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Evaluation Method for Corrosion Resistance of Hollow Fibre Membrane to Chemical Cleaning Agent

中空纤维膜耐化学清洗剂腐蚀性能评价方法

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1 Scope

This Document specifies the evaluation method for the corrosion resistance of hollow fibre membranes to acidic, alkaline, and oxidizing chemical cleaning agents.

This Document is applicable to the evaluation of the corrosion resistance of hollow fibre microfiltration membranes and hollow fibre ultrafiltration membranes to acidic, alkaline, and oxidizing chemical cleaning agents. The evaluation of the corrosion resistance of other forms of membranes to chemical cleaning agents can be implemented by reference.

2 Normative References

The following documents are essential to the application of this Document. For the dated documents, only the versions with the dates indicated are applicable to this Document; for the undated documents, only the latest version (including all the amendments) is applicable to this Document.

GB/T 1227 Accurate Pressure Gauge

GB/T 6682 Water for Analytical Laboratory Use - Specification and Test Methods

GB/T 32095.3-2015 Performance and Test Methods of Non-Stick Surface of Domestic Metal Utensils for Household Food - Part 3: Test Specification of Corrosion Resistance

GB/T 32360-2015 Test Methods for Ultrafiltration Membranes

GB/T 32361-2015 Test Methods for Pore Size Properties of Membrane Filters - Bubble Point and Mean Flow Pore Test

GB/T 38908-2020 Test Methods for Chlorine Resistance Performance of Household Reverse Osmosis and Nanofiltration Membrane Elements

GB/T 38949-2020 Determination of Pore Size for Porous Membranes - Standard Particle Method

3.6 Pure water flux

The volume of pure water passing through the membrane per unit area and unit time at a certain pressure and temperature.

[Source: CJ/T 530-2018, 3.9]

3.7 Retention

It indicates the ability to remove specific components.

[Source: GB/T 32360-2015, 3.7]

3.8 Bubble point pressure

The critical pressure when the first bubble appears and leads to continuous bubbles.

[Source: GB/T 32361-2015, 3.1]

3.9 Bursting strength

Applying fluid pressure perpendicular to the membrane surface on the membrane surface, the critical pressure when the membrane begins to burst.

[Source: HY/T 233-2018, 3.4]

4 Evaluation Method

4.1 Principle

At a certain temperature, the hollow fibre membrane sample is sealed and immersed in a certain concentration of acidic or alkaline or oxidizing chemical cleaning agent solution for a certain period of time; and compare the change rate of the performance indicators (including breaking elongation force, elongation at breaking, pure water flux, retention, bubble point pressure and bursting strength, etc.) of the membrane sample before and after immersion; according to the range of the value of the change rate of performance indicators, evaluate the category of corrosion resistance of the hollow fibre membrane to the corresponding chemical cleaning agent.

4.2 Test conditions

Test environment temperature: (20±2) °C; test water temperature for pure water flux and retention: (25.0±0.5) °C.

4.3 Reagents

Unless otherwise specified, only use analytical reagents.

b) Take out the soaked sample; and check the integrity of the sample again according to the inspection pressure specified in 4.5. If the integrity of the sample is unqualified, it is classified as Class-IV. If the integrity is qualified, continue with the following test procedures;

c) Take 70 pieces of blank samples, of which 50 pieces of samples are tested for their breaking elongation force and elongation at breaking according to the provisions of HY/T 213-2016. 5 pieces of samples are tested for the pure water flux according to the provisions of 5.1 of GB/T 32360-2015. 5 pieces of samples are tested for retention according to the provisions of 5.2 in GB/T 32360-2015 or Clause 6 a) ~ g) in GB/T 38949-2020. 10 pieces of samples are tested for bubble point pressure and bursting strength according to the provisions of Appendix A;

d) The soaked test sample is rinsed by water for several times until the pH value of the cleaning water is 6.5~7.5;

e) Take 70 pieces of test samples, and test their breaking elongation force, elongation at breaking, pure water flux, retention, bubble point pressure and bursting strength according to the same methods as procedure c);

f) Respectively take 5 groups of blank samples and test samples for parallel test; and respectively calculate the average breaking elongation forces $\overline{L_0}$ and $\bar{L}$, the average elongations at breaking $\overline{E_0}$ and $\bar{E}$, and the average pure water fluxes of $\overline{F_0}$ and $\bar{F}$, the average retentions $\overline{R_0}$ and $\bar{R}$, the average bubble point pressures $\overline{p_0}$ and $\bar{p}$, and average bursting strengths $\overline{B_0}$ and $\bar{B}$ of the blank samples and test samples. According to the formulas (1) ~ (6) in 4.7 to calculate the change rage of performances of test samples against the blank samples.

4.6.2 Corrosion resistance to alkaline chemical cleaning agents

The test procedures for evaluating the corrosion resistance of the hollow fibre membrane to alkaline chemical cleaning agents are as follows:

a) Airtightly soak a test sample in a sodium hydroxide aqueous solution for 24h;

b) Perform tests and calculations according to procedures b), d), e), and f) in 4.6.1.

4.6.3 Corrosion resistance to oxidizing chemical cleaning agents

The test procedures for evaluating the corrosion resistance of the hollow fibre membranes to oxidizing chemical cleaning agents are as follows:

a) Soak a test sample in an aqueous sodium hypochlorite solution for 24h in an airtight manner and avoid light;

b) Perform tests and calculations according to procedures b), d), e), and f) in 4.6.1.

ΔF – change rate of pure water flux, in %;

$\overline{F_0}$ – average pure water flux of blank samples, in L/(m²•h);

$\bar{F}$ – average pure water flux of test samples, in L/(m²•h).

4.7.4 Change rate of retention

The change rate of retention ΔR is calculated according to Formula (4):

$$\Delta R = \frac{|\overline{R} - \overline{R_0}|}{\overline{R_0}} \times 100 \qquad \cdots\cdots(4)$$

Where:

ΔR – change rate of retention, in %;

$\overline{R_0}$ – average retention of blank samples, in %;

$\bar{R}$ – average retention of test samples, in %.

4.7.5 Change rate of bubble point pressure

The change rate of bubble point pressure Δp is calculated according to Formula (5):

$$\Delta p = \frac{|\overline{p} - \overline{p_0}|}{\overline{p_0}} \times 100 \qquad \cdots\cdots(5)$$

Where:

Δp – change rate of bubble point pressure, in %;

$\overline{p_0}$ – average bubble point pressure of blank samples, in MPa;

$\bar{p}$ – average bubble point pressure of test sample, in MPa.

4.7.6 Change rate of bursting strength

The change rate of bursting strength ΔB is calculated according to Formula (6):

$$\Delta B = \frac{|\overline{B} - \overline{B_0}|}{\overline{B_0}} \times 100 \qquad \cdots\cdots(6)$$

Where:

ΔB – changer rate of bursting strength, in %;

$\overline{B_0}$ – average bursting strength of blank samples, in MPa;

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