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Effect of physico-chemical properties of nanofiltration membranes on nitrate removal from water

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The main goal of this study was to investigate an effect of chemical nature and ξ-potential of polymer nanofiltration membranes on removal of nitrate ions from model solutions and natural waters.

Nanofiltration membranes OPMN-P (Vladypor, Russia), BE and NE-70 (Saehan, Korea) were used in the work. These membranes are composite polymer membranes, which consist of thin polysulphonamide layer (OPMN-P membrane), aromatic polyamide layer (BE membrane) or aliphatic polyamide (NE-70 membrane) layer deposited on a porous polyester base.

The experiments were carried out with model 50 mg/l aqueous solutions of nitrate ions. Potassium nitrate (Sigma Aldrich) was used to prepare the solutions. A separate set of experiments was conducted with natural underground water.

It was established that the rejection of nitrate ions with the membranes decreases with an increase of degree of permeate selection. This dependence is due to accumulation of nitrate ions at the membrane surface during the filtration. This processes enhances the effect of concentration polarization and leads to a decrease in the rejection of nitrate ions. The increase of concentration polarization at high degrees of permeate selection also reduces the membrane flux.

All studied membranes are positively charged at low pH and have a negative charge at high pH of the solution. The difference between ξ-potentials for various membranes can be explained by a different number of functional groups on the membrane surface because of different monomers were used in the membrane fabrication process.

The obtained results have showed that the nitrate rejection with the membranes increases with an increase of the solution pH. This dependence can probably be explained by the fact that in an alkaline medium the membrane is charged negatively due to dissociation of carboxyl groups on the membrane surface, while in an acidic solution the membrane carries a positive charge because of protonation of amine groups on the membrane surface. Therefore, rejection of nitrate ions increases significantly during filtration of the base aqueous solution due to electrochemical repulsion of the nitrate ions from the co-charged membrane surface.

It was shown that BE membrane possesses the highest rejection of nitrate ions (80-90%) during filtration of natural water at neutral pH values. At these conditions OPMN-P membrane rejects nitrates up to 65-78%, while the lowest retention (40-45%) was found with NE membrane. These data are consistent with ξ-potential values of the tested membranes. Thus, it was found that the efficiency of nitrate rejection and the membrane flux are strongly dependent on the chemical nature and

ξ-potential of the membranes: the stronger the negative charge of the membrane surface, the higher rejection is.