

## FT-IR SPECTRUM ANALYSIS OF ANIONITE OBTAINED BY MODIFICATION OF POLYVINYL CHLORIDE WITH UREA

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**Annotation:** It is known that polyvinyl chloride, along with polyethylene and polypropylene, is the most important large-tonnage cheap construction polymer. For this reason, the amount of its waste is constantly increasing. One of the ways to solve this problem is the chemical modification of PVC through polymer transformations. This review discusses the conditions for synthesizing anionite by modifying PVC with urea. As a result of the study of the influence of various external factors on the modification of polyvinyl chloride with urea in the production of anionites, the optimal conditions for the modification of polyvinyl chloride with modifiers were determined, the optimal mass ratio of polymer and modifier was 1:5 mass ratio, the optimal temperature of the reaction medium was 433 K, respectively for the synthesis of PPE-2, the acceptable time for the duration of the modification was set to 8 hours.

**Keywords.** PVC, modification, urea, anionite.

**Introduction:** Global production of synthetic ionites used in automotive systems has doubled in recent years. However, as industrial enterprises expand and develop, the demand for anionic and cationic machining materials will increase dynamically. Polyvinyl chloride (PVC) ranks second after polyethylene among the five types of common plastic materials widely used in fields such as architecture, electronics, chemical engineering, packaging, and transportation. The reason for this is low production costs and its versatility [1]. The polymer can be transformed into various products with a wide range of physical and chemical properties with the help of modifiers such as plasticizers and stabilizers. Production of ionites with the participation of granulated low-cost plasticizer PVC and local modifiers and meeting the needs of industrial enterprises is an urgent problem. In recent years, in industrial enterprises and hydrometallurgy, the most widely used, economically inexpensive and effective method for extracting non-ferrous and precious metal ions from the solution, desalination of water, and purification of waste water from toxic ions is the ionization method with the participation of ionites [2, 3].

The main goal of this was synthesys and study physico chemical properties anion exchange material based on polyvinyl chloride and urea. As well as identification structure obtained polymer materials.

**Experimental part:** The synthesis of the anion exchange material, a second type anion exchanger based on polyvinylchloride and urea (PPE-2), required the use of granular plasticized PVC and urea. Granular plastic polyvinylchloride (PVC brands I40-13A, 8/2 GOST 5960-72; GOST 127.4-93, respectively) and urea ( $H_2N-CO-NH_2$ ) nitrogen mass fraction (not less than 44.8%, analytical grade) were both supplied by JSC "NAVOIAZOT" (Navoiy region, Uzbekistan). HCl and NaOH (analytical grade) were used to activate the anion exchange resin [4]. All chemicals used were purchased from Sigma-Aldrich. All aqueous solutions and standards were prepared using deionized water. Fourier-transform infrared (FTIR) spectroscopy was used to characterize functional groups in the ion exchange material PPE-2. Samples were measured with a spectrometer (Spectrum100, Perkin Elmer), equipped with an FTIR microscopy accessory, in attenuated total reflection (ATR) on a diamond crystal at room temperature in the spectral range  $4000-500\text{ cm}^{-1}$ .

**Results and discussion:** In order to modify granulated polyvinyl chloride with the participation of urea, polymer and modifiers in different mass ratios were taken, polyvinyl chloride modification was

carried out in a hermetically sealed container at different temperatures and for different reaction durations, and by studying the influence of various external factors on the modification process, the laws of polyvinyl chloride modification with urea were studied. Below are the results of the influence of external factors on the modification of polyvinyl chloride with the presence of urea[5,6].

The influence of polymer and modifier mass ratios on the process of modification of granulated polyvinyl chloride with urea was studied. Accordingly, modification processes were carried out by adding polyvinyl chloride and urea in mass ratios of 1:1, 1:2, 1:3, 1:4, 1:5, 1:6, 1:7 and 1:8, respectively. As can be seen from the data in figure 1, as the mass ratio of urea to polyvinyl chloride increased, the static exchange capacity of the obtained anionite with hydrochloric acid increased up to a mass ratio of 1:5, and then remained unchanged. The reason for this is that the low-mass urea added to the mixture initially did not completely cover the granular polyvinyl chloride grains when it was liquefied at high temperature, so the modification yield was low. It was assumed that the static exchange capacity of the anionite obtained when urea was added at a high mass value did not change, that it is more than enough to modify the chlorine atoms in the liquid urea polyvinyl chloride, and that the possibility of all urea molecules entering the inner micropores of polyvinyl chloride is low due to the intermolecular contact during the modification process. Thus, the optimal conditions for the modification of polyvinyl chloride with the presence of urea were determined as a mass ratio of 1:5, and the SEC value of the anionite obtained under these conditions was 2.9 mg-ekv/g.

In the study of the effect of temperature on the modification of polyvinyl chloride with urea, an alternative temperature of the modification process was found based on the change in the SAC value of the anionite obtained at temperatures from 393 K to 443 K. With the increase of temperature in the composition of polyvinyl chloride, the release of HCl, the formation of a double bond, and knowing that the liquefaction temperature of urea is around 405 K, the effect of temperature on the modification was studied. The obtained results are presented in table 1 below:

**Table 1.**

**SEC values and mass change of anionites obtained by modifying polyvinyl chloride at different temperatures (mass ratio 1:5)**

Temperature, K	SEC, mg-ekv/g	m <sub>1</sub> , g. Before the reaction	m <sub>1</sub> , g. After the reaction	Mass change, %
393	0,8	5	5,04	0,8
403	1,8	5	5,12	2,4
413	2,2		5.28	5,6
423	2,4	5	5,32	6,4
433	2,9	5	5,41	8,2
443	2,8	5	4,87	-2,6

As can be seen from the data in table 1 above, as the ambient temperature of the modification process increased, the SAC value of the anionite formed increased up to 433 K, then when the temperature was increased again, the static exchange capacity and mass change decreased, this is because indicates that starting from the temperature of 423 K, PVC begins to undergo thermal destruction, and at the temperature of 443 K, the thermal destruction of polyvinyl chloride significantly increases compared to the modification. As a result of these studies, the optimal temperature conditions for modification of polyvinyl chloride with urea were determined to be 433 K.

