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Ibragim Movlaev
Azerbaijan State Oil and Industry University
Doctor of Philosophy, Associate Professor

Firengiz Rehimova
Azerbaijan State Oil and Industry University
Senior laboratory assistant, master
Department of Organic Substances and Technology of Macromolecular Compounds
Baku, Azerbaijan
kerem_shixaliyev@mail.ru

OBTAINING AND STUDYING THE PROPERTIES OF DECOMMISSIONED POLYSTYRENE-BASED IONIZERS

Abstract: *Sulfonic cation exchangers were obtained using a simplified technology: sulfonation of the finished polymer framework, i.e. polymer composition based on wastes of polystyrene mechano-chemically modified with polyvinyl chloride and study of the properties of synthesized cation exchangers.*

As a result of the research, a mechano-chemical modification of polystyrene waste with polyvinyl chloride was carried out. The modification process was carried out over a wide range of temperatures, time and shear stress by capillary viscometry.

The modified systems are sulfonated with concentrated sulfuric acid in the presence of anhydrous $〖AlCl〗_3$ *as a catalyst, and ion-exchange materials have been obtained. Were studied such properties of sulfonic cation exchangers as static and dynamic exchange capacity, mechanical strength, swelling coefficient. It is shown that sulfonic cation exchangers obtained on the basis of the mechanochemically modified system OPS: PVC are not inferior in their main indicators to the industrial sulfonic cation exchanger KU-2. We propose the use of synthesized sulfonic cation exchangers for water demineralization.*

Key words: *olystyrene, modification, sulfocationate, mexono-chemical modification, ion-exchange material, polymer composition, polymer solubility index, sulfuric acid.*

Language: *English*

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Introduction

One of the most important issues in the modern chemical industry is the acquisition of new materials with different properties. In the polymer chemical industry, such materials include ion-exchange resins, especially sulfocationites.

Ion exchange resins are polymers capable of ion exchange. Synthetic resins are mainly used in water purification, separation of some elements, medicine and many other fields.

Ion exchange materials are insoluble materials that contain free ions that can exchange with ions of contact solutions. This ion exchange takes place without any physical changes of ion exchange substances.

Ion exchange resins are acidic or basic, allowing the exchange of positively charged ions (cations) or negatively charged ions (anions). Many natural substances, such as proteins, cellulose, living cells and soil particles, have ion-exchange properties and play an important role in the functioning of nature. [1-5]

PST:PVX polimer kompozisiyasının axıcılığı 150-160^{0}C temperatur diapazonunda, diametri 2,095 mm, uzunluğu 8 mm olan standart kapilyarın

köməkliyi ilə laboratoriya kapilyar viskozimetrində öyrənilmişdir.

Results

It is known that polymers are widely used in almost all industries due to their easy technology for the production of polymeric materials and products based on them, as well as their operational properties. Due to this, the amount of polymer waste increases sharply, and this figure is ~ 5% annually. Polystyrene is one of the most widely used polymers in industry, accounting for ~ 8% of all industrial and household waste.

In this regard, the production of ion-exchange materials based on a modified polymer frame using polystyrene waste is an urgent problem [6-10].

Method

As mentioned above, these components were used to conduct the research.

 polystyrene waste - a sample taken from the inner walls of the OPCK refrigerator;

 Polyvinyl chloride obtained in suspension.

In addition, the rheological properties of the polymer waste and the flow rate of the polymer alloy were studied [11-16].

Depending on the chemical nature of the raw material used in the capillary viscometer, PST: PVC polymer compositions have been developed under different conditions (ie shear stress and velocity). Mechanical mixtures of the above-mentioned polymers were prepared, and then mechano-chemical modification of this mixture was carried out. Polystyrene waste: mixtures based on polyvinyl chloride in different proportions (%, mass): 99: 1, 98: 2, 97: 3, 96: 4, 95: 5.

Mechano-chemical modification was carried out by extrusion under the following conditions:

- temperature - 150-1600C;
- time - 5 minutes.

The effect of the amount of PVC on the complex rheological properties of the polystyrene-based composition was studied. The rheological properties of the polymer system were studied by capillary viscometry in the IIRT-1 device over a wide range of displacement velocity (γ) and displacement voltage (τ) at a temperature of 150-1600C.

The shear stress was 4 ÷ 7 · 〖10〗 ^ 5Pa, and the temperature was determined taking into account the processing properties of the polymers.

Based on the results of the research, it was determined that in all cases the viscosity of the mixture is non-Newtonian and is characterized by the degree of viscosity anomaly n = d (lgγ) / (lgτ).

