ICS 91.100.60
CCS Q 25

NATIONAL STANDARD OF THE PEOPLE'S REPUBLIC OF CHINA

GB/T 47613-2026

Test method for the thermal protective performance of insulation sheets

隔热片热防护性能试验方法

Issued on: May 25, 2026 **Implemented on: December 1, 2026**

Issued by: State Administration for Market Regulation;
Standardization Administration of the PRC

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Foreword

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1.Scope This document specifies the principles, test apparatus, test specimens, and test conditions for testing the thermal protection performance of heat insulation sheets under the condition of thermal runaway in individual battery cells. Test conditions, test procedures, expression of results, and test report. This document applies to power systems using nanoporous aerogels, nanoporous materials, vacuum insulation panels, foam, or ceramic fiber paper as raw materials. Testing of the thermal protection performance of battery heat shields. Other types of heat shields can be used as a reference.

4.Principles The process of thermal protection of the heat shield under the condition of thermal runaway of a single battery cell is simulated. A hot plate is heated to a specified temperature, and a cold plate is moved upwards to contact the test... The component is brought into contact with a hot plate and subjected to a certain pressure. Under conditions where the hot plate temperature is constant (Method A) or the hot plate temperature is decreasing (Method B), the cold temperature is recorded. The plate temperature rise curve is used to characterize the thermal protection performance of the insulation sheet by the temperature of the cold plate at a certain time point (Method A) or the highest temperature (Method B).

5 Experimental Apparatus

5.1 Overview A typical design of the thermal protection performance test device for thermal insulation sheets is shown in Figure 1. The device includes a hot plate and heating device, a cold plate and temperature measuring device, a heat insulation plate and pressure device.

5.2 Hot plate and heating device The schematic diagram of the hot plate and heating device is shown in Figure 2. The hot plate and support are made of 06Cr25Ni20 stainless steel plate, with dimensions of 100mmx100mmx20mm, or other materials similar to the heat insulation sheet. Meets the required dimensions. The refractory bricks are made of ceramic fiber refractory material, with a bulk density of 400kg/m^3~450kg/m^3 and an average temperature conductivity of 500°C. The thermal coefficient is no greater than

0.15 W/(m·K), and the dimensions are shown in Figure 2.A silicon carbide heating element

is used; the hot plate can be heated to 1000°C or the target temperature of the hot plate. Temperature is set by the main controller to the desired heating temperature; heating rate is 0°C/min to 8°C/min; heat source temperature control accuracy is 1%. Regular checks are required. Check the aging of the heating device; if the power reduction reaches 10%, the silicon carbide rod should be replaced. Thermocouples shall comply with the provisions of 5.6.Thermocouples shall be embedded in the hot plate, and three thermocouple temperature sensors shall be connected in parallel for measurement. The setup is shown in Figure

2.The effective average value of the three thermocouples is used as the control parameter. The working surface should be machined to a flat surface with a flatness of

0.2 mm. The surface flatness and cleanliness should be checked regularly.

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3.The results are based on the effective average value of the three thermocouples. The working surface should be machined to a flat surface with a flatness of

0.2 mm. The surface flatness and cleanliness should be checked regularly. The unit is millimeters.

5.4 Insulation Board The insulation board is made of calcium silicate board, with dimensions of 120mmx120mmx30mm, or other dimensions compatible with the insulation sheet, and a bulk density of For insulation panels with a capacity of 850 kg/m^3 to 950 kg/m^3 and an average temperature of 300°C, the thermal conductivity should not exceed

0.13 W/(m·K). The insulation panels should be tested beforehand. Drying and cooling treatment. To avoid heat transfer affecting pressure measurements and to improve test efficiency, a circulating thermostatic device should be installed between the heat insulation plate and the pressure load sensor. sink.

5.5 Pressure Control Device Connected to a cold plate, it can provide a 25kN electric actuator and pressure sensor, and should meet the requirements of Class 1 testing machine specified in GB/T 16491.

5.6 Thermocouples Thermocouples should meet the Class 1 accuracy requirements specified in GB/T 16839.1.Type S thermocouples with a wire diameter of 0.3mm~0.5mm should be used. Type K thermocouples should have their thermal contacts insulated and not grounded.

5.7 Steel ruler The graduation value is 1 mm.

5.8 Vernier calipers The graduation value is no greater than

0.02 mm.

6 test specimens

6.1 Specimen Dimensions Tests should be conducted based on the actual number of layers and condition of the specimens, and all skins, veneers, and/or coatings should be retained during specimen preparation; if there is a border, It should be removed. The test specimen measures 100mm x 100mm, with the original thickness retained. For larger insulation sheets, cut them to 100mm x 100mm dimensions. For specimens with a length or width less than 100mm, other specimens should be cut to make up the 100mm diameter. Seams should be as small as possible and should be avoided as much as possible. In the central part. If the preparation of the specimen may affect its thermal protection performance, such as a vacuum insulation panel, then a whole specimen should be used for testing.

6.2 Number of Specimens At least three specimens should be tested.

6.3 Specimen Conditioning The specimens should be placed at (23±5)°C for at least 6 hours.

7.Test conditions The laboratory ambient temperature was (23±5)°C. The equipment should be placed entirely within a fume hood, with the fume hood door kept closed during the test. The equipment should not be subjected to any form of strong force during the test. To mitigate the effects of air convection, the room temperature change during the test should not exceed 5°C.

8 Test Procedure

8.1 Determination of Experimental Parameters The hot plate temperature Th is 600°C, and the test pressure p is 0.9MPa. If there are special requirements, the hot plate temperature Th and test pressure p can also be adjusted. It shall be agreed upon by both the supply and demand parties.

8.2 Pre-test preparation procedures and temperature balancing of hot and cold plates Remove the cold plate from the hot plate. Heat the hot plate to the specified temperature Th. Once the hot plate temperature reaches Th and stabilizes within ±0.75%, remove the cold plate. The insulation board temperature shall be maintained at (23±5)°C for at least 10 minutes. If a longer balancing time is required, it shall be agreed upon by the supplier and the buyer. Removing the cold plate from the hot plate by more than.200mm and placing a certain thickness of insulation material on the cold plate can eliminate the heat loss caused by the hot plate during the balancing process. The impact on heat transfer of the cold plate.

8.3 Experiment

8.3.1 Method A. Hot Plate Thermostat Method Measure and record the thickness of the specimen using calipers. Place the specimen on the cold plate, ensuring it is centered. Move upwards. The test begins when the cold plate contacts the specimen, and the specimen contacts the hot plate, and the temperature curves of the cold and hot plates are continuously recorded. After the test begins, the temperature of the hot plate is controlled to