

Review Article

ADSORPTION OF HEAVY METAL IONS IN POLYIONIDES OBTAINED ON THE BASIS OF PLASTICIZED POLYVINYL CHLORIDE

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Abstract

The process of adsorption of copper (II), nickel (II), cobalt (II), zinc (II) and chromium (III) ions to PPE-1 anionite and PPE-1-P polyampholyte, which are obtained on the basis of local raw materials, containing amine and phosphite group preservatives, were studied. Factors affecting the adsorption process in static conditions, that is, its dependence on time, temperature, concentration, were studied. The absorption of metal ions into anionite and polyampholyte in different temperatures was subjected to Langmuir monomolecular adsorption isomerization and Freundlich parameters were calculated. Based on the results of the study, the thermodynamic parameters of the sorption process - the isothermal-isobaric potential, free energy (ΔG), changes in the values of enthalpy (ΔH) and entropy (ΔS) were found by calculating. On the basis of anionite and polyampholyte obtained at the enterprise "Urgench Bakhmal" OOO, the practical results of the tests were obtained and analyzed.

Keywords: polyvinyl chloride, anionite, polyampholyte, adsorption, chemisorption, kinetics, isotherm, adsorbate, adsorbent, free energy, enthalpy, entropy.

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INTRODUCTION

Clean water is very important for the inhabitants of the world. Due to the increasing population in many developing countries, a sharp increase in water scarcity occurs in many parts of the world. However, a wide range of industrial activities contributes to the pollution of clean water. Heavy metals are of great concern among industrial waste. It is very important to distinguish these contaminants from water for consumption by the population. According to the latest reports, provision of usable water for the needs of population and industrial enterprises, especially in many regions of South Asia, the Middle East and Africa, is becoming a pressing problem [1]. [Cheng R, Kang M, Zhuang S, Shi L, Zheng X, Wang J, Adsorption of Sr(II) from water by mercerized bacterial cellulose membrane modified with EDTA, Journal of Hazardous Materials (2018)]

Traditional methods, such as nanofiltration, electrodialysis, which are currently used to effectively clean water, require a lot of energy and produce large amounts of waste [2]. [Ayoub G.M., Semerjian L., Acra A., E.I. Fadel M. and Koopman B. Heavy Metal Removal by Coagulation with Seawater Liquid Bittern. Journal of Environmental Engineering 2001;127: 196-202.]. For solving this problem, ion-exchange and complex-forming ion-exchange materials are also used in the treatment of

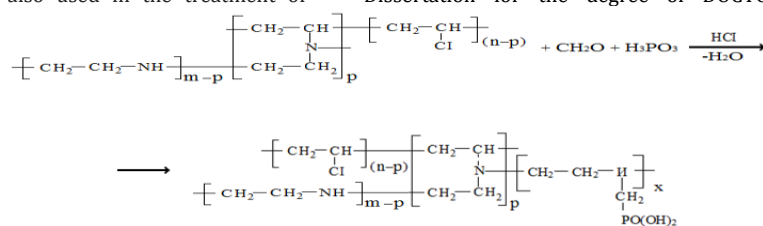
contaminated water, soft water treatment, and dehydration of natural water used by industrial enterprises. Such ionites are considered to have high mechanical, thermal stability and ease of use in technological conditions. Therefore, in almost all branches of the industry, bead ionizing materials are widely used [3-5].

PURPOSE AND MATERIALS OF THE STUDY

Materials

Study of chemical composition and properties of anionite and polyampholyte

In this study, adsorption properties of two sorbents namely PPE-1anionite and PPE-1-P polyampholytes, which are amine and phosphite groups in the composition obtained by synthesis on the basis of polyvinyl chloride (PVC), were studied in different temperatures. Modified plastic polyvinyl chloride with PEPA (Polyethylene polyamine), the anionite of the amine group was modified with phosphoric acid in the presence of formaldehyde in the reaction "Chichibabin", containing nitrogen - and phosphoric-containing PPE-1-P polyampholyte was synthesized [6]. [D. J. Bekchanov" Preparation and physico-chemical properties of nitrogen and phosphorus containing ionites based on polyvinyl chloride " Dissertation for the degree of DOCTOR of CHEMICAL



SCIENCES]

From the structure of the product obtained as a result of modification, it can be seen that sorbent at the same time holds amino and phosphite groups, which gives sorbent the properties of polyampholytes, since both the basis and ACID properties are embodied. The purpose of the study of the important physicochemical properties of newly synthesized anionite and polyampholytes and comparing them to competing ionites was to investigate sorption processes. By studying the physicochemical properties of anionite and polyampholytes obtained, high sorption properties, thermal and mechanical stability were determined. By comparing the properties of anionite, which was synthesized, by means of the properties of competing anionite AN-31, its predominance properties were determined.

