FEATURES OF SAMARIUM IONS SORPTION BY INTERGEL SYSTEM BASED ON RARE-CROSSLINKED POLYMER HYDROGELS OF POLYACRYLIC ACID AND POLY-4-VINYLPYRIDINE

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Previous studies devoted to investigation of remote interaction of rare-crosslinked polymer hydrogels of different nature in intergel systems in an aqueous medium showed that result of such interaction is significant changes in conformational, electro-chemical and sorption properties [1-7]. Remote interaction of polymer hydrogels in intergel system provides transition of the initial polymers into highly ionized state due to their mutual activation. It occurs due to binding of cleaved protons from carboxyl groups by heteroatoms of vinylpyridines. In salt solution remote interaction of macromolecules provide decrease of specific electric conductivity, increase of pH due to samarium ions sorption by intergel system. Swelling degree of each polymer decreases due to decrease of charged groups amount in result of metal ions binding. As known, sorption properties are mainly determined by nature and state of functional groups. State of functional groups can be changed by remote interaction in intergel systems.

Further studies were devoted to sorption of different metals [8-10]. The goal of the paper is to study possibility of re-arrange of selectivity of intergel system based on polyacrylic acid hydrogel (hPAA) and poly-4-vinylpyridine hydrogel (hP4VP).

Figure 1 shows dependence of specific electric conductivity from hydrogels molar ratios in the intergel system hPAA-hP4VP.

As seen from the obtained data there is a decrease in values of specific electric conductivity with time due to sorption of rare-earth metal. Minimum value of conductivity the intergel system has at hydrogels ratio hPAA:hP4VP=4:2. High values of conductivity are observed in presence of only polyacid and polybasis (hPAA:hP4VP=6:0 and 0:6 ratios). In other words, it can be said that during samarium ions sorption there is a binding of metal ions by charged functional groups and as a result there is a decrease in conductivity due to decrease of charged groups amount.

Electric conductivity shouldn't be used for conclusions about sorption of Sm^{3+} ions. High and low values of conductivity are reasons of intermolecular interactions of hydrogels in intergel pairs and side reactions.

Dependence of hydrogen ions from the hydrogels molar ratios in time is shown of figure 2. Concentration of hydrogen ions increases with time due to decrease of binding of protons by carboxyl groups. At hPAA:hP4VP=5:1 ratio dissociation of carboxyl groups prevails over proton association by nitrogen atoms. Also low values of pH are observed in presence of only polyacid (hPAA:hP4VP=6:0 ratio).

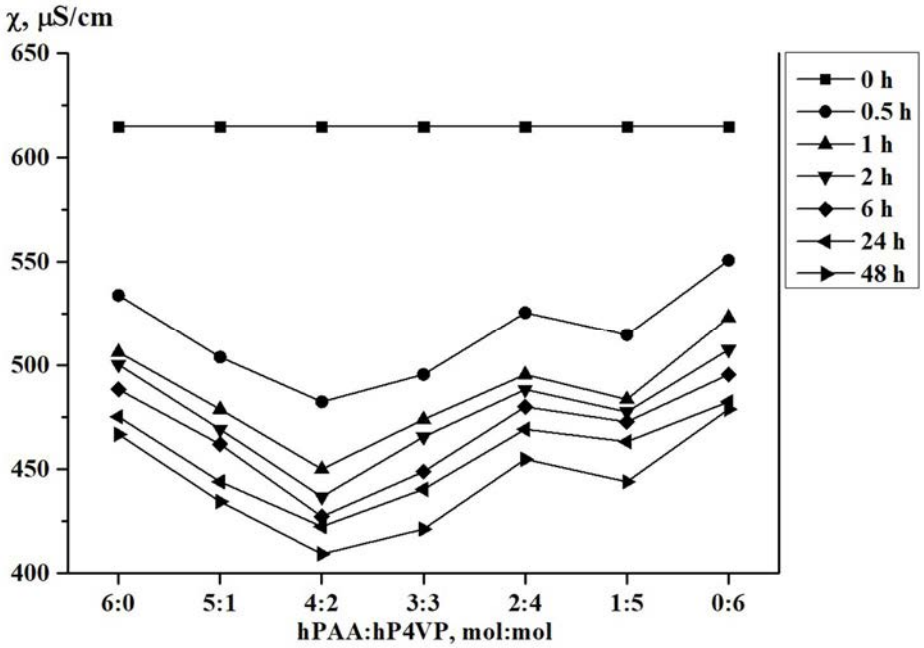

Fig. 1. Dependence of specific electric conductivity of samarium nitrate solution from hPAA:hP4VP hydrogels molar ratios in time

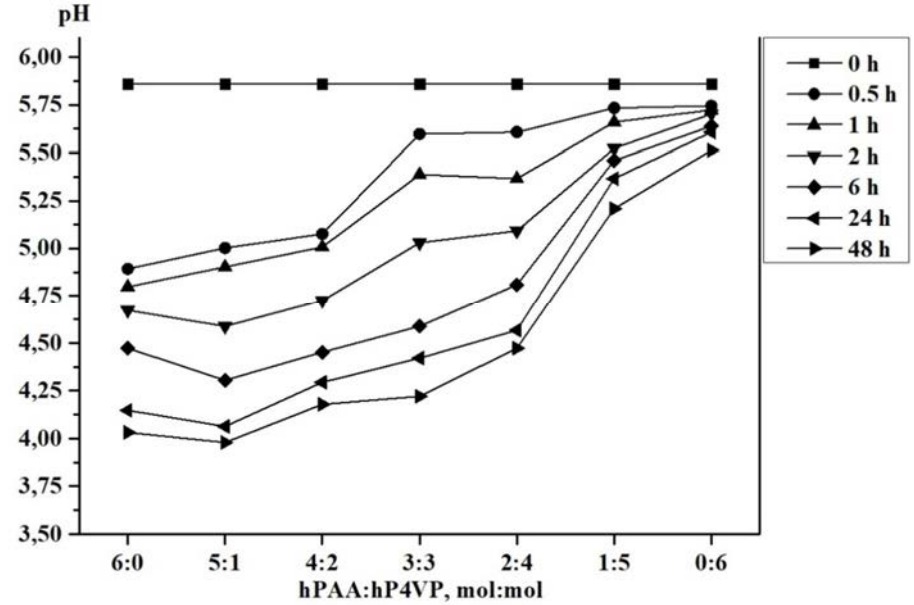

Fig. 2. Dependence of pH of samarium nitrate solution from hPAA:hP4VP hydrogels molar ratios in time

There are changes of volume-gravimetric properties of PAA and P4VP hydrogels during samarium ions sorption. Dependence of PAA hydrogel swelling degree from the hydrogels molar ratios in time is presented on figure 3. Significant increase of swelling degree in first 30 minutes of interaction is a result of mutual activation of the initial polymers with their further transition into highly ionized state.

As can be seen from figure 3, swelling degree of hPAA increases proportionally to increase of hP4VP share. Maximum values of PAA hydrogel swelling degree are seen at hPAA:hP4VP=1:5 ratio at 30 minutes.

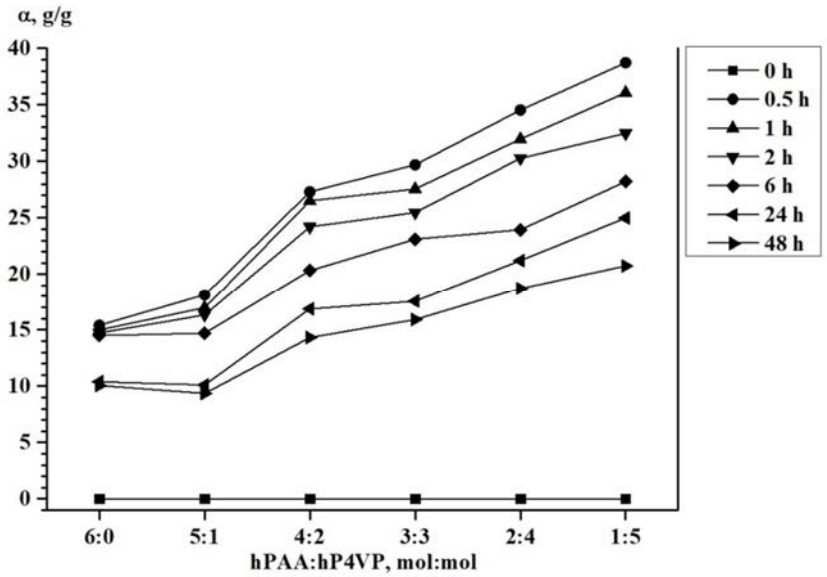

Fig. 3. Swelling degree of PAA hydrogel in intergel system hPAA-hP4VP

Swelling of polybasis (hP4VP) has the similar to polyacid swelling character (swelling degree increases with polyacid share increase). Figure 4 represents dependence of swelling degree of P4VP from the hydrogels molar ratios in time. As seen from obtained data, strong increase of swelling degree is observed at 30 minutes, sorption of samarium provides further swelling decrease. Maximum values swelling degree of hP4VP has at hPAA:hP4VP=5:1 ratio.

