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Development of the composite materials based on N-(2-vinyloxyethyl)-N-(2-cyanoethyl) amine

Abstract: The novel cationic hydrogels based on N-isopropylacrylamide (NIPAAm) and N-(2-vinyloxyethyl)-N-(2-cyanoethyl) amine (VOECEA) were synthesized for the first time by radical copolymerization. The composition of copolymers were determined by using IR spectroscopy.

Key words: N-isopropylacrylamide, N-(2-vinyloxyethyl)-N-(2-cyanoethyl) amine, thermosensitive polymers, hydrophobic interactions , swellable copolymers thermosensitive, interpolymer complex (IPC).

Introduction

In recent years the main attention of researchers of the leading scientific centers is have interested so-called “clever” or “incentive – sensitive” the polymeric materials reacting to little changes of properties of environment (pH, temperatures, electric field, etc.).

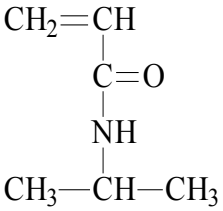
One of the most perspective in the scientific and practical relation versions incentive – sensitive materials are thermo sensitive polymers, which water solutions are characterized existence of the lower critical temperature of dissolution (LCTD) and experiencing phase transition at rather small variations temperatures [1]. Typically, such polymers are prepared using amphiphilic water-soluble monomers containing in their structure at the same time hydrophilic group and hydrophobic moieties such as, N-isopropylacrylamide, vinyl methyl ether or N-vinyl caprolactam [2].

The Kazakh National University. Al-Farabi was developed and successfully implemented other approach to the synthesis of new thermo sensitive polymers, based on radical copolymerization of hydrophilic and hydrophobic monomers.

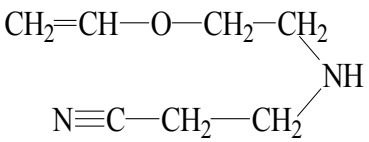
It opens the possibility to obtain soluble and cross linked polymers controlled over a wide range thermal sensitivity, perspective for use in different fields of electronics and biomedicine. This work in the actual field of research and dedicated to the creation and study of new polymers and linear mesh structures exhibiting a controlled sensitivity to changes in temperature and pH environments [3-5].

The purpose of work the obtaining composite materials of N-isopropylacrylamide and N-(2-vinyloxyethyl)-N-(2-cyanoethyl) amine, a study of their physico-chemical characteristics.

Experimental part



N-isopropylacrylamide



N-(2-vinyloxyethyl)-N-(2-cyanoethyl) amine

Synthesis of hydrogels

The syntheses of hydrogels of various compositions were performed by free radical crosslinking copolymerization at 60°C. Briefly, NiPAAm and VOECEA were dissolved in water. The concentration of the crosslinking agent, N, N-methylene-bis-akpilamid (MBAA), was 2.0 and 4.0 wt.% with respect to monomers. After being purged by the argon.

The reaction time depended on the concentration of the crosslinking agent, as well as on the NiPAAm/VOECEA comonomer weight ratio in the initial mixture and was in the range of 1 to 3 h. After the reaction was completed, the gels were cut into discs and immersed in water which was changed daily for a week, to remove unreacted reactants. The discs were dried at room temperature for a day and then at the temperature of 37°C to hydrogels (cm thick and cm in diameter). The samples were labeled as NiPAAm/VOECEA/MBAA 30/70/1, 50/50/1, 70/30/1.

Results and Discussion

FT-IR spectra of hydrogels with 1.0 wt.% of MBAA are presented in Figure 1. Figures show FT-IR spectra of homo- and copolymer hydrogels of different composition, both monomer content and crosslinking agent concentration.

The first three numbers in the sample labels correspond to the comonomer NiPAAm/VOECEA weight ratio, and the third one corresponds to the concentration of the crosslinking agent, MBAA.

