# Diffusion-transport Properties of Hydrogel Membranes Based on Copolymers of 2-hydroxyethyl Methacrylate with Polyvinylpyrrolidone

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***Abstract – The results of researches of dialysis permeability hydrogel films on the basis of copolymers of 2-hydroxyethyl methacrylate with polyvinylpyrrolidone dependently on their composition and modes of dialysis have been carried out. Possibility of synthesized hydrogels applying as the diffusion dialysis membranes has been confirmed.***

Keywords – hydrogel, copolymer, polyvinylpyrrolidone, films membranes, dialyze, permeability.

## I. Introduction

The creation of biologically compatible polymer membranes which able selectively skip one or other substances not only for the molecules size, but also depending on their nature and membrane process conditions – is an actual problem [1]. Perspective in this direction are grafted copolymers of methacrylates and polyvinylpyrrolidone (PVP). Such copolymers are effectively applied in medicine, in particular, for making contact lenses, film medical materials, drugs controlled release systems etc. [2-4]. In the work the correlation of hydrogel membranes permeability based on cross-linked copolymers of 2-hydroxyethyl methacrylate (HEMA) and PVP with its composition and dialysis process parameters has been studied. The aim of the work was to determine the main kinetic regularities of diffusion permeability of hydrogel membranes based on HEMA/PVP copolymers while dialysis and ground the capabilities of its practical application.

## II. Material and Methods

Hydrogen membranes were obtained by copolymerization of HEMA with PVP compositions in the water at mass ratio of the monomer phase and water equal to 1:1. The potassium persulfate in an amount of 0,3 wt. % per polymer-monomer composition has been applied as the initiator. Polymerization of compositions were conducted in forms of silicate glass in dry-air thermostat in the following mode: 60 °C – 2,5 hr; 75 °C – 3 hr.

To increase the mechanical strength the hydrogel was reinforced with a polyamide grid of cell dimensions $1{,}5\times1{,}5\times10^{-4}$ m. The reinforcement was carried out during molding.

Obtained hydrogel membranes were hydrated in distilled water for 24 hr and stored prior to the research start in a hydrated state.

Diffusion properties of hydrogel films were studied in dynamic mode (flow velocity of liquid $V_d$ = 2…4 dm$^3$/hr) during water solutions dialysis of a model substance (sodium chloride). The laboratory dialyzer which contains a flowable dialysis cell by area of $1{,}9\cdot10^{-3}$ m$^2$ and peristaltic pump has been utilize. The research was carried out in accordance with the developed methodology [5]. The film's permeability was determined by change in the electrical conductivity of the water solution of electrolyte during dialysis applying measuring bridge P-5010 using platinum electrodes of comparison. Dialysis permeability was estimated by the amount of electrolyte which has diffused through the studied film membrane.

## III. Result and Discussion

The influence of copolymer composition of synthesized hydrogel films on the diffusion rate of NaCl in the initial stage (Fig. 1) has been researched.

It was defined that permeability of film hydrogel membranes based on HEMA/PVP copolymers is significantly determined by the hydrogel composition. With increase of PVP amount in the initial composition the diffusion velocity increases, however, increase of PVP content in polymer-monomer composition over 20 wt. % doesn't lead to a proportional increase of NaCl diffusion velocity. Taking into account the above as well as that fact that increase of PVP content is the reason of deterioration of hydrogel films mechanical strength [3], for further research the hydrogel membranes containing PVP in the composition to 20 wt. % by weight have been applied.

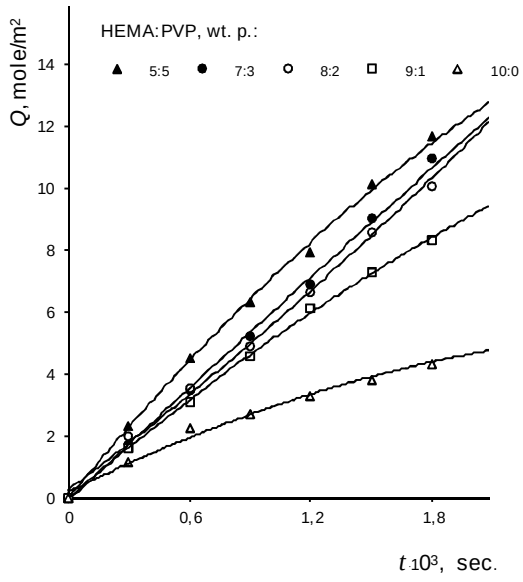


Fig.1 Kinetic curves of dialysis permeability ($Q$) HEMA/PVP membranes for NaCl ($d$ = 200 μm): NaCl = 0,154 mole/dm$^3$; $V_d$ = 3 dm$^3$/hr; $T_d$ = 20 °C.

The dependence of dialysis permeability of the synthesized membranes on liquid flow velocity has been researched. It is determined that with increasing of flow rate of liquid from 3 to 4 dm/hr NaCl diffusion velocity through the HEMA/PVP membrane increases almost twice (Fig. 2).

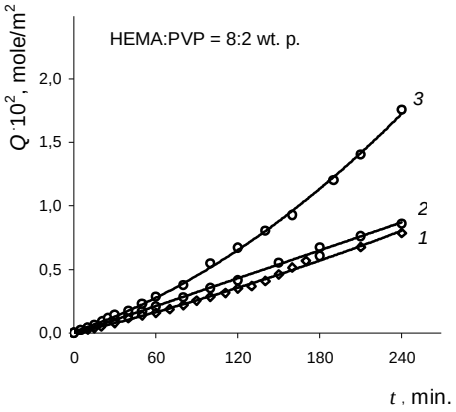


Fig.2 Kinetic curves of dialysis permeability ($Q$) HEMA/PVP membranes for NaCl ($d$ = 200 μm): $C_{NaCl}$ = 0,154 mole/dm$^3$; $T_d$ = 20 °C; $V_d$, dm$^3$/hr: *1* – 2; *2* – 3; *3* – 4.

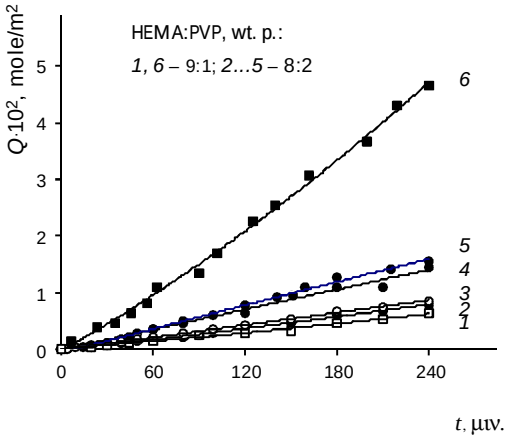


Fig.3 Kinetic curves of dialysis permeability ($Q$) HEMA/PVP membranes for NaCl ($d$ = 200 μm): $C_{NaCl}$ = 0,154 mole/dm$^3$; $V_d$ = 3 dm$^3$/hr; $T_d$, °C: *1...3* – 20; *4, 6* – 37; *5* – 50; *2, 4, 5* – reinforced films.

In order to determine the practical application of hydrogel membranes the influence of temperature dialysis effect on their permeability were investigated. It is determined that the diffusion rate of NaCl significantly increases with increasing of dialysis temperature (Fig.3, *curves* 1, 6), but such a membrane will be significantly strain through of their high elasticity. Reinforcement of hydrogel film with polyamide grid reduces their elasticity and increases strength, however effective area of the membrane working surface decreases by almost 40%. It was defined that reinforcement slightly affects dialysis permeability of hydrogel membranes (Fig.3, *curves* 2, 3). Also NaCl diffusion velocity for reinforced films increases much less with increasing of dialysis temperature (Fig.3, *curves* 2, 4, 5) than for non-reinforced films. The reason of mentioned is their elasticity reduce.

## Conclusion

The kinetic regularities of the dialysis permeability of hydrogel films based on cross-linked HEMA/PVP copolymers have been researched. The dependences of their permeability on hydrogel composition, reinforcement, and also conditions of dialysis of sodium chloride water solutions have been determined. The possibility of application of HEMA/PVP copolymer hydrogel films of as the diffusion dialysis membranes is confirmed.

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