Differential pressure test

6.2.4.1 For the electrolysis cell of the differential pressure PEM water electrolyzer, the differential pressure test shall be carried out under the design conditions. The test uses pure water as the medium. The pressure shall be separately applied to the positive or negative cell. The test pressure shall be 1.3 times the maximum operating pressure difference. At any time during the entire test process (including pressure increase, pressure holding and pressure relief), the pressure difference between the hydrogen and oxygen side does not exceed the allowable pressure difference. This requirement and allowable pressure difference shall be indicated in the product accompanying documents.

6.2.4.2 The gas in the test electrolyzer shall be drained and filled with liquid. During the test, the observation surface of the vessel shall be kept dry.

6.2.4.3 When the metal temperature of the test electrolyzer wall is close to the liquid temperature, the pressure can be slowly increased to the design pressure. After confirming that there is no leakage, continue to increase the pressure to the specified test pressure. The pressure holding time is generally not less than 30 min. Then reduce to the design pressure; hold the pressure for sufficient time for inspection. During the inspection, the pressure shall remain unchanged.

6.2.4.4 During the test, if there is no leakage in the electrolyzer, no visible deformation and abnormal sound, the test is qualified.

6.2.4.5 After passing the leakage test, the water electrolysis system for hydrogen production shall slowly release the pressure.

6.3 Detection

6.3.1 Preparation before detection

6.3.1.1 The hydrogen pipeline of the water electrolysis system for hydrogen production shall be purged and replaced. After the purging and replacement, the oxygen content in the system shall be less than 0.5%.

6.3.1.2 The raw water, electrolyte, power supply and automatic control system of the whole system shall meet the design requirements and meet the requirements for startup.

6.3.1.3 The production environment of the detection site meets the design requirements. All production auxiliary systems shall meet the conditions for startup.

6.3.1.4 After startup, gradually increase the load until the hydrogen/oxygen purity, working pressure, working temperature, and hydrogen production reach

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