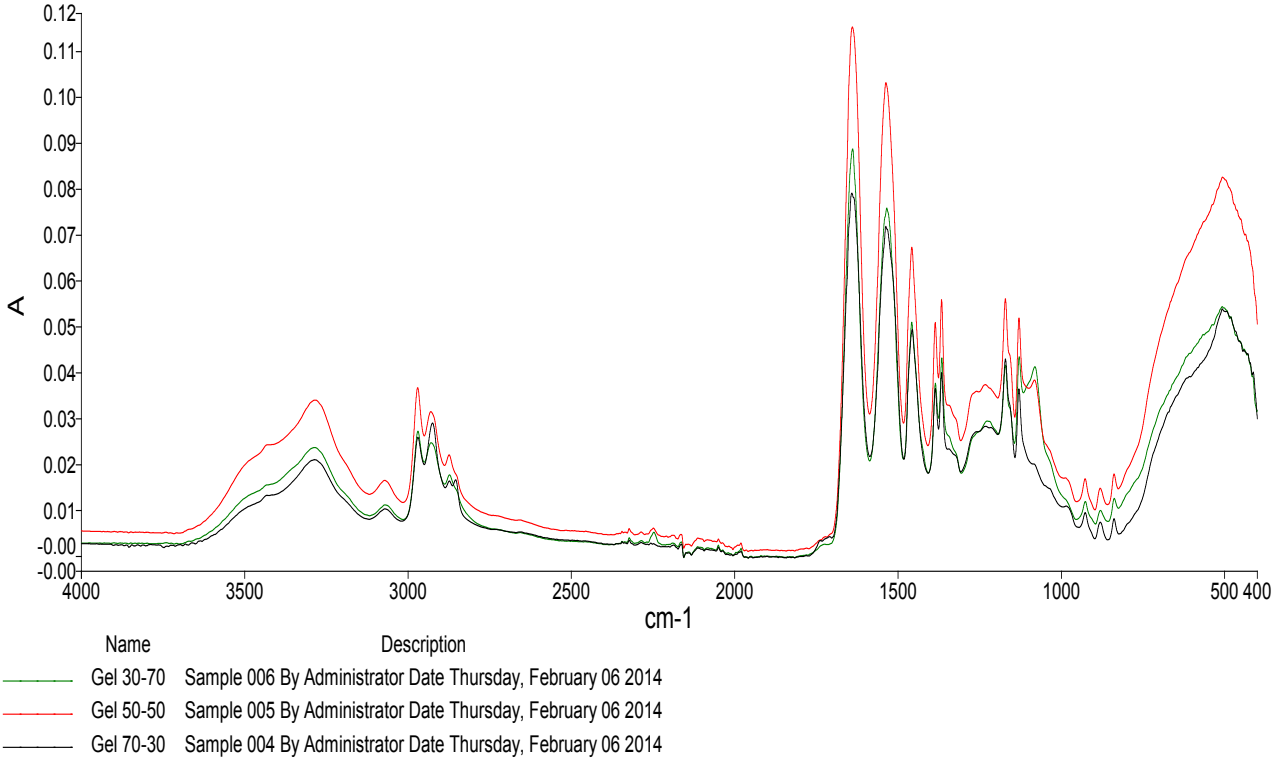
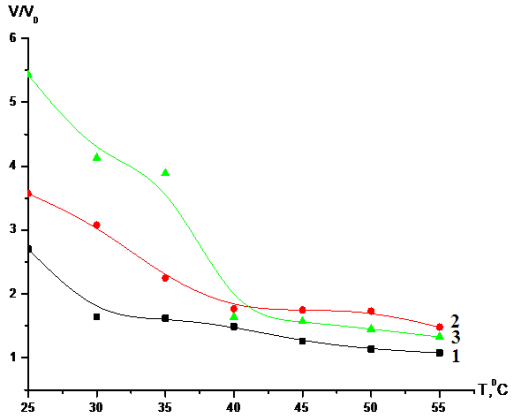


Figure 1 – FT-IR spectra of hydrogels: spectra of hydrogels with 1.0 wt.% of MBAA ((A)30/70/1; (B) 50/50/1; (C) 70/30/1;). The first two numbers in the sample labels correspond to the comonomer NiPAAm/VOECEA weight ratio, and the third one corresponds to the concentration of the crosslinking agent, MBAA

