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NATIONAL STANDARD OF THE PEOPLE'S REPUBLIC OF CHINA

GB/T 45092-2024

Testing and evaluation of electrodes performance for hydrogen production by water electrolysis

电解水制氢用电极性能测试与评价

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1 Scope

GB/T 45092-2024 sets the methods for testing and evaluating the electrodes used in water electrolysis for hydrogen production. In an alkaline electrolyser the electrode is the component that decides both the energy cost of the hydrogen and the life of the stack, and China is installing electrolysers faster than anywhere else, increasingly coupled to wind and solar whose output swings - which is the condition under which coatings delaminate and reverse-current damage occurs. The standard describes the test and evaluation indicators and then the methods: the ultrasonic weight loss test for coating adhesion, the overpotential test, the positive and negative polarisation stability, the average cell voltage and its rate of change, and electrolysis under fluctuating current, each with its principle, reagents, equipment, samples, test conditions, test steps and data processing. It takes effect on 1 March 2025.

This document describes the test and evaluation methods for ultrasonic weight loss, overpotential, positive and negative polarization stability, average cell voltage, average cell voltage change rate, fluctuating current electrolysis of electrodes for hydrogen production by water electrolysis. This document is applicable to the performance test and evaluation of electrodes for hydrogen production by alkaline water electrolysis. The hydrogen evolution electrode and oxygen evolution electrode for hydrogen production by hydroxyl ion exchange membrane water electrolysis shall be implemented with reference to this document.

2 Normative references

The contents of the following documents constitute essential clauses of this document

through normative references in the text. Among them, for dated references, only the version corresponding to that date is applicable to this document; for undated references, the latest version (including all amendments) is applicable to this document.

GB/T 678 Chemical reagent - Ethanol

GB/T 2306 Chemical reagent - Potassium hydroxide

GB/T 2900.98 Electrotechnical terminology - Electrochemistry

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

GB/T 6682 Water for analytical laboratory use - Specification and test methods

GB/T 14599 Pure oxygen and high purity oxygen and ultra-pure oxygen

GB/T 15724 Laboratory glassware beaker

GB/T 21648 Industrial dense woven wire cloth

GB/T 28817 Single cell test methods for polymer electrolyte fuel cell (PEFC)

3 Terms and definitions

The terms and definitions defined in GB/T 2900.98, as well as the following terms and definitions, apply to this document.

3.1 Overpotential The absolute value of the difference between the working potential and the theoretical potential, when an electrode reaction occurs on the electrode.

Note: The overpotential must indicate the corresponding current density. The working potential and theoretical potential are values relative to the same reference system.

3.2 Average cell voltage The average cell voltage in a certain period of time when electrolysis is carried out at a certain current density.

Note: For a single-cell electrolyzer, the average cell voltage is the average electrolyzer voltage in a certain period of time; for a multi-cell electrolyzer, it is the value obtained by dividing the average electrolyzer voltage in a certain period of time by the number of cells in series.

3.3 Reversible hydrogen electrode When hydrogen is introduced into a solution of a certain pH and reaches saturation, the electrode where the redox reaction of hydrogen and hydrogen ions on the platinum electrode reaches equilibrium and which has a balanced electrode potential.

Note: The potential of the reversible hydrogen electrode is related to pH. The potential of the reversible hydrogen electrode at 25°C is E=-0.0592pH.

4 Test and evaluation indicators

See Table 1 for electrode performance test and evaluation requirements.

5.4 Sample

5.4.1 Specifications The test electrode is a 40 mm x 40 mm rectangle. A set of test electrodes has 3 pieces; the 3 pieces shall come from the same batch of electrodes. For electrodes that need to be activated, the activated electrodes shall be used for testing.

5.4.2 Sample preparation The samples shall be cut according to the specifications of the test electrodes, with a size error of less than 2%. After cutting, the electrodes shall be kept flat; the burrs, serrations or sharp protrusions on the edges of the electrodes shall be rounded.

5.5 Test conditions The temperature of the test liquid in the ultrasonic cleaning machine is 30 °C ± 1 °C.

5.6 Test steps The test steps for ultrasonic weight loss of electrodes are as follows:

a) Treatment: Rinse the electrodes repeatedly with pure water for at least 3 times; then rinse the electrodes repeatedly with anhydrous ethanol (unless otherwise specified in this document, anhydrous ethanol shall comply with the analytical grade requirements in GB/T 678) for at least 3 times; dry the electrodes in a vacuum oven at 70 °C and a vacuum degree of no more than 200 Pa for more than 2 hours.

b) Weighing: Weigh 3 electrodes in turn; record the initial mass mi,0 of the 3 electrodes respectively, with an accuracy of

0.1 mg.

c) Ultrasonic treatment: Treat one electrode each time; place the electrode horizontally at the bottom of a 250 mL glass beaker containing 200 mL of test solution (unless otherwise specified in this document, the glass beaker shall comply with the specification of 250 mL nominal capacity in GB/T 15724); place the beaker at the bottom of the ultrasonic cleaning machine and fix it; add water to the ultrasonic cleaning machine until the water level in the inner tank is 50 mm; treat it continuously for 60 min at a temperature of 30 °C ± 1 °C. The sample placement position during ultrasonic weight loss test is shown in Figure 1.

d) Take out the test electrode; treat and weigh the post-ultrasonic electrode according to the steps described in

a) and b); record the final mass mi of the three electrodes, respectively. electrode with an external salt bridge. Before use, the reference electrode shall be calibrated for potential according to the method described in Appendix A.

6.6 Counter electrode The counter electrode is a pure nickel electrode with a purity of not