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Plastics — Ion exchange resin — Part 3: Determination of exchange capacity of anion exchange resins in hydroxide form

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ISO copyright office

CP 401 • Ch. de Blandonnet 8

CH-1214 Vernier, Geneva

Phone: +41 22 749 01 11

Email: copyright@iso.org

Website: www.iso.org

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 5, *Physical-chemical properties*.

A list of all parts in the ISO 4907 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Exchange capacity often determines the performance. In practical use, the anion exchange resin is usually converted to hydroxide (or amine) form. What is more, from the change of strong-base and weak-base groups, the degree of pollution and degradation can be judged. This document specifies how to determine the exchange capacity of anion exchange resins in hydroxide (or amine) form.

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Plastics — Ion exchange resin — Part 3: Determination of exchange capacity of anion exchange resins in hydroxide form

1 Scope

This document specifies test methods of the total exchange capacity, the strong-base group capacity and the weak-base group capacity of the styrene anion exchange resins in hydroxide form.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3696, Water for analytical laboratory use — Specification and test methods

<std>ISO 3696, *Water for analytical laboratory use — Specification and test methods*</std>

<std>ISO 4907-2:2023, *Plastics — Ion exchange resin — Part 2: Determination of water content of anion exchange resins in hydroxide form*</std>

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply. ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1

hydroxide form styrene anion exchange resin

ionic type of styrene anion exchange resins regenerated by sodium hydroxide solution under the conditions specified in this document

Note 1 to entry: It is a general term that includes the strong-base groups existing in hydroxide form and the weak-base groups existing in free amine form.

3.2

total exchange capacity

quantity of active groups in *hydroxide form styrene anion exchange resin* (3.1) that can exchange with strong acid under the conditions specified in this document

Note 1 to entry: It is expressed in millimoles per gram or in moles per ~~liter~~litre of anion exchange resins.

3.3

strong-base group capacity

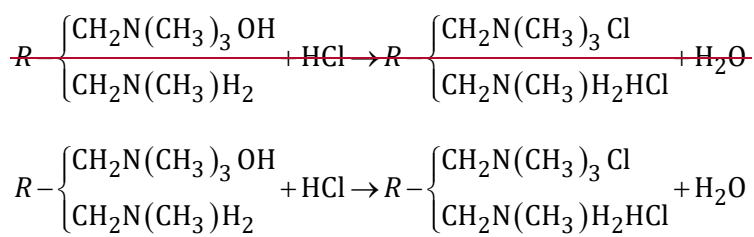
quantity of active groups in *hydroxide form styrene anion exchange resin* (3.1) that can exchange with neutral salts under the conditions specified in this document

Note 1 to entry: It is expressed in millimoles per gram or in moles per ~~liter~~litre of anion exchange resins.

4 Principle

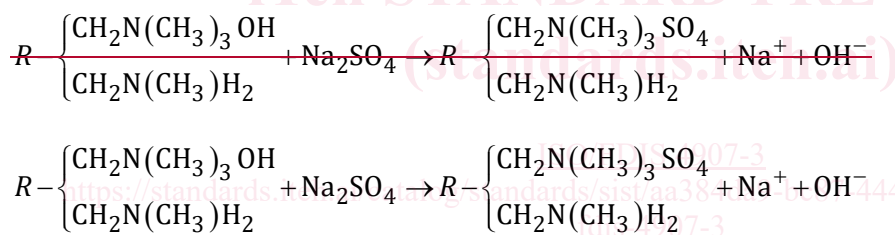
When styrene anion exchange resins in hydroxide form reacts with strong acid solution (such as hydrochloric acid solution), it can exchange active hydroxyls with other anions, and the substituted hydroxyls will neutralize with hydrions.

The reaction formula is:



When styrene anion exchange resins in hydroxide form reacts with neutral salt solution (such as sodium sulphate solution), it can exchange strong hydroxyls with other anions.

The reaction formula is:



5 Reagents

WARNING — Reagents used in this document may have potential hazards to human health and the environment. **Please strictly follow** Ensure that the the instructions for the use of reagents are strictly followed.

Unless otherwise indicated, the reagents specified in this document should be analytical grade.

Commercially available, ready-made solutions may be used.

5.1 Water, grade 2 in accordance with ISO 3696.

5.2 Sodium hydroxide, standard solution, $c(\text{NaOH}) \approx 0,10$ mol/l.

Dissolve 4 g of sodium hydroxide to 1 000 ml with water. Standardize this solution at least weekly as follows.

5.2.1 Calibration

Dry 10 g of potassium hydrogen phthalate ($\text{KHC}_8\text{H}_4\text{O}_4$, Guaranteed Reagent) at 105 °C to 110 °C for 4 h. And then cool to room temperature in a desiccator.

