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**Specification of water electrolyte system for producing
hydrogen**

水电解制氢系统技术要求

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Specification of water electrolyte system for producing hydrogen

1 Scope

This standard specifies the terms and definitions, classification and nomenclature, technical requirements, testing and detection, marking, packaging of hydrogen production systems for hydrogen and oxygen production, through water electrolysis.

This standard applies to industrial and commercial stationary and mobile water electrolysis hydrogen production systems.

This standard applies to filter-press type water electrolysis hydrogen production devices, including alkaline water electrolysis and solid polymer electrolyte water electrolysis.

2 Normative references

The provisions in following documents become the provisions of this Standard through reference in this Standard. For the dated references, the subsequent amendments (excluding corrections) or revisions do not apply to this Standard; however, parties who reach an agreement based on this Standard are encouraged to study if the latest versions of these documents are applicable. For undated references, the latest edition of the referenced document applies.

GB 150 Steel pressure vessels

GB 151 Tubular heat exchangers

GB/T 191 Packaging - Pictorial marking for handling of goods (eqv ISO 780)

GB/T 629 Chemical reagent - Sodium hydroxide (eqv ISO 6353-2)

GB/T 1972 Disc spring

GB/T 2306 Chemical reagent Potassium hydroxide (neq ISO 6353-2)

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

GB/T 3634 Industrial hydrogen

GB/T 3863 Industrial oxygen

GB/T 3985 Asbestos-rubber sheets

GB/T 4237 Hot rolled stainless steel sheets and plates

GB/T 4830 Pressure range and quality of air supply for the industrial process measurement and control instruments

GB 4962 Technical safety regulation for gaseous hydrogen use

GB 5099 Seamless steel gas cylinders (neq ISO 4705)

GB/T 5831 Determination of trace oxygen in the gases - Colorimetric method

GB/T 5832.1 Determination of moisture in gases - Part 1: Electrolytic method

GB/T 5832.2 Determination of trace water in the gases - Dew point method

GB/T 6285 Determination of trace oxygen in gases - Electrochemical method

GB 6654 Steel plates for pressure vessels

GB/T 7445 Pure hydrogen, high purity hydrogen and ultra pure hydrogen

GB/T 8163 Seamless steel tubes for liquid service (neq ISO 559)

GB/T 8175 Guide for design of thermal insulation of equipments and pipes

GB/T 8984.1 Determination of carbon monoxide, carbon dioxide and hydrocarbon in the gases - Part 1: Determination of carbon monoxide, carbon dioxide and methane in the gases - Gas chromatographic method

GB/T 8984.2 Determination of carbon monoxide, carbon dioxide and hydrocarbon in the gases - Part 2: Determination of total content of carbon monoxide, carbon dioxide and hydrocarbon in gases - Gas chromatographic method

GB/T 11352 Carbon steel castings for general engineering purposes (neq ISO 3755)

GB/T 12241 Safety valves - General requirements (eqv ISO 4126)

GB 12337 Steel spherical tanks

GB 12358 Gas monitors and alarms for workplace atmosphere general technical requirements

GB/T 13306 Plates

GB 13347 The quenching ability of fire arrester and its test method for petroleum

5.2.1.3.5 The chemical composition and structural form of the selected materials shall not cause stress corrosion, cracking or oxygen corrosion, during operation.

5.2.1.4 For the setting of the protective cover or shell of the mobile water electrolysis hydrogen production system, it shall meet the following requirements:

5.2.1.4.1 When in direct or indirect exposure to humid gas may affect the technical performance or use function of single equipment or components, it shall take protective measures OR select moisture-proof materials.

5.2.1.4.2 The protective cover or shell shall be made of non-combustible material. The minimum thickness should be 0.6 mm. Generally, galvanized steel sheet can be used. For the protective cover with a larger area, it takes strengthening measures or double-layer structure, according to the requirements of strength or rigidity.

