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Effect of temperature and pH Value of the Liquid Shared Selectivity Cation Exchange Membrane, nylon-PANI.

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ABSTRACT

Ion-exchange membranes are widely used in modern technologies, especially in the field of water treatment, substantially reducing the cost of processing waste water and to ensure their high degree of purification. The ion-exchange processes in membranes affected by various external factors, the most important of which are temperature, pH and salinity, initial solution. The aim of the research is the study of factors affecting selectivity of ion exchange membranes, and the determination of the optimal temperature and pH ranges shared the liquid water purification processes of metal ions using modified polyaniline had fulfilled (PANI) nylon membranes. In this paper, these are composite membrane with modified surface layer of silver nanoparticles on the surface of nylon. Experiments were conducted to determine the effect of temperature and pH on membrane selectivity nylon-PANI. Temperature coefficients were obtained for nylon membranes-PANI of heavy metal ion on changing selectivity membranes with temperature at 1° C.

Keywords: PH, temperature, Selectivity, Membrane, metal ions, Polyaniline.

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INTRODUCTION

Recently in production using conductive polymers such as polyaniline (PANI), for example for the manufacture of solar cells, sensors, protection from electrostatic charges and corrosion, as well as the ion exchange membranes. PANI is one of the most well studied conductive polymers and is characterized by the simplicity of the original monomer, low cost and the ability to alter their chemical properties depending on the pH and the degree of oxidation of the polymer backbone chain. The use of MRS in obtaining or modifying of ion exchange membranes has advantages in connectivity and availability of raw materials and ease of manufacture, and thanks to this quality, as the high selective permeability. Recently, many studies were carried out on the modified ion exchange membranes [1-4].

Influence of solution temperature on separation process solution is complex. The increase in temperature reduces the viscosity and density of the solution and at the same time increases the osmotic pressure. If the reduction in viscosity and density increases the permeability, the increase in osmotic pressure decreases the force and reduces the permeability. The degree of influence of factors depends on the nature of the solute and the concentration of the solution.

In the work [5] the dependence of conductivity on temperature for the MF-4CK membranes, surface layer modified solution PANI-0,1 and non-modified ion exchange membranes of MF-4CK. As a result of an increase in temperature from 30° C to 100° C conductivity of the original and the modified membranes increased, with modified membrane slope graphics above. PANI modification increases the conductivity, temperature in the whole area.

The acquisition of optimum solution temperature regions will achieve high retention ability of the membranes.

Dissolved substances, partial reverse osmosis, usually have a charge. Also, the charge rests with the membrane, membrane separation processes used. Acetate-cellulose membranes have a small negative charge. Therefore, you can assume that the change in pH can affect the technological characteristics of the membrane and, above all, the selectivity. In addition, the solution pH value affects the thickness of the boundary layer of fluid that largely determines the selective properties of membranes [6].

In the literature [7] describes the phenomenon of anomalous osmosis. When the electrolyte in the form of dissolved substance goes through a charged membrane solvent also passes through the membrane, but in the opposite direction. The diffusion of solute is the heterogeneity of the electric field across the thickness of the membrane, resulting in the emergence of an additional driving force for ions. If it leads to an increase in the migration of the solvent, the phenomenon is called anomalous positive osmosis, solvent transfer is reduced if there is a negative abnormal osmosis. Various kinds of anomalous osmosis can change the pH of electrolyte solutions.

The reverse osmosis separation of the selectivity of the membrane a minimum of electrolyte solutions at pH 5-6. For solutions of multivalent salts and electrolytes for high concentration of significant impact on selectivity of pH not detected [6].

Ion-exchange membranes via the alanine electrotransport with different initial solution pH was studied by [8], with the participation of hydrogen and hydroxide ions to transfer electric current. The optimal pH for extraction of alanine in cationic form 2,1 pH. At lower pH prevailing competitive transfer of hydrogen ions.

Ion-selective membranes possess a high degree of separation of the solutions, both low and high concentrations of dissolved salts, but certain values of pH ion exchange membrane's ability to the most high.

METHODS

This work received ion-exchange membrane layer which is polyaniline (PANI). Studies on membrane separation laboratory facility [9].

As a matrix for the polymerization of aniline was used PTFE and nylon membranes with pore sizes 0.45 µm. Modification of membrane formation on the surface layer in the pores and PANI, which is a cationic, ion-exchange membrane allows you to get that rivals on several cation selectivity.

Synthesis of membrane surface distribution of polymerization of aniline by PANI in matrix membranes. In the first case, the membrane is maintained for 5 minutes in a solution of aniline hydrochloride. Next, the membrane was placed into a solution of ammonium. PANI particles formed directly in the matrix of the membrane, as evidenced by the color change of the polymer on the dark green.

Measurement of the concentration of metal ions in the solution and have conducted method of atomic adsorptive spectrometry with electro thermal atomization "Quantum Z.ETA".

Potentiometric pH changes were carried out using pH-meter ion meter-"I160" with standard pH selective electrode, with digital output on a personal computer.

Capacity (selectivity) calculated according to the formula

$$\varphi = (Cf - Cp) / Cf \ ,$$

where Cf is the concentration of metal ions in solution and the Cp concentration in leach ate of solute.

Study of the influence of the temperature factor carried out under the following conditions:

- The original solutions of Fe^{3+} ions, Fe^{2+}, Cu^{2+}, Zn^{2+}, Ni^{+};
- Temperature source solution from 20° C to 90° C;
- Concentration of solutions of metal ions, ranged from 0.1 to 2.5 mg/l.

Study of influence of pH on the selectivity of the membrane were conducted in the following conditions:

- The original solutions of Fe^{3+} ions, Fe^{2+}, Cu^{2+}, Zn^{2+}, Ni^{+};
- pH of 2 to 11 u. Ph;
- Temperature source solution from 25°C;
- Concentration of solutions of metal ions varied from 0.1 mg/l up to 2.5 mg/l.

After each experiment conducted regeneration membrane by storage in 3% solution of hydrochloric acid followed by deionized water. As a result of regeneration membrane take the hydrogen form.

RESULTS

The original microfiltration membrane pore size nylon 0.47 µm does not have the metal ion selectivity. Aniline modified membranes have the retention ability of the metal ions, within 80-99% of the initial concentration.

From Figure 1, the ability of the ion exchange membrane of nylon-PANI increases with increasing temperature grout, with a maximum capacity is observed at a temperature of 90° C.

Table 1: Value temperature coefficient k for metal ions

Metal ions	Fe^{3+}	Fe^{2+}	Cu^{2+}	Zn^{2+}	Ni^{+}
Coefficient – k	1,0	0,74	0,70	0,68	1,05

Dependence of the selectivity of the membrane "nylon-PANI" on temperature for all solutions of salts of metals is close to linear. Effect of temperature factor on membrane selectivity for each metal ion has its own character. Since the dependence of temperature of selectivity is linear, for ion-exchange membrane was made calculation of average temperature coefficient (table 1) for each metal ion, by the formula $k = \Delta Q / \Delta T$, where ΔQ and ΔT is the average arithmetic value of the changes of temperature and selectivity, respectively.

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K-coefficient, which characterizes the degree of influence of temperature on the selectivity of the membrane and an increase in selectivity with increasing temperature one degree, l/h °C.

Temperature coefficients are the maximum values for ions Ni^{+}, Fe^{3+}, therefore the effect of temperature on the ability of these metal membrane most high. Increase the temperature of the liquid at 1° c increases the retention ability of the membrane of nylon-PANI at an average rate of 0.83%.

To determine the effect of pH on ability of metal ions on membrane, through the membrane allow solutions of metal ions with hydrogen indicators from 1.6 to 12 u. pH, the acid HCl and NH4OH. In Figure 3 shows the experiment research based on the selectivity of the membrane "nylon-PANI" from pH solution of metal ions. Changing selectivity membranes from pH solution varies for different metal ions.

DISCUSSION

On research [10] modification PANI leads to an increase in conductance in the entire field of temperature. According to the model Gierke of the ion-exchange groups form, Starting in the membrane pores the size of a few nanometers, with sorbed water. They can also absorb to particles formed during polymerization PANI. By introducing these particles appear more centres of migration. You may also change the microstructure of the membrane, which increase the conductivity. In the work [11] in the study of modified katiobmennoj results showed that membrane transport monovalent and bivalent cations, as well as the protons of different influences the presence of layers of Amin in the membrane.