FT-IR spectra of hydrogels are similar. Each spectrum shows a wide band in the area of 3300–3100 cm−1 which corresponds to the C– O–C stretching vibration of carboxylic groups in VOECEA and N–H stretching vibration of NiPAAm. Stretching of C–H group from NiPAAm is also noticeable at 2976 cm−1. Peak at 1723 cm−1 originates from the vibration of the carbonyl group in N-(2-vinyloxyethyl)-N-(2-cyanoethyl) amine. Typical amide I band and amide II band of NiPAAm ap-

pear around 1650 cm−1 and 1540 cm−1, respectively. Two typical bands of C–H vibrations of nearly the same intensity at 1386 and 1379 cm−1 correspond to the stretching vibration of C–H bond of CH (CH3)2 groups. The band around 1174 cm−1 originates from the amide III band in P(NiPAAm). Band at 1207 cm−1 corresponds to C–O stretching of carboxylic groups in N-(2-vinyloxyethyl)-N-(2-cyanoethyl) amine. At 1400 cm−1 some C–O–H banding in plane is visible. Characteristic bands in the FT-IR spectra correspond to the absorption bands of hydrogels characteristic for homopolymers of poly(N-(2-vinyloxyethyl)-N-(2-cyanoethyl) amine) and poly(N-isopropylacrylamide) but are slightly shifted in relation to the wavenumbers of pure polymers because of the crosslinking reaction and the formation of the hydrogel polymer network.

We investigated swelling capacity of hydrogels in different environments of pH, as hydrogels on a basis [NIPAAM]: [VOECEA] of a positive charge.

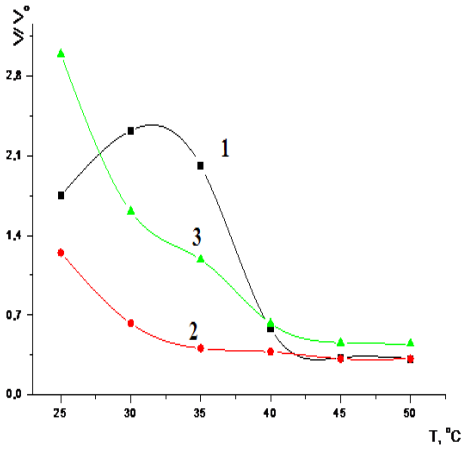


NiPAAm/VOECEA hydrogels with 1.0 wt.% of MBAA ((1)30/70/1; (2) 50/50/1; (3) 70/30/1;).

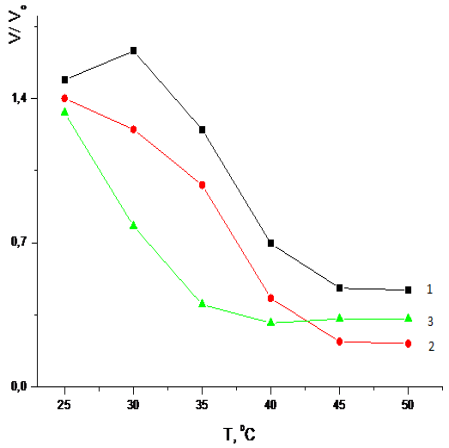
Figure 2 – Influence of the temperatures to hydrogels based on the NiPAAm/VOECEA.

Conclusion

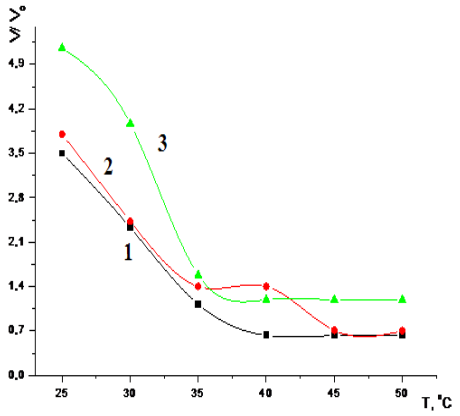
Thus, in this work has been synthesized cationic type hydrogels based on NIPAAM/VOECEA and has investigated physical and chemical properties of the new NIPAAM/VOECEA hydrogels. The syntheses of hydrogels of various compositions were performed by free radical crosslinking copolymerization and also has been investigated thermosensitivity of hydrogels. We have proved that, the above temperature the is lower swelling of copolymers.



(3)NiPAAm/VOECEA hydrogels with 1.0 wt.% of MBAA (30/70/1); pH = 4,0 (1); 7,0 (2); 9,0 (3); [CA] = 0,5%



(4)NiPAAm/VOECEA hydrogels with 1.0 wt.% of MBAA (50/50/1); pH = 4,0 (1); 7,0 (2); 9,0 (3); [CA] = 0,5%



(5)NiPAAm/VOECEA hydrogels with 1.0 wt.% of MBAA (70/30/1); pH = 4,0 (1); 7,0 (2); 9,0 (3); [CA] = 0,5%

Figure 3-5 – The behavior of hydrogels based on the NiPAAm/VOECEA depends on the temperatures in different environments of pH.

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