5.2.1.4.3 When the protective cover or shell needs to be provided with an insulating layer, it shall be designed in accordance with GB/T 8175. The insulating material shall be non-combustible material; meanwhile measures shall be provided, to prevent the material from flying and scattering.

5.2.1.4.4 The inner surface of the protective cover or shell must be flat and free of hydrogen accumulation space; an exhaust port shall be provided at the highest point on the top. If there are two or more tops with the highest point, an exhaust port shall be provided, at each highest point.

5.2.1.4.5 There shall be a hydrogen concentration alarm device in the protective cover or shell, which shall be interlocked with the exhaust fan or the purging gas exchange shut-off valve.

5.2.1.4.6 Inspection ports and maintenance ports shall be set up in the protective cover or shell, at a position convenient for inspection and maintenance; the number and size of them shall be determined, according to the inspection and maintenance targets or functions. Inspection openings and maintenance openings shall be provided with view windows or cover plates.

5.2.2 Electrolyzer

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

The performance parameters and structure of the water electrolyzer shall be based on basic requirements for reducing the power consumption per unit hydrogen, reducing the manufacturing cost, prolonging the service life. The structural type of the water electrolyzer, the electrolytic cell and its electrodes, the structure, coating, material of the diaphragm shall be selected reasonably.

5.2.2.2 The hydrogen production capacity, purity, impurity content of the water electrolyzer shall be negotiated, according to the manufacturer's enterprise standard and the user's requirements.

5.2.2.3 The electrode material and coating of the electrolytic cell shall be determined, according to the design of the tank body AND the general requirements of the water electrolysis hydrogen production system.

5.2.2.4 Diaphragm material of diaphragm asbestos cloth shall meet the requirements of TC 211. It shall be determined, according to the technical requirements of tank design and supply conditions.

5.2.2.5 The selection of the sealing gasket shall ensure that the water electrolytic cell is impermeable, in the working state; meanwhile it can withstand the working state changes, when the cell is turned on and shutdown; its quality shall conform to GB/T 3985 or the relevant standard for the selected material for the design of specific water electrolytic cell.

5.2.2.6 The manufacturing requirements of the disc spring shall comply with the provisions of GB/T 1972.

5.2.2.7 The inner and outer surfaces of the castings shall be smooth; there shall be no defects, such as pores, cracks, significant uneven thickness. The steel castings shall meet the requirements of GB/T 11352.

5.2.2.8 The welds of the main welding structures shall not have defects, such as pores, slag inclusions, cracks.

5.2.2.9 The quality and inspection of the electroplated parts of the water electrolyzer shall meet the following requirements.

5.2.2.9.1 The coating surface of the plated parts shall be free from serious defects, such as bubbling, peeling, partial absence of coating and scratches. The surface quality of the coating shall be 100% inspected.

5.2.2.9.2 The quality and inspection of the coating thickness, bonding strength, porosity of the plated parts shall meet the requirements of JB 2111, JB 2112, JB 2115, respectively.

5.2.2.9.3 The inspection sampling and sampling method of the coating thickness, bonding strength, porosity of the plated parts shall be in accordance with the provisions of GB/T 2829. Tests of plating may be carried out on specimens, which are plated simultaneously by the same process.

5.2.3 Pressure vessels

5.2.3.1 The pressure vessel of the water electrolysis hydrogen production system is

5.2.4.4 A safety valve for pressure relief must be installed, on the pressure-type hydrogen tank or before the first shut-off valve in the inlet/outlet pipe. The safety valve shall meet the requirements of GB/T 12241. Atmospheric hydrogen tanks shall be equipped with automatic venting pipes.

5.2.4.5 If the hydrogen tank of the mobile water electrolysis hydrogen production system is installed in a protective cover or shell, its hydrogen capacity shall not exceed 20 m³. When oxygen is recovered and an oxygen tank is installed, the hydrogen tank and the oxygen tank shall be configured respectively in different bases and protective covers. Oxygen tanks shall be degassed, according to HGJ 202.

