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**Technical specification for liquid hydrogen production
system**

液氢生产系统技术规范

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Technical specification for liquid hydrogen production system

1 Scope

This standard specifies the basic technical requirements, hydrogen liquefaction equipment, liquid hydrogen storage, hydrogen discharge, automatic control and detection analysis, electrical facilities, lightning protection, anti-static and protective grounding, auxiliary facilities, safety protection of the liquid hydrogen production system.

This standard applies to the design of newly built, rebuilt, expanded liquid hydrogen production systems.

This standard does not apply to liquid hydrogen production systems, which are used in the military, national defense, aerospace fields.

2 Normative references

The following documents are essential to the application of this document. For the dated documents, only the versions with the dates indicated are applicable to this document; for the undated documents, only the latest version (including all the amendments) is applicable to this standard.

GB 3836.4 Explosive atmospheres - Part 4: Equipment protection by intrinsic safety i

GB 3836.14 Explosive atmospheres - Part 14: Classification of areas - Explosive gas atmosphere

GB/T 4208 Degrees of protection provided by enclosure (IP code)

GB/T 4830 Industrial process measurement and control instruments - Pressure range and quality of air supply

GB 4962 Technical safety regulation for gaseous hydrogen use

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

GB/T 8979 Pure nitrogen and high purity nitrogen and ultra-pure nitrogen

GB/T 24499 Technology glossary for gaseous hydrogen, hydrogen energy

hydrogen storage vessels should be installed at the edge of the plant area. The terrain is required to be flat and open, with good natural ventilation. Meanwhile it should provide anti-collision walls or fences; set up obvious fire prohibition signs and safety warning signs.

4.3 Pipes, valves and accessories

4.3.1 For the design of piping and its accessories, it shall comply with the relevant national standards and special equipment safety technical specifications.

4.3.2 When necessary, along the liquid hydrogen pipelines AND at pipeline connections, it shall be equipped with cold and heat compensation structures.

4.3.3 Cryogenic liquid pipelines shall be equipped with measures, to prevent the pipeline from overpressure, due to pipeline heating up.

4.3.4 For the selection of insulation method AND insulation materials of the pipeline, as well as the selection of the thickness of the insulation layer, it shall be determined according to the medium temperature and cold loss requirements. Vacuum insulated pipelines should adopt multilayer insulation materials. The main technical properties shall meet the requirements of GB/T 31480 and GB/T 31481. The main technical properties of non-vacuum insulated pipelines shall meet the requirements of GB/T 8175.

4.3.5 The selection of pipeline valves AND the welding of pipeline joints shall comply with the relevant requirements of GB 50177.

4.3.6 The minimum clear distance, BETWEEN the pipelines AND other overhead pipelines, buried pipelines and buildings, shall comply with the relevant requirements of GB 50177.

4.3.7 The configuration of liquid hydrogen transmission pipelines shall meet the following requirements:

- a) The material shall be compatible with liquid hydrogen;
- b) It shall take thermal insulation measures;
- c) The inside of the pipeline shall be carefully cleaned and dried, to remove grease, moisture and mechanical impurities;
- d) The pipe connection should be welded. The pipe joint shall be sealed and reliable;
- e) Liquid hydrogen transmission pipelines shall be laid on the ground. The layout of the pipelines shall avoid crossing roads. If open trenches are

production of liquid hydrogen.

5.1.4 The liquefaction process equipment shall be reasonably arranged, in accordance with the sequence of the process flow AND site conditions. Meanwhile it shall fully utilize the position difference. The distance, between equipment and equipment, and between equipment and building (structure) components, shall meet the requirements of production operation, installation maintenance, overhead pipelines, underground trenches, etc.

5.1.5 The hydrogen compressor should be installed in a separate building (structure). The hydrogen concentration alarm device shall be installed in the hydrogen compressor room, where hydrogen is likely to accumulate, meanwhile it shall be interlocked with the mechanical exhaust fan.