The effective viscosity was calculated under constant displacement stress (τ = 5,073 · 〖10〗 ^ 5Pa). The results of the obtained effective viscosity (η_e) are given in Table .1 and shown in Figure 1.

Table 1. PST: Rheological parameters of PVC polymer composition alloy (t = 1500C)

Composition of the composition,% by mass		Q, sm^3/sec	$lg\tau$, Pa	$lg\gamma, san^{-1}$	$lg\eta_e$, Pa·sec	ƏAG, q/10 min
PST	PVX					
99	1	$4{,}06\cdot10^{-10}$	5,073	$2{,}75\cdot10^{2}$	2,323	0,830
98	2	$9{,}60\cdot10^{-10}$	5,073	$3{,}12\cdot10^{2}$	1,952	1,311
97	3	$9{,}76\cdot10^{-10}$	5,073	$3{,}13\cdot10^{2}$	1.943	1,910
96	4	$14{,}11\cdot10^{-10}$	5,073	$3{,}29\cdot10^{2}$	1,783	2,438
95	5	$21{,}36\cdot10^{-10}$	5,073	$3{,}47\cdot10^{2}$	1,406	2,825

The data in the table show that as the amount of modifier in the polymer mixture increases from 1% to 5%, the effective viscosity of the mixture decreases and, of course, the consumption of extruder and the rate of displacement of the polymer alloy increase.

Therefore, the effective viscosity of the alloy at the same displacement stress varies depending on the amount of modifier added to the polymer mixture, ie polyvinyl chloride.

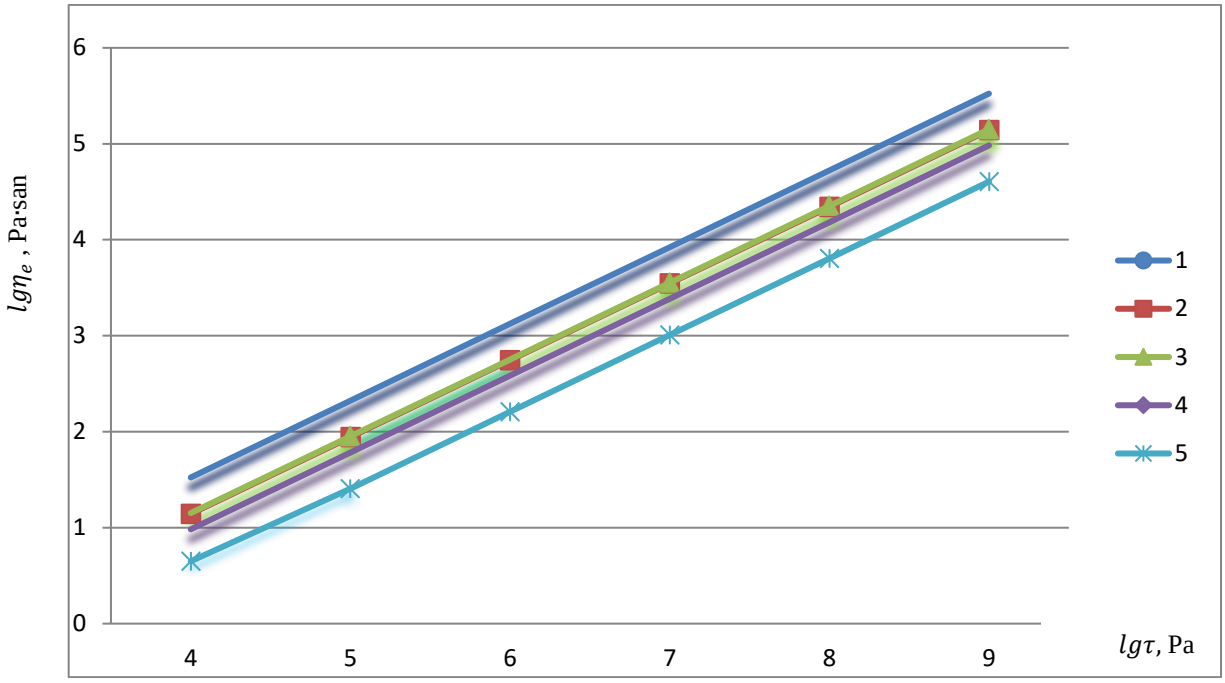

Fig.1. PST: Dependence of the velocity of the PVC polymer composition on the shear stress, (T = 1500C): 1,2,3,4,5 curves The amount of PVC by weight of 1,2,3,4,5%, respectively

The homogeneity of polymer compositions obtained in different proportions is confirmed by the non-Newtonian nature of the flow of polymer alloys (Figure 3.4). The linear nature of the dependence of the displacement velocity on the displacement voltage and the monotonous change in the effective viscosity depending on the amount of modifier added to the modified composition indicate that all samples are homogeneous.