5.2.5 Hydrogen compressor

5.2.5.1 The hydrogen compressor, which is used for hydrogen pressurization, shall be set, according to the process of the water electrolysis hydrogen production system and user requirements. The form includes increasing pressure from normal pressure to low pressure or medium pressure or high pressure, increasing pressure from low pressure to medium pressure or high pressure, increasing medium pressure to high pressure or ultra-high pressure, etc.

5.2.5.2 According to the requirements of the intake/exhaust pressure and hydrogen purity of the hydrogen compressor, the piston type, membrane type and other types of compressors are selected.

5.2.5.3 The performance, structure, material of the hydrogen compressor shall meet the requirements of hydrogen characteristics; the reliable explosion-proof and anti-leakage measures shall be provided.

The hydrogen compressor shall be equipped with an explosion-proof electric motor; its explosion-proof level shall be dIICT1, which shall meet the requirements of GB 50058.

5.2.5.4 The hydrogen compressor shall be equipped with safety pressure relief device - safety valve, one by one. The safety valve shall be equipped with a protective cover; the discharged hydrogen shall be connected to the outside. The intake pipe of the hydrogen compressor shall be equipped with a low-pressure over-limit alarm device and a shutdown interlock.

5.2.5.5 A hydrogen buffer tank shall be provided, in front of the hydrogen compressor. For hydrogen compressors for hydrogen delivery, a bypass circulation pipe shall be installed, between the intake pipe and the exhaust pipe.

5.2.5.6 The electrical cabinet/control cabinet of the hydrogen compressor, in the mobile water electrolysis hydrogen production system, shall use adjacent nearby. The electrical cabinet/control cabinet shall be filled with pressurized air or nitrogen in the cabinet, OR adopt the dIICT1 level of explosion-proof electrical appliances, according to the provisions of GB 50058.

The hydrogen compressor in the mobile water electrolysis hydrogen production system shall be fixed on the base; vibration isolation measures shall be provided. The installation and acceptance of the compressor shall comply with the provisions of GB 50275.

5.2.6 Hydrogen purifier

5.2.6.1 Hydrogen purifier is used to remove oxygen impurities, moisture, etc. in hydrogen. Oxygen impurities are removed by catalytic method; moisture in hydrogen is removed by cooling method and adsorption method.

5.2.6.2 The design, manufacture, inspection, acceptance of various vessels in the hydrogen purifier shall comply with the requirements of the "Regulations on safety technical supervision of pressure vessel", GB 150, GB 151.

5.2.6.3 The temperature control of the hydrogen purification process should be controlled, by an automatic control device.

5.2.6.4 The detection of trace impurity concentration of oxygen and moisture, after hydrogen purification, can adopt the methods of GB/T 5831, GB/T 6285, GB/T 5832.1, GB/T 5832.2, GB/T 8984.1, GB/T 8984.2. According to user requirements, continuous testing instrument should be set up.

5.2.7 Pressure regulator/valve

5.2.7.1 The pressure regulator/valve is used for the pressure balance of the hydrogen side and the oxygen side, at the water electrolyzer outlet, OR the pressure regulation of the hydrogen/oxygen, which is supplied outside the water electrolysis hydrogen production system.

5.2.7.2 The pressure regulator/valve shall comply with the relevant standards or enterprise standards, for pneumatic control valves and self-operated control valves.

5.2.8 Hydrogen cut-off valve/shut-off valve

5.2.8.1 According to the requirements of air flow cut-off, analysis, test, blow-off replacement, in the production process of the water electrolysis hydrogen production system, a cut-off valve/shut-off valve shall be set at the relevant position.

5.2.8.2 The working pressure and temperature parameters of the cut-off valve/shut-off valve shall be determined, according to its position in the system. The selection of such valves shall fully consider the characteristics of hydrogen, whilst the selection of valves for pure hydrogen systems shall also consider that the pure hydrogen will not be contaminated.

When the hydrogen system adopts the electric valve, the valve with the corresponding explosion-proof level shall be selected, according to the provisions of GB 50058.

