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**NATIONAL STANDARD OF THE
PEOPLE'S REPUBLIC OF CHINA**

GB/T 23150-2024

Replacing GB/T 23150-2008

Tubular heating element for water heaters

热水器用管状加热器

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Table of Contents

1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Technical requirements	2
5 Test methods	4
6 Inspection rules	6
7 Marking, packaging, transport and storage	7
Bibliography	9

1 Scope

The document sets the technical requirements, the inspection rules and the requirements for marking, packaging, transport and storage of tubular heating elements used in water heaters for household and similar purposes, and describes the matching test methods.

It applies to the design, manufacture, inspection, packaging, transport and storage of such elements, called heating tubes below. It does not apply to tubular heating elements used in air conditioners, washing machines, dishwashers, microwave ovens or ovens.

2 Normative references

Six documents are cited: GB/T 2423.17-2008 on the salt mist test Ka for electric and electronic products, GB/T 2828.1 on sampling procedures for inspection by attributes indexed by acceptance quality limit, GB/T 4706.1-2024 on the general safety requirements for household and similar electrical appliances, GB/T 4706.12-2024 on the particular requirements for storage water heaters, GB/T 17897-2016 on the ferric chloride pitting corrosion test for stainless steel, and JB/T 4088.1-2022 on the general requirements for tubular heating elements for domestic use.

3 Terms and definitions

The heater is the part that converts electrical energy into heat. The heating element is a tubular element with a metal sheath in which the heater is insulated from that sheath. The lead-out rod is a metal part well connected to the heater which connects to the power supply directly or through tabs, connecting strips, conductors and similar parts fixed to it. The first and third definitions come from JB/T 4088.1-2022.

The effective heating surface is the metal tube surface corresponding to the effective heating length of the element. The surface effective load is the power per unit area over that effective heating surface. Normal operation is the working state of the element under its conditions of normal use when rated voltage is applied. Operation life is the accumulated working time of the element under normal working conditions until it fails. These four definitions are adapted from JB/T 4088.1-2022.

The tube body is the metal tube that directly encloses the insulating filler, and the tube surface is the heat exchange surface in direct contact with the medium being heated; both definitions come from NB/T 10309-2019. An anticorrosion metallic heating element is a tubular element whose sheath is a metal tube in which the tube body and the tube surface are of the same material, or of different materials with the tube surface carrying a degree of corrosion resistance, and which meets the corrosion resistance requirements of this document.

4 Technical requirements

Appearance: no part shows local swelling or rust; bends form a smooth arc and, apart from what the process requires, show no twisting, wrinkling or unevenness; exposed parts carry no sharp edges, sharp corners or burrs; there is no visible mechanical damage; and the threads and terminal tabs on the element are complete and of standard type, with the insulator free from cracks and breakage and firmly cemented.

Water pressure: after the test of 5.3, all welds are firm, smooth and clean, with no looseness, cold welding or unwelded joints; water does not leak from the flange and the flange shows no permanent deformation affecting safety. The leakage current and electric strength after the test meet 4.3.1 and 4.3.2.

Safety: leakage current does not exceed 0.3 mA/kW and the maximum does not exceed 3 mA; no breakdown occurs during the electric strength test; and input power lies within 90 % to 105 % of the rated input power.

Humidity resistance: after a 48 h humidity test to 5.7, the leakage current and electric strength meet 4.3.1 and 4.3.2.

Dry firing protection: the element is dry fired for 30 min at rated voltage, during which no tube deformation, flame ejection, molten metal or dangerous quantity of toxic or ignitable gas or other effect on safety occurs. After the test the element is cooled to room temperature and the tube body other than the flange is immersed in water; after 24 h the leakage current and electric strength meet 4.3.1 and 4.3.2. A note states that this requirement does not apply to an element with a surface effective load above 11 watts per square centimetre and does not apply to copper or aluminium tubes.

Tensile strength: the lead-out rod withstands a pull of 980 N for 3 min without displacement that does not return by itself at once and without breaking or shattering. The weld between

the terminal tab and the lead-out rod withstands a pull of 200 N in the longitudinal and transverse directions for 3 min, after which the tab does not break or come away.

High and low temperature shock: after the test of 5.10 the leakage current and electric strength meet 4.3.1 and 4.3.2. Salt spray: the element withstands a 48 h salt spray test, after which the leakage current and electric strength meet 4.3.1 and 4.3.2. Operation life: not less than 4 000 h. Non-metallic materials meet Clause 30 of GB/T 4706.1-2024.

Corrosion resistance: an element declared as having a corrosion resistance function, or an anticorrosion metallic heating element, is tested to 5.14, after which the leakage current and electric strength meet 4.3.1 and 4.3.2.

