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

GB/T 45141-2025

**Test method for modified fouling index of reverse osmosis feed
water**

反渗透进水修正污染指数测定方法

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1 Scope

This document specifies the principle, the requirements for the microporous membrane, the apparatus and equipment, the test procedure, the data processing, the precision and the test report for the determination of the modified fouling index (MFI 0.45) of reverse osmosis membrane feed water.

This document applies to the determination of the modified fouling index of reverse osmosis membrane feed water.

2 Normative references

The contents of the following documents constitute indispensable provisions of this document through normative reference in the text. For dated references, only the edition corresponding to that date applies to this document; for undated references, the latest edition (including all amendments) applies to this document.

GB/T 6672 Plastics film and sheeting - Determination of thickness by mechanical scanning

GB/T 32361-2015 Test methods for pore size of separation membranes - Bubble point and mean flow pore method

GB/T 32373-2015 Test methods for reverse osmosis membranes

HY/T 053-2001 Microporous membranes

HY/T 0429-2024 Polytetrafluoroethylene hollow fibre microporous membranes

3 Terms and definitions

The following terms and definitions apply to this document.

3.1 modified fouling index, MFI 0.45. A technical index used to assess the content of particles, colloids, micro-organisms and other foulants in reverse osmosis membrane feed water, obtained by calculating the linear slope of the filtration time per unit volume of permeate against the cumulative volume of permeate for a 0.45 micrometre microporous membrane.

3.2 dead-end filtration. A mode of operation in which the whole of the solvent is forced through the membrane.

4 Principle

Dead-end filtration through the membrane is used. Because an irreversibly compressed filter cake or gel layer forms, the membrane pores become blocked or smaller and the permeability of the microporous membrane falls. From the linear relationship between the filtration time per unit volume of permeate and the cumulative volume of permeate, MFI 0.45 is calculated and used to assess the degree to which the feed water fouls the reverse osmosis membrane.

5 Requirements for the microporous membrane

A 0.45 micrometre flat-sheet polyethersulfone microporous membrane is used. Its performance requirements and the corresponding test methods are given in Table 1.

Table 1 pairs each property with a requirement and with the method by which it is measured. The membrane diameter is 25 mm or 47 mm, with no test method assigned. The thickness is 120 micrometres to 150 micrometres, measured to GB/T 6672, with the measuring points sampled as in 4.2 of GB/T 32373-2015. The mean pore size is 0.40 micrometres to 0.55 micrometres, measured to 5.4.2 of GB/T 32361-2015. The pore size distribution is not less than 90 percent, expressed as the cumulative pore size distribution at or below the greater of the mean pore size and the most probable pore size, measured to 5.4.2 and 5.5.1.2 of GB/T 32361-2015. The relative deviation between the mean pore size and the most probable pore size is not more than 5 percent, measured to Annex B of HY/T 0429-2024. The pure water flux is not less than 75 millilitres per square centimetre per minute, measured to 6.3 of HY/T 053-2001 at a test pressure of 200 kPa.

6 Apparatus and equipment

6.1 Test apparatus. The apparatus for the modified fouling index falls into two types: the direct apparatus, which applies where the outlet pressure of the reverse osmosis pretreatment plant is 250 kPa or higher, shown in Figure 1; and the indirect apparatus,

which applies where that pressure is below 250 kPa, shown in Figure 2. The parts of the apparatus in direct contact with the water sample under test shall be of corrosion-resistant material.

The parts identified in Figure 1, the direct apparatus, are: 1, feed valve; 2, pressure-regulating valve; 3, pressure gauge; 4, upper cover of the membrane cell; 5, membrane support plate; 6, lower cover of the membrane cell; 7, vent valve.