RESULTS AND THEIR ANALYSIS

In the analysis of equilibrium processes in adsorption, adsorption isotherms are the most important means. Several models are used to represent equilibrium processes in liquid and solid systems. The most convenient and widely used of them are the Langmuir and Freundlich models [7]. [O. V. Netskina Adsorption from solutions on a solid surface Novosibirsk 2015; 3-15]

Based on the results of the study, the thermodynamic parameters of the sorption process - the isothermal-isobaric potential, free energy (ΔG), changes in the values of enthalpy (ΔH) and entropy (ΔS) were found by calculating. The results obtained are presented in Table (Table 1).

Table 1 The results of the Langmuir isotherm of adsorption of metal ions to PPE-1 and PPE-1-P

Metal ion	T, K	q_e , mmol/g	K, l/mmol	$-\Delta G$, J/mol	$-\Delta H$, J/mol	$-\Delta S$, J/mol·K
1	2	3	4	5	6	7
PPE-1						
Cu (II)	303	215.8	58.3	10243	2333	33.8
	313	243.2	80.2	11403		36.4
	323	261.8	102	12420		38.6
Ni (II)	303	128.4	62.2	10405	2307	34.5
	313	135.5	77.4	11308		36.4
	323	141.9	107	12540		38.3
Co (II)	303	110.7	52.8	9990	4000	32.9
	313	112.9	72.8	11156		35.6
	323	132.9	84.1	11896		36.8
Zn (II)	303	229.7	40.0	9292.6	2857	30.7
	313	235.8	66.7	10928		34.9
	323	251.7	81.8	11828		36.6
Cr (III)	303	204.6	32.3	8754.7	2333	28.9
	313	224.8	46.2	9974.3		31.8
	323	244.1	57.1	10864		33.6
PPE-1-P						
Cu (II)	303	238.8	30.0	8567.6	5000	28.3
	313	255.2	48.0	10081		32.2

	323	275.9	72.2	11491		35.8
Ni (II)	303	115.5	25.7	8179.6	3750	26.9
	313	122.8	42.0	9726,5		31.6
	323	139.3	65.1	11213		34.7
Co (II)	303	104.6	22.8	7882,4	4286	26.3
	313	128.6	40.9	9657.9		30.8
	323	171.3	63.3	11140		34.5
Zn (II)	303	209.7	50.2	9854.5	2143	32.5
	313	225.8	65.7	10892		34.8
	323	248.7	86.7	11982		37.1
Cr (III)	303	212.2	44.4	9557.6	3000	31.5
	313	272.6	60.1	10653		34.4
	323	295.2	91.4	12126		37.5

The table shows all the calculated results of the adsorption isotherm on the Langmuir equations. As can be seen from the results, the amine and phosphite groups in the composition were combined with anionite and polyampholyte to form a stable complex with Copper (II), nickel (II), cobalt (II), zinc (II) and Cr (III) ions, thus together with Copper (II), zinc (II) and Cr (III) ions, nominating a high tendency with polyampholyte compared to other metal ions and forming a strong complex.

PRACTICAL RESULTS OF THE STUDY

The resulting anion exchanger anionite and polyampholyte were tested in a community-owned wastewater treatment plant with limited liability for "effective technological solutions". This construction is designed to clean the wastewater separated from the fabrics obtained from cotton from the Enterprise "Urgench Bakhmal" OOO in the process of dyeing. The cleaning plant has a system consisting of a grid cleaning device from mechanical impurities, a section for adjusting the pH seal of wastewater, a section for foam flotation, a section for air conditioning, a system for drinking water. Since the main goal from the application of synthesized

anionite and polyampholytes was to keep heavy metals in the composition of the wastewater, we found it necessary to put adsorbent columns in the purification plant system. After the pH level of the wastewater in the treatment plant is brought to 6-7 degrees, the wastewater is supplied to the adsorption column using a centrifugal pump. Adsorption column (figure) is a cylindrical shape, on the inside of which is mounted a special grid, adsorbents alternately on its surface of anionite PPE - 1 and polyampholytes PPE-1-P are inserted into the 2/1 part of the device. Wastewater is supplied to the divider inside the column with the help of a tube and evenly distributed over the surface of the adsorbent as a film. In order to conduct the adsorption process at a temperature of 323-333K, the heat exchange device with coil was transferred from the adsorbent layer, and for this purpose, the layer constantly holds the baking mode. The adsorption process is controlled on the basis of comparison of the indicators of input and output. The duration of the adsorption process is 3600 hours. After that, the adsorbent layer is regenerated. When regenerating, a solution of 0,1 N hydrochloric acid is used.

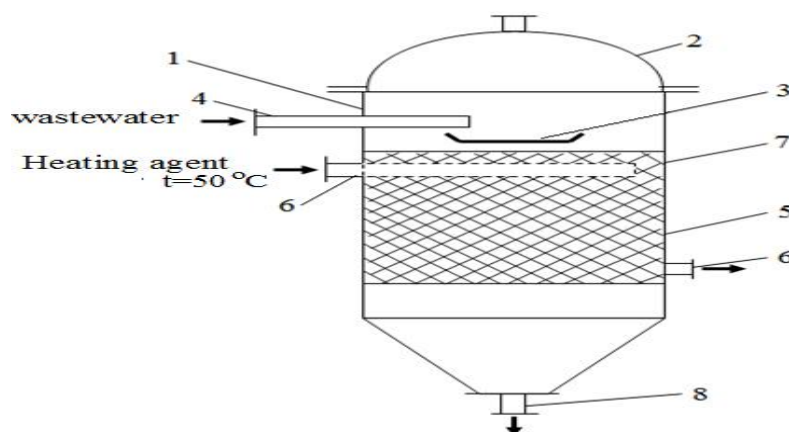


Figure. Adsorption column designed to clean wastewater from heavy metals

1-housing; 2 – cover; 3 – divider; 4 – discharge pipe; 5 – grill; 6 – fittings for heater; 7 –heater with coil; 8- fittings for purified water.

The sorption of metal ions in wastewater into ionites was studied by spectrometric methods. The study was investigated in the Laboratory of experimental technologies of Tashkent Institute of Bioorganic Chemistry by mass spectrometry in a ISP-MS -type device and showed that a large

number of heavy metals are adsorbed on the surfaces of polyampholytes. The results of the study were presented in Table (Table 2).

The data presented in the table show that PPE-1 anionite and PPE-1-P polyampholyte obtained on the basis of polyvinyl chloride, effectively adsorb heavy metal ions in the wastewater of the enterprise.

Table2 The results of sorption of some heavy metals in various types of polionites

№	Element	Amount of sorption, mg/kg					
		PPE-1, 303K	PPE-1, 313K	PPE-1, 323K	PPE-1-P 303K	PPE-1-P, 313K	PPE-1-P, 323K
1	Zinc	65.12	87.7	141	66.71	85.23	104.9
2	Copper	44.5	62.1	106.9	1780	1891	2269
3	Nickel	8.123	10.5	13.5	33.16	35.69	46.39
4	Chromium	21.5	23.6	40.73	8646	9039	14901
5	Iron	208	225	267.1	221.4	376.6	437.4
6	Calcium	108	178	215	105.3	218.3	1308
7	Magnesium	178	213	241	187.2	223.7	295.8
8	Cobalt	16.6	14.6	16.85	11.42	14.52	15.47

CONCLUSION

In this research work, the sorption process of heavy metal ions to PPE-1 anionite and PPE-1-P polyampholyte, which are obtained on the basis of local raw materials, containing amine and phosphite groups, was studied in artificial solutions, in static conditions and in technological conditions. Factors affecting the sorption process in static conditions, namely, time dependence, temperature influence, dependence on concentration, were studied. The results of the same analysis were found by calculating the thermodynamic parameters of the sorption process using the Langmuir and Freundlich models. The change in thermodynamic parameters in the sorption process is due to the exothermic nature, which indicates the chemical absorption of metal ions into polyionite. These results show that the obtained polyionites have high mechanical, thermal stability and ease of use in technological conditions. Therefore, ionizing polyionites are used in almost all branches of industry. They are widely used in softening the hardness of water in thermal and nuclear power plants, desalination of water in water treatment departments of chemical plants, separation of rare, precious, non-ferrous and heavy metal ions in technological solutions in hydrometallurgy

and purification of wastewater from toxic ions to improve the environmental condition.

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