Since the duration of the modification process of granular high-porosity polyvinyl chloride in the presence of urea affects the degree of replacement of chlorine atoms in the macromolecule with

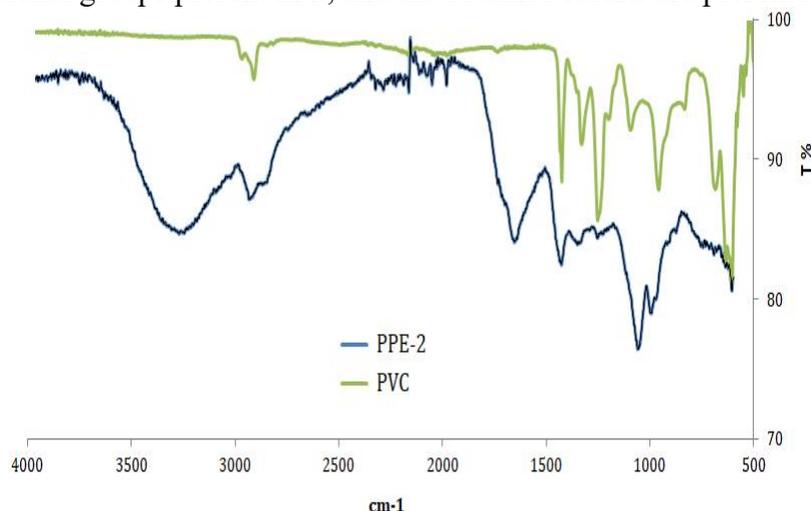
amino groups in urea, in our further studies we studied the effect of the reaction duration on the modification process. The obtained results are shown in the figure below:

The results of the research showed that the static SEC value of the obtained anion exchange material increased when the duration of modification of granulated PVC with urea was increased to 8 hours, and then no significant change was observed. Based on this, the optimal time for modification of PVC with urea was determined to be 8 hours.

During the study of the factors affecting the modification of granular polyvinyl chloride with urea, the following optimal conditions were determined: the optimal mass ratio for the modification reaction of polyvinyl chloride and urea is 1:5 mass ratio, the optimal duration of the modification is 8 hours, and the optimal temperature of the reaction medium was found to be 433 K. Our further work on the modification of polyvinyl chloride was carried out under the optimal conditions found above.

### FT-IR spectroscopic analysis of anion-carrying material obtained on the basis of polyvinyl chloride and urea

FT-IR spectroscopic analysis was carried out in order to identify the anion exchange material synthesized by the modification of granular polyvinyl chloride in the presence of urea and to determine the functional groups present in it, and the obtained results are presented in Figure 3 below:



**Figure 1 FT-IR spectra of polymeric materials based on polyvinyl chloride and urea (a- PVC, b-PPE-)**

The FT-IR spectra of PVC in Figure 1 above and the anion exchange PPE-2 materials obtained based on it are presented. The obtained FT-IR data were analyzed as follows. In the FT-IR spectrum of the material obtained as a result of the modification, absorption lines were observed in the 1630-1680  $\text{cm}^{-1}$  range, these absorption areas are characteristic of the valence vibrations of the  $>\text{C}=\text{C}<$  bonds, which indicates that the temperature increase during the modification of polyvinyl chloride in the presence of urea also led to the process of polyvinyl chloride dehydrochlorination. .

In the IR-spectrum of the original PVC (Fig. 3 (a)), intense absorption lines in the 693-635  $\text{cm}^{-1}$  range were detected, which in turn are typical for C-Cl valence vibrations, but in the above mentioned ranges of the modified PVC (3 (b) -fig.) the intensity in the IR spectrum has sharply decreased, which can be explained by the fact that the chlorine atoms in PVC have been replaced by amino groups in urea.

From the IR spectra of the initial polymer and modified polymers, it can be seen that Figure 3 (a, b) absorption areas at 1480  $\text{cm}^{-1}$ , 2922  $\text{cm}^{-1}$  and 2862  $\text{cm}^{-1}$  respectively indicate C-C bonds [7], as well as C-N deformation,  $\text{CH}_2$  groups shows deformation vibration [8]. Also, in the IR spectrum of

the modified polymer material, a strong absorption intensity in the 3000-3500  $\text{cm}^{-1}$  regions was determined, which is characteristic of amino groups, the absorption region of 3288  $\text{cm}^{-1}$  indicates the deformation vibration of N-H bonds, and the absorption region of 1650  $\text{cm}^{-1}$  indicates O= C-N-H confirms the presence of bonds.

**Results and conclusions:** As a result of these studies, the optimal temperature conditions for modification of polyvinyl chloride with urea were determined to be 433 K.

The results of the study showed that when the duration of modification of granulated PVC with urea was increased to 10 hours, the static SEC value of the obtained anion exchange material increased up to 8 hours, and then no significant change was observed. Based on this, the optimal time for modification of PVC with thiocarbamide was determined to be 8 hours.

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