Weigh 0,75 g of potassium hydrogen phthalate (m_1) to the nearest 0,00 1 g, and dissolve with 100 ml water in a flask. Add 0,1 ml of phenolphthalein indicator solution. Titrate with 0,10 mol/l sodium hydroxide solution (5.2) until the pink colour appears and persists for 15 s. Record the consumption volume of alkali (V_1).

5.2.2 Blank determination

Pipet 100 ml of water. Carry out a blank determination according to the appropriate procedure 5.2.1. Record the consumption volume of alkali (V_2).

5.2.3 Calculation

See Formula (1):

$$c(\text{NaOH}) = \frac{1\,000 \times m_1}{204,220 \times (V_1 - V_2)} \quad c(\text{NaOH}) = \frac{1\,000 \times m_1}{204,220 \times (V_1 - V_2)} \quad (1)$$

where

$c(\text{NaOH})$ is the actual concentration, expressed in moles per litre (mol/l), of the sodium hydroxide solution;

m_1 is the mass, expressed in grams (g), of potassium hydrogen phthalate;

V_1 is the titration consumption volume, expressed in millilitres (ml), of the sodium hydroxide solution;

V_2 is the blank consumption volume, expressed in millilitres (ml), of the sodium hydroxide solution.

5.3 Hydrochloric acid, standard solution, $c(\text{HCl}) \approx 0,10$ mol/l.

Dilute 9 ml of hydrochloric acid (1,19 g/ml) to 1 000 ml with water. Calibrate this solution at least weekly as follows.

5.3.1 Calibration

Dry 5 g of sodium carbonate (Na_2CO_3 , Guaranteed Reagent) at 270 °C to 300 °C for 4 h. And then cool to room temperature in a desiccator.

Weigh 0,2 g of sodium carbonate (m_2) to the nearest 0,000 1 g, and dissolve with 100 ml water in a flask. Add 0,1 ml of bromocresol green-methyl red indicator solution. Titrate with 0,1 mol/l hydrochloric acid solution (5.3) until the greenish-blue colour disappears. Record the consumption volume of acid (V_3).

5.3.2 Blank determination

Pipet 100 ml of water, carry out a blank determination according to the appropriate procedure 5.3.1. Record the consumption volume of acid (V_4).

5.3.3 Calculation

See Formula (2):

$$c(\text{HCl}) = \frac{1\,000 \times m_2}{52,994 \times (V_3 - V_4)} \quad c(\text{HCl}) = \frac{1\,000 \times m_2}{52,994 \times (V_3 - V_4)} \quad (2)$$

where

$c(\text{HCl})$ is the actual concentration, expressed in moles per litre (mol/l), of the hydrochloric acid solution;

m_2 is the mass, expressed in grams (g), of sodium carbonate;

V_3 is the titration consumption volume, expressed in millilitres (ml), of hydrochloric acid solution;

V_4 is the blank consumption volume, expressed in millilitres (ml), of hydrochloric acid solution.

5.4 Sodium hydroxide solution, $c(\text{NaOH}) = 2$ mol/l.

Dissolve 80 g of sodium hydroxide to 1 000 ml with water.

5.5 Sodium sulfate solution, $c(\text{Na}_2\text{SO}_4) = 0,5$ mol/l.

Dissolve 71 g of sodium sulfate to 1 000 ml with water.

5.6 Hydrochloric acid solution, $c(\text{HCl}) = 1$ mol/l.

Dilute 90 ml of hydrochloric acid (1,19 g/ml) to 1 000 ml with water.

5.7 Bromocresol green-methyl red indicator solution.

Dissolve 0,2 g of bromocresol green and 0,015 g of methyl red in 100 ml of ethanol [≥ 95 % (V/V) ethanol]. Store in an amber glass bottle.

5.8 Phenolphthalein indicator solution.

Dissolve 1,0-g of phenolphthalein in ethanol [≥ 90 % (V/V) ethanol] and dilute to 100 ml.

5.9 Methyl red-methylene blue mixed indicator solution.

Dissolve 0,1 g of methyl red and 0,1 g of methylene blue in 100 ml of ethanol [≥ 90 % (V/V) ethanol], respectively. Mix the above two solutions in equal volumes. Store in an amber glass bottle.

5.10 Sodium chloride solution, $c(\text{NaCl}) = 10$ %.

Dissolve 100 g of sodium chloride to 1 000 ml with water.

NOTE According to titration (GM 31.2) in ISO 6353-1, automatic potentiometric apparatus can also be used as an alternative. Select equivalence point of the acid-base titration by pH electrode as the endpoints, or equivalence point of the chloridion content titration by silver electrode as the endpoints.

6 Apparatus

WARNING — Apparatus used in this document may have potential hazards to human health and the environment. **Please strictly follow** Ensure that the instructions for the use of apparatus are strictly followed.

Usual laboratory equipment and, in particular, the following should be used: