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JAPANESE INDUSTRIAL STANDARD

**Measurement methods of
polarization resistance of copper
alloy tubes for condenser**

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In the event of any doubt arising,
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Measurement methods of polarization
resistance of copper alloy tubes for condenser

H 0530-1993

1. Scope This Japanese Industrial Standard specifies the measurement method of polarization resistance of copper alloy tubes for condensers made of brass, white copper, or the like.

2. Definitions The main terms used in this Standard are defined as follows:

- (1) polarization The producing of relative displacement of the electric potential of the testing tube to the natural electrode potential by applying an electric current from an outer power source to the interface of the testing tube and the solution, or the status thereof.
- (2) polarization resistance The status that an electric potential is applied so that an electricity passes according to the Ohm's law in the process of corrosion of a metallic material. In this case, the polarization resistance value is computed from formula (1).

$$R_p = \frac{\Delta E}{i} \dots\dots\dots(1)$$

where, R_p : polarization resistance value of the testing tube ($\Omega \cdot \text{cm}^2$)

ΔE : electric potential applied to the testing tube,
that is, relative polarization value to the natural
electrode potential (mV)

i : measured electric current density (mA/cm^2)

- (3) artificial seawater A synthetically regulated salt water to afford almost the same affects as those of seawater.
- (4) reference electrode An electrode made of silver-silver chloride, etc. used for determination of an electric potential of a copper alloy immersed in a solution.
- (5) counter electrode Another electrode made of platinum plate, etc. used to send an electric current to the testing tube.
- (6) natural electrode potential An electric potential produced at the interface between the testing tube and the solution when the testing tube is immersed into the solution.
- (7) picking out tube from condenser An operation of picking out a tube to outside from a condenser for measurement of polarization resistance.
- (8) picked out tube A tube which is taken to the outside of a condenser by picking out operation.
- (9) testing tube A short tube being cut out from a picked out tube for measurement.

- (10) new tube A tube of the same quality as the testing tube and of a new one of which the inside surface is free from contamination or the like.

3. Preparation of testing tube

3.1 Preparation of testing tube for evaluation under actually equipped conditions to condenser

3.1.1 Summary After discontinuance of the operation of the circulating water pump, blow the water box rapidly, plug the relevant tube, and keep the wet conditions inside of the said tube until the picking out tube from the condenser. After picking out the tube, take appropriate disposition so as to keep the wet conditions continuously, stopper plugs, and carry to the place of practice for measurement.

3.1.2 Picking out tube and transportation Picking out the tube and transportation shall be carried out as follows:

- (1) After discontinuance of the operation of the circulating water pump, blow the water box rapidly.
- (2) After blowing the water box, open the manhole(s) rapidly, identify the inside of the tube maintains wet state, and stopper with rubber plugs the both ends of the tube to be picked out.
- (3) After the completion of preparatory work for picking out the tube, take off the rubber plugs tentatively, and pick up the tube.
- (4) In the case of cutting the picked out tube to short length, use an appropriate cutting device which is liable not to adhere the chips to the inner surface of the tube.
- (5) Stopper instantly the both ends of the picked out tube with rubber plugs. If the inside of the picked out tube is liable to dry up, wet it with appropriate amount of filtered cooling water ⁽¹⁾ or 3 % - sodium chloride solution.

Note ⁽¹⁾ Cooling water filtered with a filter of 0.47 μm .

- (6) Pertaining to the picked out tube, enter the necessary items such as direction of flow of cooling water, sequence counted from the entrance, and the top and bottom of the tube in the condenser while servicing.
- (7) Envelop the picked out tube with a cushion material, further put in a wooden box or container of good heat insulating property, and carry it to the place of practice for measurement.
- (8) Must not expose the picked out tube to the direct sunlight, and also must not subject to rapid change of temperature.

3.1.3 Tube preservation It is preferable that the duration days from the completion of blowing the water box to the time of measurement is as short as possible. Do not make measurement if it elapses 30 days or more.

In addition, it is prohibited to expose the picked out tube to the direct sunlight, or to subject to rapid change of temperature.

3.1.4 Cutting out of test tube Cutting out of the testing tube shall be carried out as follows:

- (1) Detach the plugs from the picked out tube.
- (2) It is preferable to cut out as many testing tubes as possible. In the case where only one testing tube is measured, this tube shall be cut out from the mid-portion of the picked out tube. If this is infeasible, cut out a testing tube from a portion not less than 2 m apart from the entrance and exit ends of the picked out tube, respectively.
- (3) In cutting out, select the portion where the peeling of adhered substance is as little as possible and further it is not dried up.

3.2 Preparation of testing tubes for evaluation after drying up Preparation of the testing tube for evaluation after drying up shall be carried out as follows:

- (1) After arrival in the place of practice for measurement, detach the plugs from the picked out tube.
- (2) It is preferable to cut out as many testing tubes as possible. In the case where only one testing tube is measured, this tube shall be cut out from the mid-portion of the picked out tube. If this is infeasible, cut out a testing tube from a portion not less than 2 m apart from the entrance and exit ends of the picked out tube, respectively.
- (3) In cutting out, select the portion where the peeling of adhered substance is as little as possible.
- (4) In the case where the inside of the tube is not dried up, it shall be dried up by leaving in a clean room where the direct sunlight does not stream in.

4. Measurement method of polarization resistance

4.1 Summary After electrically insulating treatment is conducted to those portions as outside surface of the testing tube which contacts with the test solution, cross-section of the ends and inside surface where adhered substance is fallen off, immerse the testing tube into the test solution for the specified period, and restore its inside surface to the in-servicing conditions as far as possible. Attach the testing tube to the testing apparatus, and make measurement while the test solution is run at a specified flow velocity.

4.2 Category of measurement methods The measurement method of polarization resistance shall conform to either one of the following:

- (1) **Large polarization method** A method to obtain the polarization resistance calculated from the electric potential and its corresponding electric current when a specific quantity of cathodic polarization displaced from the natural electrode potential of the testing tube is applied to the testing tube.