

Peculiarities of hydrogel – polyamide composition membranes formation

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Abstract – *Quality composition of the subphase for modification of hydrogel membranes by ultra thin polyamide layer is selected. It was designed the laboratory appliance which allows applying the surface layer of polyamide by direct contact of the hydrogel film with a thin layer of modifying solution. The compositional film membranes based on hydroxyethyl methacrylate cross-linking copolymers with polyvinylpyrrolidone and aliphatic polyamide are obtained.*

Key words – hydrogels, polyvinylpyrrolidone, polyamide-6, modification solution, subphase, compositional film membranes.

I. Introduction

Modern development of membrane technologies requires the creation of new polymer membranes, which in turn stimulates the development of technological methods for various membrane materials combining their component layers to improve functional properties.. Composite membranes preferably consist of several successive layers, each of which provides certain options filtration process or as a composite whole [1]. Hydrogel membranes are characterized by good permeability, but the lack of strength, which narrows the scope of their use. It is therefore gaining increasing importance to solve the problem of strengthening hydrogel tapes by modifying the surface layers of reinforcing material, the ability to maintain separation of hydrogel membranes and improve their physical and chemical properties. The preparation of such membranes will use them under increased pressure, particularly in the process of ultrafiltration or hemodialysis. Polymer hydrogels are macromolecular hydrophilic stitched systems that are capable of absorbing large quantities of water, while maintaining the properties of solids. Hydrogel materials along with hydrophobic properties and high compatibility with biological tissues must own and other target properties such as permeability, mechanical strength of the material in the hydrated state, etc. [2]. Combining in one material these properties can create unique polymer products, including new membrane materials of medical and biological purposes. These objectives can be achieved through the creation of composite materials. The method of modifying the

application of solutions from the surface of the liquid phase allows obtaining composite membranes with ultrathin coatings on porous matrix.

II. Result and Discussion

As a basis for forming composite membranes used hydrogel membrane film obtained by polymerization using compositions based on aqueous solutions of HEMA with PVP [2]. Previous studies by solution composition for forming permeable polyamide ultrathin tapes [3]. These solutions consist of mixtures of polyamide-6 and PVP solvent system based on aqueous solutions of formic acid (HCOOH). Inert liquid phase (phase sub) prepared from a mixture of cyclohexane (C₆H₁₂) and carbon tetrachloride (CCl₄).

Physical and mechanical properties of synthesized tapes composite membranes in hydrated state determined by breakthrough film attached to the annular clamps, under the pin indenter the developed methodology [2]. Pellicle membrane permeability measured in dynamic mode using laboratory dialyzer during dialysis aqueous solutions of model substances (sodium chloride) for developed methodology [4]. To obtain composite membranes were chosen method of deposition of ultrathin polyamide tapes on the surface of the water-containing hydrogel. This polyamide layer firmly kept on the surface of the hydrogel due to physical interaction related polymer substrate and the surface modifying layer. Cut the selected method is applied in thin films on a solid substrate surface with a liquid phase. Liquid phase allows modifying solution spread about on the surface, forming a uniform layer of a thin tapes. To ensure the spreading of such a modified solution should have a lower density than subphase not dissolve and do not interact with it.

Having regard to modifying the composition of solutions based on formic acid solutions and mixtures PA–PVP as inert liquid phase was chosen mixture of cyclohexane and carbon tetrachloride, which are infinitely mixed together. Cyclohexane does not react with any component modifying solution, but has a low density and CCl₄, in turn, the high density insoluble and does not react with water [5,6] and polyamide-6 (PA-6) [7] but it is partially soluble PVP in an amount of less than 1% [8] and formic acid is less than 3% [5].