Dry firing followed by quenching: in the test of 5.15 no melting, flame ejection or release of harmful gas or other effect on safety occurs, and afterwards the leakage current and electric strength meet 4.3.1 and 4.3.2. A note states that this does not apply to copper or aluminium tubes. Stepped voltage increase: the element withstands a stepped voltage test up to 2.5 times rated voltage, during which no melting, flame ejection or release of harmful gas or other effect on safety occurs, and afterwards the leakage current and electric strength meet 4.3.1 and 4.3.2.

5 Test methods

General conditions for tests involving energizing: ambient temperature $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$, no draught and no strong radiation, relative humidity not more than 85 %, and an altitude below 2 000 m; supply voltage deviation not more than $\pm 1\%$; the element mounted in the appliance or under simulated conditions; measuring instruments or devices that do not appreciably affect the measured value; unless stated otherwise, an element with several rated voltages or one or more rated voltage ranges tested at the least favourable voltage within the stated range, the upper limit of the rated voltage range being taken as the least favourable by default; no flammable or explosive goods or gases in the test area; suitable safety protection for the test staff and suitable devices to fix and shield the element so that high temperature or inadequate electrical protection injures nobody and damages nothing around; and no people moving about in the test area.

Instrument accuracy: electrical measuring instruments for type inspection are of accuracy class 0.5 or better and those for delivery inspection class 1.0 or better; temperature measuring instruments have a permitted relative error not exceeding $\pm 1\%$; time measuring instruments a permitted error not exceeding $\pm 0.1\text{ s}$; length measuring gauges a permitted relative error not exceeding $\pm 0.5\%$; and humidity measuring instruments a permitted relative humidity error not exceeding $\pm 1\%$.

Appearance is checked visually. The water pressure test follows the method of 22.47 of GB/T 4706.12-2024, the pressure being raised at 0.13 MPa/s to the stated value, twice the rated pressure for a closed water heater, and held for 15 min, followed by visual

examination; the element is then taken out and wiped dry, the leakage current test of 16.2 of GB/T 4706.1-2024 is run, and the electric strength test of 16.3 is run for 1 min with a basically sinusoidal voltage at 50 Hz or 60 Hz, a test voltage of 1 250 V and a trip current setting of 5 mA.

Leakage current: the element, immersed in water, works in the normal operating state with the test voltage adjusted so that the input power equals 1.15 times the rated input power; once steady, the leakage current test of 13.2 of GB/T 4706.1-2024 is run. Electric strength follows 16.3 of GB/T 4706.1-2024 for 1 min with a basically sinusoidal voltage at 50 Hz or 60 Hz, a test voltage of 1 500 V and a trip current setting of 5 mA. Input power follows Clause 10 of GB/T 4706.1-2024, the element being immersed in water and worked at rated voltage in the normal operating state, the input power being measured once steady.

Humidity resistance: the test of 15.3 of GB/T 4706.1-2024 is run with the element kept for 48 h; the leakage current test of 16.2 is then run at 1.06 times rated voltage within 5 s of applying the test voltage, and the electric strength test of 16.3 is run for 1 min with a basically sinusoidal voltage at 50 Hz or 60 Hz, a test voltage of 1 250 V and a trip current setting of 5 mA.

Dry firing protection: under the conditions of 5.1.1 the element is dry fired for 30 min at rated voltage, then cooled to room temperature, the tube body other than the flange is immersed in water, and after 24 h the leakage current and electric strength tests of 5.7.2 are run. Tensile strength follows 6.11 of JB/T 4088.1-2022, the axial pull on the lead-out rod and on the terminal tab being measured separately with a tension meter without any sudden force.

High and low temperature shock: the element is kept at -20 °C for 1 h, moved within 5 min into an environment at 120 °C and kept there for 1 h, which forms one cycle; after five consecutive cycles the leakage current and electric strength tests of 5.7.2 are run. Salt spray: following 3.1 of GB/T 2423.17-2008, a salt solution of mass fraction (5 +/- 1) %, at 35 °C +/- 2 °C and with a pH between 6.5 and 7.2, is used for a 48 h salt spray test; the element is then washed and dried naturally indoors for 0.5 h to 1 h before the tests of 5.7.2.

Operation life follows 6.12 of JB/T 4088.1-2022. Non-metallic materials follow 30.2 of GB/T 4706.1-2024, and where the non-metallic material taken from the element is too little for the test, the same material may be taken and tested on extra specimens.

Corrosion resistance: after the salt spray test of 5.11, following method A of 4.1 of GB/T 17897-2016, the element surface designed to contact the liquid, or the effective heating surface, is fully immersed in a ferric chloride solution of mass fraction 6 % at a test temperature of 50 °C +/- 1 °C for 6 h without interruption; the tests of 5.7.2 then follow.

Dry firing followed by quenching: with the supply connected, the voltage is adjusted so that the surface effective load of the element is set at 8 watts per square centimetre, and the element is dry fired at that voltage for 10 min; within 2 s the surface designed to contact the