5.1.6 The unit equipment shall not straddle the two sides of the deformation joint of the building.

5.1.7 The heating time of the hydrogen liquefaction device shall not be less than the cooling time.

5.2 Configuration of process equipment

5.2.1 For the configuration of process equipment, it shall be determined after technical and economic comparisons, based on factors such as product quality requirements, liquefaction process flow and technical parameters, equipment production capacity, equipment utilization efficiency.

5.2.2 For the type selection of process equipment, it shall be carried out according to factors such as the type of material, flow rate, temperature, pressure.

5.2.3 For the selection of compressors, turboexpanders, etc., it shall be determined according to the liquid hydrogen production capacity, process flow and technical parameters. For the compressors, turboexpanders, vacuum pumps, water pumps and other equipment, it shall select the high-efficiency type-finalized products which is stable in operation, low in noise, low in failure rate, convenient for maintenance.

5.2.4 For the supporting pressure vessel in the hydrogen liquefaction equipment, it shall comply with the relevant national standards and special equipment safety technical specifications.

5.2.5 For the motors and machinery and equipment, which are installed outdoors, they shall have anti-rust and protective measures. The motor shall comply with the relevant requirements of GB/T 4208.

5.2.6 For units, auxiliary equipment and pipelines, that are prone to vibration in

shall also be a high level alarm interlocking device.

7 Hydrogen discharge

7.1 General provisions

7.1.1 The liquid hydrogen production system shall be equipped with a hydrogen discharge pipeline, according to the process requirements, including: discharge pipe, empty valve, safety valve, etc.

7.1.2 On the outer wall of the low-temperature hydrogen discharge pipe at the outlet of the hydrogen liquefaction device, it shall be provided with an insulation layer at a place accessible to personnel, to prevent frostbite.

7.1.3 The low-temperature hydrogen discharge pipeline shall have sufficient length, to ensure that the hydrogen temperature at the discharge port, is higher than the air liquefaction temperature. The temperature of the discharge nozzle shall not be lower than 90 K.

7.1.4 For the discharge pipe, whose hydrogen pressure exceeds 10 MPa, AND the discharge pipe, whose pressure is lower than 1.6 MPa, they shall not share the discharge main pipe.

7.1.5 In the discharge pipelines of processes such as purging, replacement, regeneration, it should set up check valves.

7.1.6 The discharge pipes of normal temperature pipelines and low temperature pipelines shall be set separately.

7.2 Discharge pipe

7.2.1 The discharge of hydrogen shall be equipped with a special discharge pipe, which shall be directly discharged to the outdoor atmosphere.

7.2.2 The discharge pipe shall be set up vertically. The discharge pipe's opening shall avoid the radiant heat and the jet flame, which are produced by hydrogen combustion, from impacting people or equipment, otherwise it may cause personal injury or equipment performance damage.

7.2.3 The hydrogen discharge pipe shall be made of copper, aluminum alloy, stainless steel or other metallic materials. Plastic pipes or rubber pipes shall not be used.

7.2.4 The discharge nozzle shall be equipped with devices, to prevent air backflow, rain and snow intrusion, anti-condensation, blocking by foreign matter. Meanwhile, it shall take effective static elimination measures.

8.2.5 For the temperature detection for the liquid hydrogen production system, it mainly includes the temperature display of each heat exchanger in the liquid hydrogen cold box, the temperature adjustment of heat exchanger, etc.

8.2.6 For the temperature sensor in the liquid hydrogen cold box, it shall select a product with a wide temperature range. It shall set up a backup sensor at the key temperature point.

8.2.7 For the continuous measurement of the liquid level of liquid hydrogen and liquid nitrogen storage vessels, it should adopt a differential pressure measuring instrument. The remote display should be converted into a standard volume.

8.2.8 The hydrogen flow rate of the raw material at the inlet of the cold box shall be monitored.

8.2.9 For the display mode and function of the secondary instrument, it shall be determined according to the requirements of the liquid hydrogen production process and control system. When signal transmission is required, it may select an instrument, which has an analog signal output function OR a digital signal output function.

8.3 Automatic control

8.3.1 The liquid hydrogen production system should use a digital control system, such as a distributed control system (DCS), a data acquisition system, an industrial microcomputer or a programmable control system (PLC). The hardware and software configuration of the control system shall be adapted to the production scale and control requirements.

8.3.2 For the control system, it shall be type selected in accordance with the principles of easy integration with other control equipment and easy expansion of functions. The selected system shall be stable and reliable.

8.3.3 The detection and control of process parameters in the production process shall include the following:

- a) Detection of operating parameters of the liquid hydrogen production process;
- b) For important parameters for accounting or scheduling, it shall set an accumulation function;
- c) For the main parameters for analyzing the causes of accidents and failures, it shall set a recording function;
- d) Operation status and parameter detection of important valves,

- c) At the outlet of the hydrogen liquefaction device and the liquid hydrogen storage vessel, it should analyze the content of impurities, such as para-hydrogen, oxygen, nitrogen, water, carbon monoxide, carbon dioxide, total hydrocarbons, in the liquid hydrogen. The parahydrogen content is not less than 95%.

8.4.2 Detection analysis methods

For the impurity content in hydrogen and liquid hydrogen, the analysis method shall be implemented in accordance with the relevant requirements of GB/T 40045.

9 Electrical facilities

9.1 General provisions

9.1.1 For the electrical facilities of the liquid hydrogen production system, which is in an explosive environment, they shall comply with the relevant requirements of GB 50177.

9.1.2 For the arrangement of electrical devices and circuits in explosive environments, it shall comply with the relevant requirements of GB 50058, GB 3836.4, GB 3836.14.

9.2 Power supply

9.2.1 For the power supply of the liquid hydrogen production system, it shall be classified according to the load specified in GB 50052.

9.2.2 The main wiring of the power supply shall be simple and reliable, safe in operation, flexible in operation, convenient in maintenance.

9.2.3 For the power supply's voltage level and power supply loop, it shall be determined according to the scale of production, nature and power consumption, combining with the power supply conditions of the regional power grid. The liquid hydrogen production system should adopt 10 kV power supply.

9.3 Electrical equipment and wiring

9.3.1 The power distribution equipment of the liquid hydrogen production system shall be close to the load center. It shall be controlled centrally. The power distribution room and control room shall not be adjacent to places, that are corrosive and prone to water accumulation.

9.3.2 Explosion-proof lamps shall be used for the lighting of rooms with explosion hazard. The light source should be high-efficiency light sources, such

electricity in an explosive environment. They shall comply with the relevant requirements of GB 50177.

10.6 For the equipment and pipelines, which require grounding, they shall be provided with grounding terminals. Between the grounding terminal and the grounding wire, it may be fastened and connected by bolts. For the equipment and pipelines with vibration and displacement, it shall use a flexible connection wire for transition at the connections.

11 Auxiliary facilities

11.1 Instrument gas supply

11.1.1 The instrument gas source shall comply with the relevant requirements of GB/T 4830.

11.1.2 For the design capacity of the instrument gas source, it shall be determined based on the total gas consumption of the process equipment, considering the utilization factor and the piping system leakage factor.

11.1.3 For the capacity of the gas storage buffer tank for the instrument gas, it shall ensure that, when all air compressors are stopped, it should guarantee the gas consumption requirements for 20 min ~ 30 min of equipment, under the conditions that the gas supply pressure is not lower than the minimum allowable working pressure of the pneumatic equipment.

11.1.4 For gas supply points with large fluctuations in gas consumption, it should take gas from the gas source main pipe. It should use a single-line gas supply method.

11.1.5 For the occasions with multiple instruments or densely arranged instruments, it should use branch-trunk gas supply method, where it is leaded from the branch-trunk pipe to the air distributor or the gas supply point.

11.1.6 When the gas supply pipeline network supplies gas to the instruments of multiple devices (such as hydrogen production device, hydrogen liquefaction device, hydrogen pipe network, etc.), it should use the loop pipeline network for gas supply.

11.2 Nitrogen supply

11.2.1 The nitrogen of the liquid hydrogen production system is mainly used for: regeneration gas of hydrogen purification, purging replacement gas of hydrogen system, shielding gas of isolating air, positive pressure protection gas, debugging and repairing gas of pneumatic instrument, instrument purging gas, standby gas for instrument gas source, etc.

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