In the work [12] investigated temperature dependence of conductivity of cation exchange MF-4CK membranes modified with zirconium phosphate sour. It is expected that transport protons in the studied material is carried out with the direct participation of water molecules. And, the translational mobility last stimulates migration of protons. According to the model of membrane type Matrix Gierke Nafion self-organization occurs at its formation, resulting in a nanopore, filled with water molecules and SO3H-groups, and channels. You can assume that the pores and channels are expanded in the presence of nanoparticles dopant. Therefore, the growth of ionic conductivity of membranes modified hydrophilic nanoparticles can be attributed mainly to the influence of dopanta on the structure of the pores and channels.

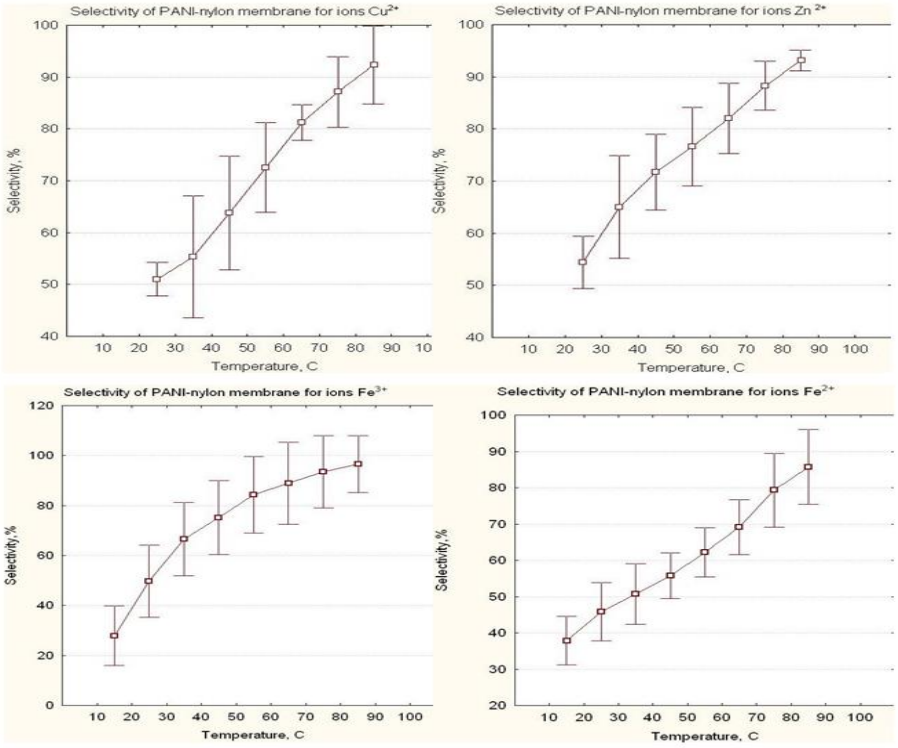

Figure 1: The dependence of selectivity of the membrane nylon-PANI from the solution temperature for metal ions: Fe^{3+}, Fe^{2+}, Cu^{2+}, Zn^{2+}.

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Thus, the temperature increase of the shared fluid increases the selectivity of ion exchange membranes nylon-PANI in the Division of solutions of metal ions. With rising water temperatures decreases the size of the water clusters due to increased thermal motion of molecules, and so does modify the properties of the membrane. As a result of the high temperature is increasing the activity of water molecules, the hydrogen ion is more chip away, and instead are more hydrogen ions, metal ions, which are less influenced by the temperature of the liquid.