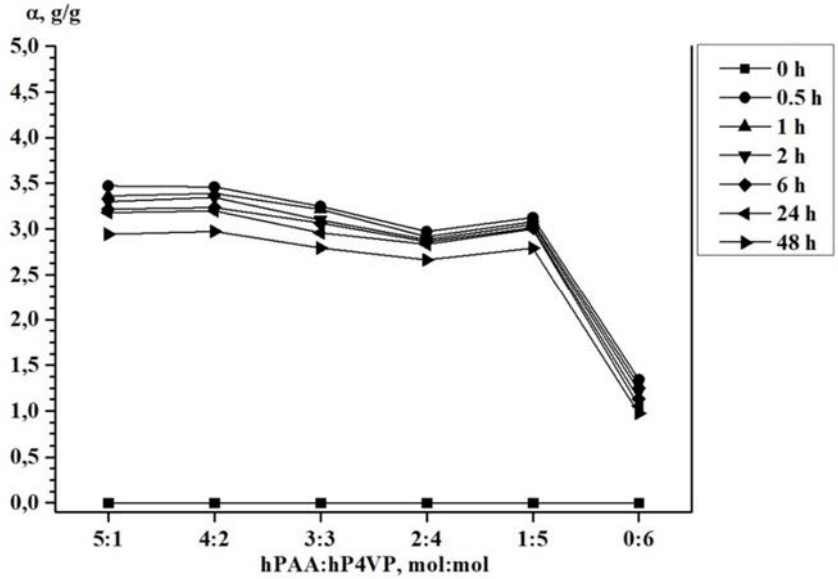

Fig. 4. Swelling degree of P4VP hydrogel in intergel system hPAA-hP4VP

Figure 5 represents extraction degree of samarium ions by the intergel system hPAA-hP4VP. Individual polymer hydrogels have low values of extraction degree of Sm^{3+} ions due to absence of mutual activation phenomenon. Individual hydrogels' sorption degree in relation to samarium ions is 66.3% for polyacrylic acid hydrogel and 62.9% for poly-4-vinylpyridine hydrogel. Maximum sorption of samarium by intergel system hPAA-hP4VP occurs at hPAA:hP4VP=4:2 ratio. Extraction degree is 91.1% at this ratio at 48 hours of remote interaction.

It should be noted that also ratios hPAA:hP4VP=5:1 and 3:3 have very high values of sorption degree what, in turn, point to high ionization degree of the initial polymers. Comparison of sorption degree shows that the intergel system have significantly higher sorption degree comparatively with individual hydrogels.

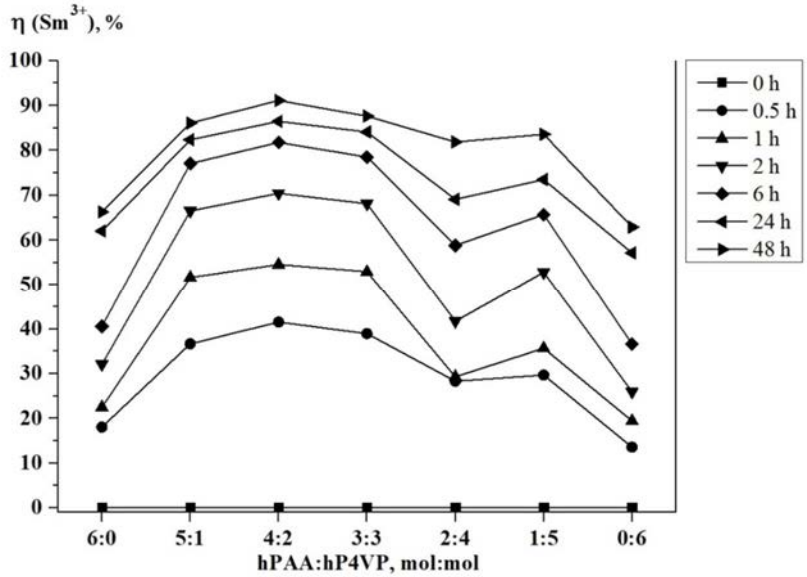

Fig. 5. Extraction degree (in relation to Sm^{3+} ions) of intergel system hPAA-hP4VP

Conclusions

1. **Mutual activation of polymer hydrogels in the intergel system hPAA-hP4VP provides significant changes of electrochemical, conformational and sorption properties of polymers.**
2. **Decrease of specific electric conductivity and pH with time point to sorption of samarium ions by the intergel system hPAA-hP4VP.**
3. **Swelling of both polymers (hPAA and hP4VP) firstly significantly increases due to mutual activation, after that there is decrease due to sorption of the rare-earth metal.**
4. **Individual hydrogels have not very high sorption degree of samarium ions. Extraction degree of hPAA and hP4VP is 66.3% and 62.9% respectively.**
5. **Maximum values of sorption degree is observed in the intergel system at hPAA:hP4VP=4:2 ratio, extraction degree is 91.1%.**

Acknowledgments

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