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Study Properties of Phosphate Cation Exchanger

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ABSTRACT. In this articles thermo chemical properties of the obtained phosphate cation exchanger based on a styrene-furfural polymer are investigated. It was found that the tested phosphate cation exchangers are more heat-resistant than sulfocation exchangers

KEYWORDS:sorption, styrene, furfural, phosphorylation, cation exchange resin, ion exchange, thermochemical resistance, static exchange capacity.

I. INTRODUCTION

Ion-exchange polymers are widely used in many fields of science and technology. In industrial conditions, ion exchangers often have to be used in aqueous solutions of acids, alkalis at elevated temperatures in the power system, etc. [1]. The use of ion exchangers in high-temperature production processes is limited by insufficient heat resistance of well-known brands of ion exchangers produced by industry [2].Most ion exchangers, especially polycondensation type, according to published data, are characterized by reduced heat resistance, as a result of which their use is limited. From this point of view, the study of the heat resistance of ion exchangers is of practical importance, since shows to determine the permissible temperature limits and recommend the studied ion exchangers for operation at elevated temperatures..

II. SIGNIFICANCE OF THE SYSTEM

In this articles thermo chemical properties of the obtained phosphate cation exchanger based on a styrene-furfural polymer are investigated. The study of literature survey is presented in section III, methodology is explained in section IV, section V covers the experimental results of the study, and section VI discusses the future study and conclusion.

III. METHODOLOGY

We studied the heat resistance of sulfonic and phosphate cation exchangers obtained by sulfonation and phosphorylation of a styrene-furfural polymer. The thermal stability of cation exchangers was studied in water, in aqueous solutions of acids and alkalis, as well as by differential thermal analysis. Thermal stability was characterized by a change in exchange capacity, swelling, and weight loss of the ion exchanger. For comparison, we studied the heat resistance under similar conditions of the well-known brands of KU-1 cation exchangers (based on phenolsulfonic acid and formaldehyde) and SF (phosphoric acid cation exchangers based on styrene and divinylbenzene) and KU-2 (based on the sulfonated styrene-divinylbenzene copolymer).

The thermal stability of cation exchangers was studied in water at the boiling point of water for a certain time. Cation exchangers were used in hydrogen form. Table 1 shows the exchange capacity of cation exchangers.

From the data in table 1 it can be seen that the exchange capacity of sulfonic acid cation-exchange resin (KU-FS) based on sulfonated styrene-furfural polymer and phosphoric acid cation exchange resin (KFF) based on phosphorylation of styrene-furfural polymer as a result of heat treatment for 24 hours does not change its value, further heating in water for 72 hours, slightly reduces the exchange capacity for KU-FS - 1-2%, and for KFF - 1-1,2%, while for KU-1 cation exchanger, the loss in capacity corresponds to 14%, and phosphoric acid cation exchanger - 1,2% .

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IV. EXPERIMENTAL RESULTS

When the test cation exchangers are heated in water, a decrease in the exchange capacity is associated with the process of thermal desulfurization and dephosphorylation, which are a hydrolysis reaction, as a result of which SO_4^{2-} and PO_4^{3-} pass into the aqueous phase.

Table 1
Thermal stability of cation exchangers in water (boiling point of water, heating time - 72 hours)

Cation exchanger	SEC before heat treatment in 0,1n solution, mEq/g		Weight loss%	he specific volume of cation exchange matter swollen in water, mg/g	
	NaOH	NaCl		before heat treatment	after heat treatment
KU-FS	5,2	2,1	2	3,5	3,0
KFF	6,8	1,0	1,2	3,5	3,0
KU-1	3,1	1,8	14,4	3,5	2,8
KU-2	4,6	2,8	10,5	4,8	4,3
СФ	6,4	0,8	1,2	3,8	3,4

Therefore, the heat resistance of cation exchangers can also be indirectly judged by the change in pH of the aqueous extract. Water extracts after heat treatment of cation exchangers for 72 hours had a slightly acid reaction (pH = 4.8-5.6). The specific volume of the tested samples of cation exchangers almost does not change, therefore, there are no significant changes in the cation exchangers. The thermal stability of KU-FS and KFF cation exchangers in air was studied by thermogravimetric analysis. Air-dried samples of the tested cation exchangers were subjected to differential thermal analysis on a Paulik-Paulik-Erdeyderivatograph.

In Fig. 1. Differential-thermal curves of cation exchangers are presented. The heating curves are characterized by one endothermic effect for KU-FS cation exchanger at t = 118-140°C and 140-170°C for KFF phosphate cation exchanger, which can be attributed to dehydration of ion exchangers. Cleavage of functional groups i.e. The decomposition of the polymer in KU-FS sulfocationionites begins under the influence of an exothermic effect at t=270-350°C, and for phosphoric acid cation exchanger KFF - at 353-570°C. The cationite framework, i.e. styrene-furfural polymer is sufficiently resistant to high temperatures. When cation exchangers are heated to 850°C, the weight loss is about 48%.

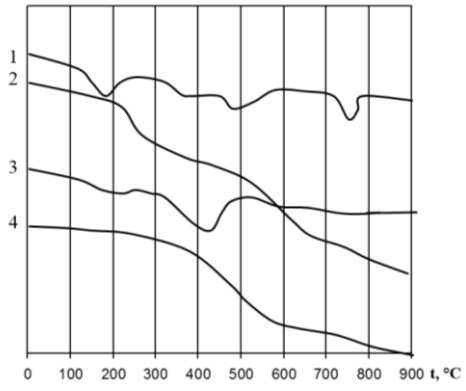

Fig. 1.Thermograms (1,3) and weight loss curves (2, 4) of cation exchangers 1, 2 - phosphate cation exchange resin based on styrene-furfural polymer; 3, 4 - sulfocationite based on styrene-furfural polymer

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Table 2
Thermo-chemical resistance of cation exchangers after boiling for 5 hours

Cation exchangers	Static exchange capacity, mEq/g		
	before heat treatment	after boiling in 1n HNO_3 solution	after boiling in 1nNaOH solution
KU-FS	5,2	4,8	5,0
KFF	6,8	6,5	6,8
KU-1	3,61	2,1	2,8
KU2	4,6	4,2	4,5
SF	6,8	6,5	6,8

V. CONCLUSION AND FUTURE WORK

The study of the thermochemical stability of cation exchangers in acid and alkali solutions showed (Table 2) that boiling the test cation exchangers in a 1 n HNO_3 solution and 5 nNaOH solution reduced the exchange capacity of KU-FS cation exchange resin by 3,2 and 2,7%, and FF cation exchange resin by 2,3 and 1,7 %, i.e. the tested KU-FS and FF cation exchangers are superior in temperature resistance to KU-1 cation exchanger and are not inferior to SF and KU-2 cation exchanger - polymerization type. Based on the studies, it was found that the tested phosphate cation exchangers are more heat-resistant than sulfocationexchangers.This is apparently due to the high binding energy CP compared with the binding energy S-C.

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