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**Testing method for proton exchange membrane electrolyzer
performance**

PEM电解槽性能测试方法

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1 Scope

This document describes the basic inspection, fundamental test, and performance test methods for proton exchange membrane electrolyzers (hereinafter referred to as the "PEM electrolyzers") and specifies the requirements for test reports.

This document applies to the inspection and testing of PEM electrolyzers with a rated hydrogen production pressure less than or equal to 10 MPa and a single-cell rated hydrogen production capacity of 1 m³/h to 500 m³/h. PEM electrolyzers with a rated hydrogen production pressure greater than 10 MPa, or a rated hydrogen production capacity less than 1 m³/h or greater than 500 m³/h, may be inspected and tested using this document as a reference.

NOTE. unless otherwise specified, all pressures refer to gauge pressure. The standard state in this document are a temperature of 0 °C and a pressure of 101.325 kPa (absolute pressure). The volumes of hydrogen and oxygen in this document refer to the volumes under standard state.

2 Normative References

GB/T 8979

GB/T 24499

GB/T 37562

GB/T 45539

3 Terms and Definitions

The terms and definitions defined in GB/T 24499 and GB/T 45539 are applicable to this document.

4 Basic Inspection

4.1 Check the PEM electrolyzer product manual.

4.2 Visually inspect the PEM electrolyzer for any damage, scratches, or other defects in its appearance and structure.

4.3 Visually check that the PEM electrolyzer label is affixed to the designated location and

that the label content is complete and clear.

4.4 Perform a polarity check on the PEM electrolyzer. Inspect the wiring terminals and electrical connections to confirm they meet the requirements. During normal operation test, use a voltmeter to check the polarity of the PEM electrolyzer wiring terminals.

4.5 If the PEM electrolyzer has an inspection line, it shall be checked to prevent short circuits, open circuits, etc.

4.6 The gas and water pipe joints and electrical interfaces of the PEM electrolyzer shall meet the requirements of the manual and satisfy the demands of installation, operation and maintenance.

4.7 Grounding checks shall be performed on the PEM electrolyzer before testing.

5.1.1 Principles

The strength test of the PEM electrolyzer generally adopts a hydrostatic test, with the test pressure being 1.25 times the design pressure. For PEM electrolyzers unsuitable for hydrostatic tests, a pneumatic strength test can be used, with the test pressure being 1.1 times the design pressure. Safety measures shall be formulated in accordance with safety production management regulations for the strength test, safety protection and monitoring devices shall be installed, and safety supervision and management shall be carried out throughout the process.

5.1.2 Hydrostatic test

The hydrostatic test shall use deionized water. The conductivity of the deionized water shall be less than or equal to 0.1 mS/m, and the water quality shall meet the requirements of GB/T 37562.

The hydrostatic test procedures are as follows.

a) Connect the gas outlets of the anode and cathode chambers of the PEM electrolyzer and install pressure sensors, pressure gauges, or other pressure monitoring devices.

Seal other inlets and outlets of the electrolyzer. During the test, the surface of the PEM electrolyzer shall be kept dry;

b) Introduce deionized water into the anode and cathode chambers, slowly raise the pressure to the design pressure. After confirming that there is no leakage, continue to raise the pressure to the specified test pressure. Hold the pressure for 30 minutes, during which time the pressure shall remain constant;

c) Observe the electrolyzer for any leakage, visible deformation, or abnormal sounds.

5.1.3 Pneumatic test

The pneumatic test uses high-purity nitrogen, which shall comply with the relevant provisions in GB/T 8979. The pneumatic test procedures are as follows.

- a) Connect the outlets of the anode and cathode chambers of the PEM electrolyzer and install pressure sensors, pressure gauges, or other pressure monitoring devices. Seal all other inlets and outlets of the PEM electrolyzer;
- b) Introduce high-purity nitrogen into the anode and cathode chambers, slowly raise the pressure to 10% of the specified test pressure and hold the pressure for 5 minutes. The method of applying leak detection liquid (or other leak detection tools) to perform an initial inspection of all joints, connecting components and the PEM electrolyzer. After confirming that there is no leakage, continue to raise the pressure to 50% of the specified test pressure. If no abnormalities are observed, gradually raise the pressure in increments of 10% of the specified test pressure, until the test pressure is reached, and hold the pressure for 10 minutes. Then, reduce the pressure to the design pressure and hold it for sufficient time for inspection. During the inspection, the pressure shall remain constant;
- c) Observe the PEM electrolyzer for any abnormal noises. Use a special-purpose leak detection liquid to check for bubbles and visible deformation.

5.2 Airtightness Test

The test gas for the hydrogen side is one of hydrogen, helium, a hydrogen-nitrogen mixture, or a helium-nitrogen mixture. The test gas for the oxygen side is nitrogen or helium. The airtightness test procedures are as follows.

- a) Connect the test device as shown in Figure 1;
 - b) Connect the outlets of the anode chamber (oxygen side) and cathode chamber (hydrogen side) of the PEM electrolyzer, and seal other inlets and outlets of the PEM
- T2---the gas temperature at the end of the test, expressed in (K);
- p1---the absolute pressure of the PEM electrolyzer at the start of the test, expressed in (MPa);
- p2---the absolute pressure of the PEM electrolyzer at the end of the test, expressed in (MPa).

5.4 Internal Crossflow Test

After the PEM electrolyzer passes the airtightness test, an internal crossflow test is conducted using high-purity nitrogen or helium as the test gas. For PEM electrolyzers with an isobaric structure, the pressure is maintained at a differential pressure of 0.2 MPa for 5 minutes; for PEM electrolyzers with a differential pressure structure, the pressure is maintained at the maximum permissible operating differential pressure for at least 5 minutes. The internal crossflow rate shall meet the manufacturer's requirements in the