50316. Supports shall be avoided from being welded to the single equipment.

5.3.5 Cooling water pipeline

Whether to take insulation measures shall be determined, according to its operating temperature. When insulation is required, the insulation material shall be non-combustible.

For the cooling water pipeline that cannot interrupt the cooling water supply, it shall provide a water cut-off protection device; set an alarm and shutdown interlock.

5.4 Electrical equipment and wiring

5.4.1 Configuration of DC power supply

5.4.1.1 The DC power supply of each water electrolyzer generally adopts thyristor rectifier or silicon rectifier alone. The rectifier shall be equipped with voltage regulation function and automatic current stabilization function.

5.4.1.2 The selection of rectifiers for water electrolyzer shall meet the following requirements:

- The rated DC voltage shall be greater than the working voltage of the water electrolyzer; the voltage regulation range should be 0.6 ~ 1.05 times the rated voltage of the water electrolyzer;
- The rated DC current shall not be less than the working current of the water electrolyzer; it should be 1.1 times the rated current of the water electrolyzer.

5.4.1.3 The fortification of electrical facilities in the hydrogen production environment shall be in Zone 1 or Zone 2, according to the provisions of GB 50177. The electrical equipment and wiring, in the explosion-hazardous environment, shall be selected and configured, according to the provisions of GB 50058 and JB 3836.

5.4.2 Electrical facilities of the mobile water electrolysis system

5.4.2.1 For the mobile water electrolysis hydrogen production system, the area of the hydrogen production device installed in the protective cover shall have an explosion hazard level of Zone 1; the relevant electrical equipment and wiring shall be configured, in accordance with the provisions of GB 50058 and JB 3836 .

The setting of the lightning protection facilities of the mobile water electrolysis hydrogen production system is related to the installation area or place, which shall be determined through consultation with the purchaser, AND shall comply with the provisions of GB 50177 and GB 50057.

5.4.2.2 The forced ventilator and its motor of the protective cover shall be explosion-proof AND comply with the provisions of GB 50058 and JB 3836.

5.4.2.3 There shall be an alarm device for hydrogen concentration, which exceeds the limit, in the protective cover. When the hydrogen concentration exceeds 0.5%, the forced fan shall be started to exhaust; when the hydrogen concentration exceeds 1.0%, the production shall be stopped for inspection.

5.4.3 Electrical grounding

5.4.3.1 The grounding resistance of the water electrolyzer shall be checked, according to its structural characteristics. For the water electrolyzer, whose two ends are connected to the positive and negative poles of the DC power supply, the resistance to ground is not less than 1.0 M Ω .

5.4.3.2 The flanges and valve connections of hydrogen equipment, pipelines, valves shall be bridged, by metal (copper) connecting wires.

5.4.3.3 Grounding resistance inspection of explosion-proof electrical appliances and wiring.

5.4.3.4 The hydrogen compressor shall take grounding measures, to remove static electricity; the grounding resistance shall not be greater than 30 Ω .

5.5 Automatic control and monitoring

5.5.1 General requirements

The hardware and software of the automatic control and monitoring device of the water electrolysis hydrogen production system shall be able to withstand the occurrence of possible accidents; they shall be able to immediately give an alarm and stop, when a fault occurs; carry out necessary and proper treatment.

5.5.2 Automatic control and monitoring device

5.5.2.1 Pressure sensor

The pressure sensors are set as follows: the hydrogen side/oxygen side pressure and pressure difference at the outlet of the water electrolyzer, the inlet pressure of the hydrogen compressor, the pressure of the hydrogen tank, the pressure of the positive pressure air in 5.2.5.6, etc.

5.5.2.2 Temperature sensor

The temperature sensors are set as follows: the temperature of the gas or electrolyte at the outlet of the water electrolyzer, the outlet temperature of the cooling water of the

- When the hydrogen concentration in the monitored air exceeds 1.0%.

