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INVESTIGATIONS ON SYNTHESIS OF ION-EXCHANGE MATERIALS, BASED ON GOSSYPOL AND FURAN DERIVATIVES

1. INTRODUCTION

Ion-exchangers are widely used in various fields of science and engineering. The efforts toward synthesis of new ion-exchangers are very important, especially in connection with urgent necessity of transition to wasteless and ecologically safe industrial technologies.

From this points of view synthesis and investigations of ion-exchangers based on gossypol and furan derivatives are of great interest.

Gossypol — 2,2-di-1,6,7-trioxy-3-methyl-5-isopropyl-8-aldehyde-naphtyl is a yellow cotton pigment. It contains a large number of polar groups, in particular six hydroxyl groups and two aldehyde ones. Salts of bi- and polyvalent metals in reaction with gossypol solutions yield the gossypol ion-exchangers containing beryllium, magnesium, calcium, lead, barium, cadmium, ferrum, argentum, cobalt, and other elements.

Fatty acids distillation from cotton soap stocks includes complex processes of further transformations of gossypol derivatives, i.e. their interaction with each other as well as with unsaturated fatty acids, and other by-products. As a result of these processes (if fatty acids distillation proceeds in the controlled conditions at the temperature of 493—503 K) the distillation is accompanied by gossypol resin formation in the still.

Synthesis of polymers with dense space structures and high thermo-chemical resistance may be also based on furan complexes. The raw stocks for the synthesis of furan derivatives (furfurol, furfuryl alcohol, tetrahydrofurfuryl alcohol) are produced from pentosan contained in waste materials of vegetable origin, i.e. in the agricultural or wood-processing wastes.

2. EXPERIMENTAL

Cation exchangers have synthesized in the process of polycondensation of gossypol and gossypol resin with crotonaldehyde in the presence of catalyst (concentrated sulphuric acid) applying subsequently thermal processing. They were also obtained from furan derivatives in the process of polycondensation

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of furfurol and furfuryl alcohol or tetrahydrofurfuryl alcohol with furfurol in the presence of catalyst (dilute sulphuric acid) applying further thermal processing.

The polymers were treated with sulphuric acid or phosphorus chloride in presence of ICl3 as a catalyst.

3. RESULTS AND DISCUSSION

The ion-exchange capacity (IEC) of the resulting sulpho-cation exchanger resins determined in batch conditions in 0.1 normal solution of sodium hydroxide is from 4.0 to 5.8 meq/g, and that in 0.1 normal solution of calcium chloride — from 0.8 to 2.2 meq/g.

IEC of phospho-cation exchange resin in 0.1 normal solution of sodium hydroxide is from 3.2 to 4.5 meq/g.

Physicochemical characteristics and sorption studies of the obtained ion-exchange resin have revealed that:

1. Sulpho- and phospho-cation exchangers are stable in 5 normal solution of sodium hydroxide and sulphur acid at 373 K during 6 hours. IEC loss and weight loss in these conditions do not exceed 2.1%.

2. Structure of the ion-exchangers has been studied by methods of potentiometric titration, IR, UV, NMR-spectroscopy, thermography as well as using physical and chemical analyses. As a result polyfunctional nature of the synthesized ion-exchangers has been proved.

3. Efficiency of the cation exchange resin in water softening process in flow-through conditions has also been tested. The softening process conducted at the exchanger's hydraulic load of 25 m/h allowed the content of calcium in water to decrease from 55 mg/dm^3 to 1.3 mg/dm^3 or that of magnesium from 18 mg/dm^3 to 0.5 mg/dm^3 during 12 hours run time.

4. IEC of the resins determined in the mixed solution of metal compounds (cobalt — 88 g/dm^3, copper — 5 g/dm^3, nickel — 2.4 g/dm^3) is equal to 61 mg/g for cobalt, 9.6 mg/g for copper, and 2.4 mg/g for nickel.

5. Thus, the obtained new ion-exchange resins can be applied for wastewater treatment and hard water softening due to their satisfactory physicochemical properties, good sorption characteristics, low prices, and accessibility of raw materials.