Abstract of scientific publications

"Transport characteristics and physico-chemical properties of polymeric membranes modified by carbon nanoparticles."

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Membrane processes are widely used for the compound purification, wastewater treatment, concentration and fractionation of industrial liquid and gas mixtures. The objects of A.V. Penkova and M.E. Dmitrenko study are two technologically important membrane processes - evaporation through the non-porous polymeric membrane (pervaporation) and ultrafiltration. Pervaporation and ultrafiltration are membrane processes for the separation of liquid mixtures. Pervaporation allows separating liquid mixtures containing close boiling points components or azeotropic mixtures which are difficult to separate by distillation or by other means. Ultrafiltration is used in various industries: in the dairy, food, textile, pharmaceutical and metallurgical fields. Modern problems of chemical technology determines the relevance and the need to develop the combined (hybrid) processes and to search the new membranes, including the directed modification of known membrane materials due to the fact that the intensive development of membrane methods requires the search for new membranes having improved physico-chemical and transport properties. One of the major modern methods of the change of functional properties of polymeric materials is the introduction of modifiers to the polymer matrix. The most important type of modified materials are polymer nanocomposites containing nanoparticles as modifiers. At the same time despite the effectiveness of the polymer modification by nanoparticles, such as improvement in the mechanical and physico-chemical properties that are important for the membrane separation, in the recent literature just several publications devoted to these tasks. Introduction of modifiers allows getting the tailoring properties of a membrane material and a process.

In this regard the study of the most important transport properties, selectivity, and other parameters under the modification of the membrane material is very important. For this purpose to carry out the analysis of physical and chemical aspects of the membrane mass transfer is necessary. The understanding of the mechanism of mass transfer across the membrane is necessary to justify the choice of materials, analysis, evaluation and prediction of process results. It should be noted that the existing approaches for the analysis of membrane transport have a theoretical value; in practice, mainly the simplified versions are used, for example, based on Fick's law.

Thus, the main research directions of A.V. Penkova and M.E. Dmitrenko are:

• Development of methods of polymer modification by carbon nanoparticles in solution and in the absence of solvent (the solid-phase interaction); obtaining composites with different contents

of carbon nanomodifier and preparation of different types of membranes based on them (non-porous: diffusion, supported (with a thin selective layer) and porous: ultrafiltration type).

• The study of the structural characteristics and physico-chemical properties of the composites.

• The study of the transport properties and the selectivity of the membranes based on nanocomposites "polymer - carbon particles" in the pervaporation processes of the binary and quaternary systems, as well as during the ultrafiltration. Development of recommendations on optimization of their structure.

• Physico-chemical analysis of the membrane mass transfer in pervaporation (including the effect of modifiers), the research of descriptions of the thermodynamic modeling of the process.

A.V. Penkova and M.E. Dmitrenko were the first who studied the influence of nanocarbon structures introduced into the polymer matrix on the properties of the membrane material in pervaporation and ultrafiltration processes. Such polymer membrane matrixes were chosen as polyphenylene oxide, polyphenylene isophtalamide, polyvinyl alcohol, as the fillers were chosen carbon nanoparticles (fullerene, carbon black, carbon nanotubes, fullerenols, astralenes). New methods of polymer modification by nanocarbon structures were first developed. Novel nanocomposite membranes have been designed to improve the transport properties of polymeric membranes.

It was shown that membranes modified by carbon nanoparticles had better transport characteristics during the separation of binary and multicomponent mixtures in pervaporation and these nanocomposites membranes possess high anti-fouling ability for the separation of proteins during ultrafiltration (membrane surface was not polluted due to the adsorption of proteins on the surface and in the membrane pores).

A.V. Penkova demonstrated and confirmed on the basis of the PhD thesis and published data the possibility of thermodynamic description of pervaporation process and approximation of experimental data in binary systems with the use of non-equilibrium thermodynamics relations.