5.6 Installation and assembly

5.6.1 General requirements

5.6.1.1 The installation and assembly of the water electrolysis hydrogen production system shall be carried out, according to the design drawings, technical requirements or engineering design drawings of the equipment manufacturer.

5.6.1.2 The installation, assembly, test of the water electrolysis hydrogen production system shall meet the requirements of GB 50177.

5.6.2 Installation of water electrolyzer

5.6.2.1 The installation methods of the water electrolyzer are: integral installation and decentralized installation.

5.6.2.1.1 The pressure type water electrolyzer is generally installed as a whole, that is, after the tank body is assembled in the manufacturing plant, it is transported to the site for overall installation. According to the specifications, size, weight of the water electrolyzer, a hoisting and positioning plan is formulated; the installation is carried out after sufficient preparation. Then air tightness inspection is carried out, according to design drawings and technical requirements.

5.6.2.1.2 The normal pressure water electrolyzer is generally installed in a distributed manner, that is, the pole frame, main and auxiliary pole plates, diaphragms, air passages, liquid passages, other components of the electrolyzer are transported to the site of use; they are assembled in accordance with the design drawings and technical requirements of the manufacturer. The assembly work is carried out, jointly by the manufacturer and the user OR under the guidance of the technical staff of the manufacturer, each fulfills their own responsibilities, according to the contract.

5.6.2.1.3 The water electrolyzer of the mobile water electrolysis hydrogen production system should be assembled at the manufacturer plant. At the user's site, it only needs following the drawing and instruction manual of the manufacturer, to carry out positioning and connection of various pipelines.

5.6.2.2 Inspection after installation

5.6.2.2.1 For the water electrolyzer installed as a whole, after installation, it shall check the various related dimensions and the accuracy of connection pipelines; check the electric grounding resistance; check the connection of positive and negative poles of the water electrolyzer, etc.

5.6.2.2.2 For water electrolyzer, which is installed in a decentralized manner, after the

assembly is completed, first check the accuracy of various relevant dimensions and connecting pipelines. Connect the steam, for cooking, clamping, air tightness tests of the tank body. Check electrical grounding correctness and grounding resistance. Check the connection of positive and negative poles of the water electrolyzer, etc. For the assembly and inspection of new water electrolyzer, the manufacturer shall send technicians to the site, to be responsible for solving the equipment quality and related problems.

5.6.2.2.3 After the water electrolyzer of the mobile electrolytic hydrogen production system is installed on the user's site, it shall check the relevant dimensions and the accuracy of the connection pipeline; check the electrical grounding resistance, etc.

5.6.3 Installation of hydrogen compressor

5.6.3.1 Before installing the hydrogen compressor, it shall check the exit-factory certificate as provided by the manufacturer; be familiar with the technical specification and related drawings.

5.6.3.2 The installation and acceptance of the hydrogen compressor shall comply with the provisions of GB 50275. It shall be carried out, in accordance with the relevant standards of the compressor and the requirements in the manufacturer's technical specification.

5.6.3.3 Before the hydrogen compressor is connected to the water electrolysis hydrogen production system for trial operation, the following work shall be carried out.

5.6.3.3.1 Check the accuracy of electrical wiring and grounding;

5.6.3.3.2 Carry out a single-machine no-load test run. Check the operation and movement of various parts and components, as well as the air tightness and safety devices of each part;

5.6.3.3.3 Use nitrogen, which has an oxygen content of less than 0.5%, to carry out purging replacement.

5.6.4 Installation of hydrogen tank

5.6.4.1 Before the installation of the hydrogen tank, it shall check the integrity of the exit-factory certificate, pressure vessel inspection documents and various technical data, according to the requirements of the "Regulations on safety technical supervision of pressure vessel" and design drawings.

5.6.4.2 According to the size, weight, site conditions of the hydrogen tank, formulate an installation plan and related safety measures. Check the inside and outside of the tank and all relevant dimensions, according to the design drawings and technical description documents. After careful preparations are made, the installation in place can be carried out.

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