The parts identified in Figure 2, the indirect apparatus, are: 1, feed tank of about 30 L; 2, outlet valve; 3, electric diaphragm pump - for a membrane of 25 mm diameter, maximum working pressure 300 kPa, maximum flow 0.23 L/min, suitable flow range 0.10 L/min to 0.15 L/min; for a membrane of 47 mm diameter, maximum working pressure 600 kPa, maximum flow 1.3 L/min, suitable flow range 0.4 L/min to 0.8 L/min; 4, return valve; 5, pressure-regulating valve; 6, pressure gauge; 7, upper cover of the membrane cell; 8, membrane support plate; 9, lower cover of the membrane cell; 10, vent valve.

6.2 Measuring instruments. The measuring instruments used in the test are as follows: a pressure gauge of accuracy class 0.4 with a measuring range of 0 kPa to 600 kPa; a stopwatch with a resolution of 0.01 s; two measuring cylinders of 1 L capacity with 10 mL divisions; and a thermometer with a range of 0 degrees Celsius to 100 degrees Celsius and an indication error of plus or minus 1.0 degrees Celsius.

7 Test procedure

7.1 According to the product water pressure of the reverse osmosis pretreatment plant, select the direct or the indirect apparatus (see Figure 1 and Figure 2).

7.2 Connect the feed and flush the membrane cell and the test pipework.

7.3 Open the upper cover of the membrane cell, place the membrane face up on the membrane support plate of the lower cover, lay the O-ring flat on the membrane and tighten the cell. When feed water flows from the vent valve, close the vent valve. Avoid contaminating the membrane during installation.

7.4 Adjust the feed pressure to 207 kPa plus or minus 10 kPa; after holding the pressure steady for 10 s, start timing and collect permeate continuously for 20 min, recording the cumulative volume of permeate once every minute.

7.5 At the end of the test, measure the feed temperature and check the integrity of the membrane.

8 Data processing

8.1 Plot a curve with the filtration time per unit volume of permeate on the vertical axis and the cumulative volume of permeate on the horizontal axis. The unit of the vertical axis is seconds per litre; the unit of the horizontal axis is litres.

8.2 Over the interval of the curve corresponding to 15 min to 20 min, carry out a linear fit and calculate the slope; the linear correlation coefficient shall be not lower than 0.99.

8.3 MFI 0.45 is calculated by formula (1), and the feed viscosity is calculated from the feed temperature by formula (2); the feed viscosity and the actual effective membrane area are substituted into formula (1) to give MFI 0.45 under the standard test conditions, namely a feed pressure of 207 kPa, a water temperature of 20 degrees Celsius and a membrane diameter of 47 mm.

The symbols in formula (1) are as follows. MFI 0.45 is the modified fouling index of the reverse osmosis feed water, in seconds per litre squared. The slope term is the linear slope of the curve of filtration time per unit volume of permeate against cumulative volume of permeate over the interval 15 min to 20 min, in seconds per litre squared. The viscosity at 20 degrees Celsius is the standard feed viscosity, 1.005 thousandths of a pascal second. The viscosity term is the feed viscosity, in pascal seconds. The pressure term is the feed pressure, in kilopascals; the reference pressure is the standard feed pressure, 207 kPa. The area term is the actual effective membrane area, in square metres; the reference area is the effective area of a membrane of 47 mm diameter, in square metres, equal to 13.8 ten-thousandths of a square metre. The result is expressed to one decimal place.

The symbols in formula (2) are as follows. The viscosity term is the feed viscosity, in pascal seconds; the temperature term is the feed temperature, in degrees Celsius.

9 Precision

Where, in the same laboratory, the same operator uses the same equipment and follows the same test method to carry out ten mutually independent tests on the same object within a short period of time, the relative standard deviation shall be not more than 6 percent.

10 Test report

The test report shall contain the following: information on the 0.45 micrometre membrane, such as the manufacturer and the product batch number; the test conditions, such as the membrane area and the feed temperature and pressure; the curve of filtration time per unit volume of permeate against cumulative volume of permeate, together with its slope; the modified fouling index of the reverse osmosis feed water; and the test personnel and the test date.