Thus, the results obtained show that the composition of polystyrene waste is 5% dull. When PVC is added, the components blend well with each other and a homogeneous system is obtained in all mixtures.

The obtained polymer compositions can be processed by known processing methods, and the viscosity indicators allow the addition of fillers in order to improve the physical and mechanical properties of the compositions [17].

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Side panels

3.1. PST: Production of sulfokationites based on PVC polymer composition

Modified systems were sulfonated with solid sulfuric acid to obtain sulfocationites. Sulfation of copolymers was carried out according to the methodology given in Chapter II.

To determine the optimal conditions of the sulfonation process, this process was carried out over a wide temperature and time range:

temperature: 30 ÷ 800C;

time: 2 ÷ 8 hours

Due to the high static and dynamic variability of sulfocationites obtained at a temperature of 400C and 4 hours of sulfonation, we can take these parameters as optimal conditions.

PST: in the IR spectrum of sulfocationite obtained on the basis of PVC polymer composition, specific to sulfogroups = 460-470cm-1 (arylsulfides), = 1045-1060cm-1 (alkylsulfoxy), = 1180-1210cm-1 (sulfogroups 〖SO〗 _4 ^ -), = 1350-1400cm-1 (alkylsulfones) has been identified and this proves the formation of a new polymer, sulfocationite

3.2. Results of the study of the properties of sulfocationites

One of the main properties of ion-exchange materials is ion exchange capacity, which is characterized by static and dynamic exchange capacity (SDT and DDT). This value is determined by the absorption of the ionite mass in the gram-equivalent amount of ions. Static change capacity is the capacity of ion exchange resin under static conditions, and the capacity of dynamic change is the change capacity of ionites when they "slide" in the filtrate under filter conditions. Therefore, high ion exchange capacity is a basic requirement for both cationites and anion exchange resins.

Ion exchange materials must also have high kinetic properties (high ion exchange rate) and resistance to various acids and alkalis. Ion exchange

resins are water-insoluble and have limited swelling properties.

Taking into account the above, the main parameters of ion-exchange materials have been determined - static and dynamic change capacity, swelling rate, mechanical resistance and resistance to various aggressive environments. Test methods for the properties of ion-exchange materials are given in Chapter 2.3.

Table 2 shows the main indicators of synthesized ion exchangers.

Table 2. PST: The main parameters of sulfocationites obtained on the basis of PVC polymer composition

№	Sulfokationite obtained on the basis of polymer body, (%) mass		Swelling coefficient in water	SDT according to NaOH, mg-ecv / g	DDT according to CaCl2, mq-eq / q	Mechanical durability after 10 hours of shaking,%
	PST	PVX				
1	99	1	1,04	5,9	0,59	90
2	98	2	0,91	6,2	0,69	90
3	97	3	0,75	5,6	0,62	90
4	96	4	0,57	5,7	0,61	90
5	95	5	0,49	6,7	0,79	90

Conclusions

Polystyrene waste was mechano-chemically modified with polyvinyl chloride. Optimal conditions of the modification process (temperature, pressure, time) were determined. The initial components were taken in several proportions.

The rheological properties of PST: PVC polymer compositions prepared in different proportions have been studied. Based on the results obtained, the homogeneity of the modified systems was confirmed. The melting index of polymer alloys was determined.

Ion-exchange materials were obtained by sulfonation on the basis of mechano-chemically modified polymer compositions. Optimal conditions of sulfonation process (time and temperature) have been determined.

IR spectra of primary components, modified systems and sulfocationites were extracted and the course of mechano-chemical modification, as well as sulfonation reaction was confirmed.

Static and dynamic change capacities, mechanical resistance, swelling coefficient, etc. of synthesized sulfocationites. physical and mechanical properties were studied. It was noted that the above-mentioned indicators of sulfocationites obtained on the basis of PST: PVC mechano-chemically modified systems are satisfactory.

The modified systems were sulfonated in the presence of solid sulfuric acid, anhydrous 〖AlCl〗_3 catalyst, and ion exchangers were obtained. Physico-mechanical properties of synthesized sulfocationites, such as static and dynamic change capacity, mechanical resistance, swelling coefficient were studied. It was noted that the above-mentioned indicators of sulfocationites obtained on the basis of PST: PVC mechano-chemically modified systems are satisfactory in comparison with KU-2 sulfocationite used in industry.

We offer the use of synthesized ion exchange resins in industrial water desalination.

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