Neat quantitative composition of the liquid phase consisting of a mixture of cyclohexane and carbon tetrachloride containing the last above 60% vol., Allowing it to spread surface modifying solutions based on mixtures of PA-6–PVP in the solvent system: HCOOH–H₂O. Titration studies found that a composition subphase provides its minimal physical interaction with components modifying solution. Research the liquid organic phase of formic acid was carried out at the maximum of their contact, which reached intense stirring in contact and at the phase boundary - when carefully poured acid on the surface of the liquid subphase without additional mixing. Established that the solubility of formic acid significantly depends on the contact interface. Intensive phase dispersion leads to the formation of emulsions formic acid in the organic phase, which

eventually splits and content of formic acid in subphase eventually decreases. For contact at the phase boundary HCOOH – subphase, the amount of acid increases due not significant acid solubility in solvents but not exceeding 0,5%.

To form the composite hydrogel membrane we developed a laboratory setting (Fig. 1), in which the location of the drive drum in the bath liquid (subphase) equipped with barrier allows the hydrogel coating on the surface of the film subphase, and the presence of the drying chamber allows control mode drying and forming a composite film.

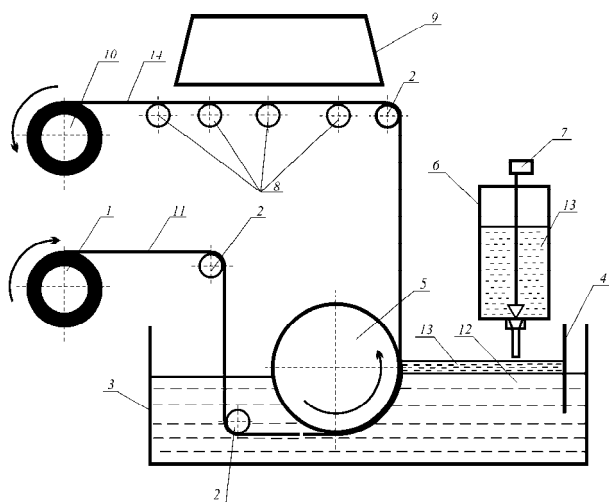


Fig. 1. Scheme of laboratory setup for forming composite hydrogel membranes

To form the composite films spool with hydrogel film set in a knot unwinding 1, and the free end of the film rounding all components of the installation, including a guide roller 2, drive drum 5, which is located across the width tub 3, guide roller 2 and backing roller 8 and fixed winding 10 in the node. Bath 3 filled with liquid (subphase) 12. On the surface subphase 12 located between the driven drum 5 and four barrier with reservoirs feed 6 to measured out polymer solution 13 and 4 moving barrier set its thickness. Turned on hydrogel patei unwinding unit 1, the drive drum 5, the composite film winding unit 10, the drying chamber 9. Hydrogel pates 11 via guide rollers 2 moved through the liquid subfazu 12 rounding drive drum 5 and the output of subphase contact with the modifying solution 13 is deposited on its surface, rounds guide roller 2 and moved on supporting rollers 8 through the drying chamber 9, where the solvent evaporates at a temperature of 75-80 °C and composite films formed in a hydrated state at 14 wound bobbin winder in the node 10.

With this method of deposition of ultra-thin film held firmly on the surface of the hydrogel due to physical interaction related polymer substrate and the surface modifying layer.

Research has established that strength at break of the obtained composite membrane in the hydrated state can be forwarded to regulate within 0,2-1,1 MPa, thus changing their relative elongation at break in the range of 90...300%. Determined that according to the composition and technological parameters of forming synthesized composite membranes characterized permeability coefficient for sodium chloride $(0,3-2,3) \cdot 10^4 \text{ mol} \cdot \text{m}^{-2} \cdot \text{hr}^{-1}$.

Conclusion

So we worked out the technology, design and installation subphase composition chosen for forming composite polymer membrane lining in the form of hydrogel layer coated on one side reinforced polyamide ultra-permeable layer. Research has established that obtained using the proposed method hydrogel-polyamide composite membrane characterized by increased strength compared to the hydrogel matrix and adjustable selective permeability, which are determined by the composition of the mixture PA-PVP, its concentration in the solution and modifying the temperature and time parameters forming.

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