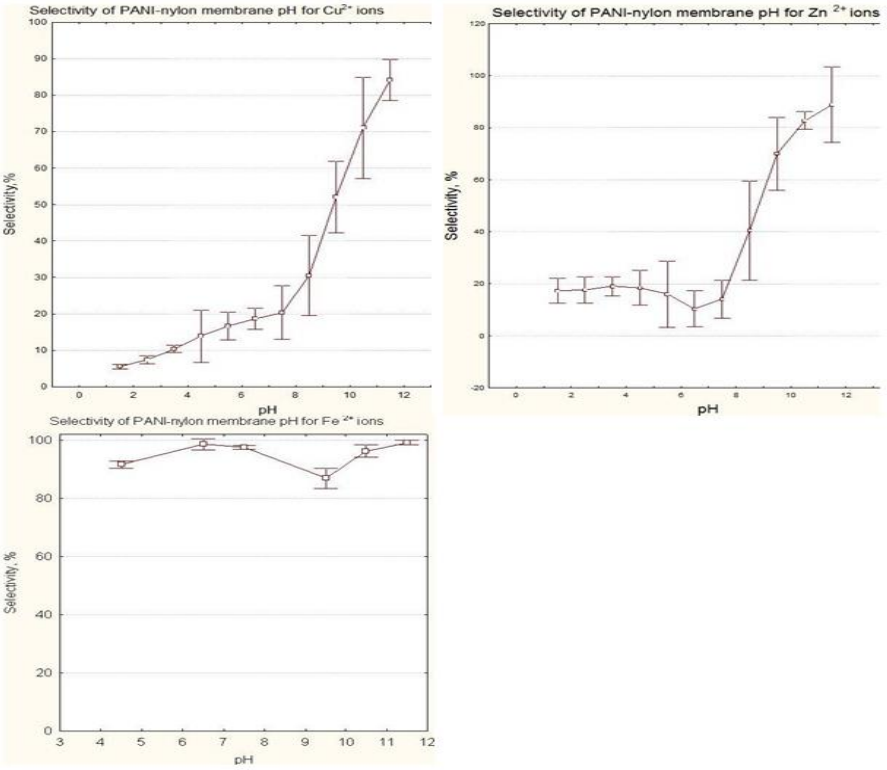

Figure 2: Dependence of the selectivity of the membrane nylon-PANI from the pH of a solution for metal ions: Fe^{2+}, Cu^{2+}, Zn^{2+}.

Studies have shown that the influence of pH on the selectivity of the membrane has ion for each metal in nature. In the work [13] we investigated the ability of nylon membranes with pore size 0.01 µm, it is shown that complexation and filtering processes of metal ions is dependent on the pH. Metal-free drying is more effective in alkaline medium than in acidic conditions. The selectivity of the membrane increases with pH, and is highest in the 8-12 pH for ions of copper. According to [14] in this pH range is minimum solubility of Cu^{2+} ions. For ions Zn^{2+} plot of selectivity is pH value has a minimum of 5.5-8 u. pH selectivity and maximum selectivity is observed in the area of minimum solubility ions Zn^{2+} 9-11 u. Ph. Ferric ion selectivity is 90-100% throughout the region from 4 to 11.5 units. pH, the pH is equal to the minimum solubility of iron ions in the water. Part of the metal ions in the associated state as colloids, as the region with the lowest pH solubility of metal ions has a high selectivity of the membrane, membrane's ability to seem nylon-PANI is not only the exchange, but also ion of colloids in the pores of the membrane.

CONCLUSIONS

Derived cation exchange membranes polymerization of aniline in the structure of the nylon and PTFE membranes. Proven membrane selectivity for cations in model solutions of salts of metals. Shared fluid temperature rise increases the selectivity of ion exchange membranes nylon-PANI in the division of solutions of metal ions. High temperature leads to increased activity of water molecules, a hydrogen ion is more chip away and place of hydrogen ions, metal ions, which are less influenced by the temperature of the liquid.

The calculated temperature coefficients are the maximum values for ions Ni +, Fe3 +, therefore the effect of temperature on the ability of the high for these ions. Increase the temperature of the liquid at 1°C

increases the retention capacity of the membrane nylon-PANI by an average of 0.83%. The influence of pH on the selectivity of the membrane has ion for each metal in nature. The ability of membrane nylon-PANI is not only ion exchange of colloids in the pores of the membrane as pH values with minimum solubility of metal ions to a high selectivity of the membrane.

Further planned to obtain the anisotropic ion exchange membranes and study of their properties.

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