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NATIONAL STANDARD OF THE PEOPLE'S REPUBLIC OF CHINA

GB/T 20042.5-2024

Replacing GB/T 20042.5-2009

Proton exchange membrane fuel cells - Part 5: Test methods for the membrane electrode assembly

质子交换膜燃料电池 第5部分：膜电极测试方法

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1 Scope

GB/T 20042.5-2024 specifies the test methods for the membrane electrode assembly of a proton exchange membrane fuel cell. The MEA is where the fuel cell actually happens, and it is also where almost all of the cost and all of the degradation sit: it is bought and sold on a polarisation curve and a durability figure, and neither means anything without a stated test protocol, because the same MEA gives materially different numbers at a different humidity, stoichiometry, back pressure or cell temperature. This document fixes them: the test station

and the single cell hardware, the conditioning and break-in procedure, the measurement of the polarisation curve and of the high frequency resistance, the hydrogen crossover and the electrochemical surface area, the response to load change, the accelerated stress tests for chemical and for mechanical degradation, the durability testing and the reporting. The 2024 edition replaces GB/T 20042.5-2009. For an MEA maker, a stack builder or a laboratory in China, this is the protocol a comparison rests on.

This document describes the methods for the thickness uniformity test, platinum group metal loading test, polarization curve test, hydrogen permeation current density test and insulation resistance test, electrochemical active surface area test, oxygen reduction reaction activity test, ohmic polarization test, membrane electrode sub-item aging test, anode hydrogen oxidation reaction polarization test, membrane electrode anode anti-voltage reversal test, impurity tolerance test, membrane electrode durability test of proton exchange membrane fuel cells. This document is applicable to the detection of membrane electrodes of proton exchange membrane fuel cells; other polymer electrolyte fuel cells shall refer to it.

2 Normative references

The contents of the following documents constitute essential clauses of this document through normative references in the text. For reference documents with dates, only the versions corresponding to the dates apply to this document; for reference documents without dates, the latest versions (including all amendments) apply to this document.

GB 3095-2012 Ambient air quality standards

GB/T 6682-2008 Water for analytical laboratory use - Specification and test methods

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

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

GB/T 20042.1-2017 Proton exchange membrane fuel cell - Part

3 Terms and definitions

The terms and definitions as defined in GB/T 20042.1-2017, GB/T 28816-2020, as well as the following terms and definitions, apply to this document.

3.1 Pt group metal loading The mass of platinum group metal per unit active area of fuel cell (electrode).

3.2 Electrochemical active surface area; ECSA The surface area of the unit mass of platinum group metal catalyst in the membrane electrode participating in the electrochemical reaction, as tested by electrochemical method.

3.3 Gasket A component that has a sealing function by applying a compressive force to

achieve compression deformation.

4 General provisions

Unless otherwise specified, the hydrogen used in the following tests shall comply with the requirements of GB/T 37244-2018 or GB/T 34872-2017.The air used in the following tests shall comply with the requirements of grade 1 air in GB 3095-2012, or standard air containing oxygen (purity >= 99.99%) and nitrogen (purity >= 99.99%) at a ratio of 21.0% to 79.0%, in accordance with the provisions of GB/T 8979 and GB/T 14599.

5 Thickness test

5.1 Overview The method of membrane electrode thickness test specified in this chapter refers specifically to the membrane electrode active area thickness test.

5.2 Test instrument Thickness gauge. Accuracy not less than

0.001 mm.

5.3 Sample preparation The effective area of the sample shall not be less than 25 cm2. The sample shall be free of wrinkles, defects, damage.

5.4 Test method Under the conditions of temperature 23 °C ± 2 °C and relative humidity (50 ± 5)%, stand for no less than 4 h.

5.5 Data processing

5.5.1 The difference between the maximum value and the minimum value is calculated according to formula (1).

5.5.2 The average thickness is calculated according to formula (2).

5.5.3 The maximum relative thickness deviation is calculated according to formula (3).

6 Platinum group metal loading test

6.1 Test instruments and equipment The test instruments and equipment are as follows:

6.2 Test method

6.2.1 Reagents and materials The reagents and materials are as follows:

6.2.2 Treatment of samples to be tested The samples to be tested are treated according to the following steps.

6.2.3 Drawing of standard curve The content of each metal component in the catalyst has an order of magnitude difference. The instrument method of ICP-OES or ICP-MS

(hereinafter referred to as ICP) suitable for the detection range corresponding to the content level shall be selected, to perform spectral analysis on the standard solution of platinum group metals and the standard solution of non-platinum group precious metals in the catalyst; draw the standard curve of platinum group metals and non-platinum group precious metals.

6.2.4 Analysis of metal concentration in test sample The concentration of platinum group metals and non-platinum group precious metals in the test sample is analyzed by ICP.

6.2.5 Data processing

6.2.5.1 Calculation of platinum group metal loading The loading of a single platinum group metal element in the membrane electrode is calculated according to formula (4).

7 Polarization curve test

7.1 Test instruments and equipment Test device. The schematic diagram of the proton exchange membrane fuel cell test device is shown in Figure A.1 of Appendix A.

7.2 Sample preparation Sample size. The effective area of the membrane electrode sample is 25 cm2; the test sample is flat, free of stains, defects, damage.

7.3 Single cell assembly

7.3.1 Single cell structure It usually includes the following components (see Appendix B for the assembly relationship of the single cell structure).

7.3.2 Single cell assembly Single cell assembly is to assemble the end plate, electrical insulation sheet, current collector, flow field plate, gasket, MEA, gasket, flow field plate, current collector, electrical insulation sheet, end plate in sequence (see B.1 of Appendix B). If a bolt- tightening fixture is used, the tightening sequence of the bolts is shown in the sequence marked with numbers in B.2.The single cell is clamped using tightening bolts, nuts, torque wrenches.

7.4 Single cell leak test

7.4.1 Overview Before the single cell leak test, ensure that the single cell is well sealed.

7.4.3 are two optional reference methods.

7.4.2 Wet immersion method Connect the gas inlets on both sides of the single cell to the air inlet; connect to air or nitrogen; connect the gas outlets on both sides to the pressure gauge; close the gas switches at the end of the gas lines on both sides. Pressure the gas at the gas inlets on both sides (the fluctuation range of the inlet pressure is ±10 kPa); control the outlet pressure (absolute pressure) to be 50 kPa higher than the maximum pressure value used in the single cell test condition.