



MODIFICATION OF A NEW POLYMER COMPLEX BASED ON POVIDONE IODINE

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Abstract

In the article, the structure of sodium carboxymethylcellulose (NaKMTs) and povidone-iodine polymer complex aqueous solutions was studied using physicochemical research methods. By studying the physico-chemical properties of the obtained polymer complex, it was determined that our polymer complex has a high surface activity.

Keywords: sodium carboxymethylcellulose (NaKMTs), carboxymethylcellulose (KMTs), iodine complex of polyvinylpyrrolidone, surface-active substance (SAS), surface tension, PVJ-N-methylene.

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1. Introduction

Povidone-iodine is also used as an antiseptic for the treatment of diseases, fungi and viruses on the skin and mucous membranes. According to its chemical composition, it is a complex compound of iodine with polyvinylpyrrolidone. Compared to iodine alcohol solution, povidone-iodine has a longer effect. Because, in the new product, iodine atoms are sorbed to polyvinylpyrrolidone and form a povidone-iodine complex. When applied to burns and wounds, iodine enters the blood and binds to serum albumin, after which it is excreted by the kidneys. Polyvinylpyrrolidone is one of the most widely used excipients in the pharmaceutical industry. Among cellulose derivatives, sodium carboxymethylcellulose (NaKMTs) has a special place due to its good solubility in water, polyelectrolyte properties and the ability to enter into interpolymer (IPK) reactions, as well as the ability to form complexes through ion and ion-

coordination bonds with the formation of spatial networks. Sodium carboxymethylcellulose is non-toxic and inert to biological objects, which makes it used in medicine and pharmaceuticals as a binder and absorbable thread.

The interpolymer complex is a product formed by the interaction of two polyelectrolytes, which, due to a number of important, invaluable properties, occupy an important place in engineering, materials technology, medicine, pharmaceuticals and other fields of the national economy. The optical density (D) of aqueous solutions of components of NaKMTs and povidone-iodine mixtures in different proportions was measured. In the dependence graph of optical density of the solution on the PVJ/NaKMTs ratio, the greatest interaction between functional groups occurred at the upper point of the curve at the ratio of 1.5:1.0. It was shown that the increase in optical density depends on the concentration of NaKMTs and povidone-iodine in the critical concentration.

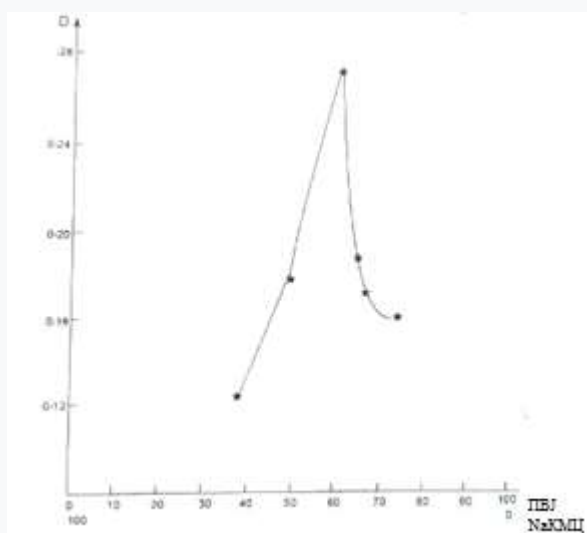


Figure 1. Plot of PVJ/NaKMTs ratio (D) versus optical density

It is known that during the formation of an interpolymer complex, the conformation of reacting macromolecules changes, and depending on the composition of the mixture, the optical density curves pass through the maximum, and the viscosity,

electrical conductivity, and potentiometric titration curves pass through the minimum. A sharp decrease in electrical conductivity (χ) and pH value of the solution medium was observed at the PVJ/NaKMTs ratio of

1.5:1.0, which indicated strong intermolecular interactions (Figures 2-3).

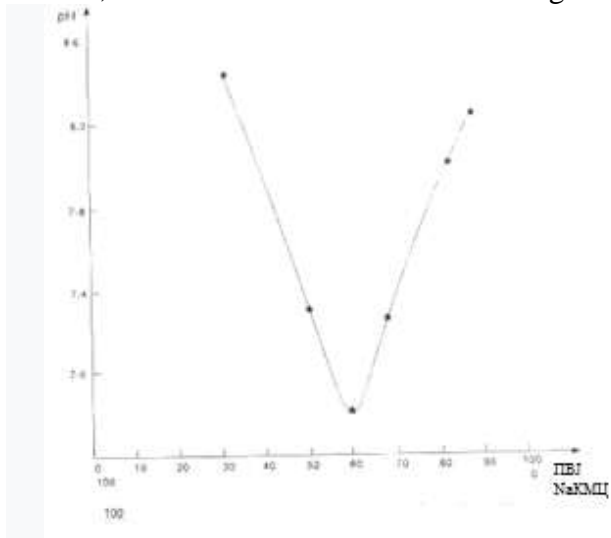


Figure 2. PVJ/NaKMTs ratio
Graph of dependence on pH

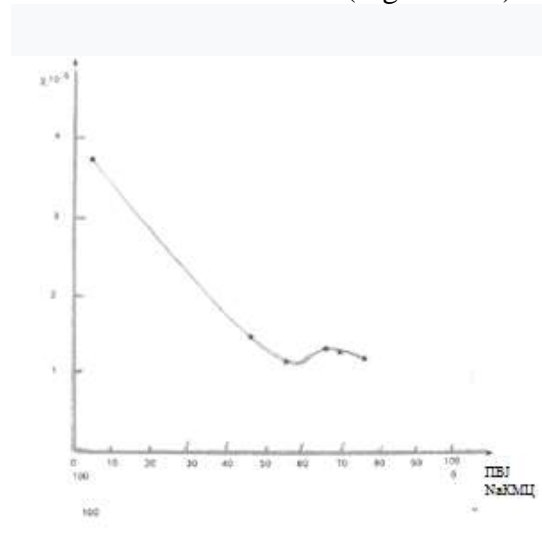


Figure 3. Graph of dependence of
PVJ/NaKMTs ratio on electrical conductivity
(ch).

The surface tension of aqueous solutions of the components of PVC/NaKMTs mixtures in different ratios, their adsorption capacity and surface activity were determined using a stologmometer. It can be seen from the pictures 4-5 that as the concentration of PVJ/NaKMTs

solution increases, the surface tension decreases. This caused the PVC to further reduce the surface tension of water. This is because it can be seen that the addition of NaKMTs further increased its surface activity.

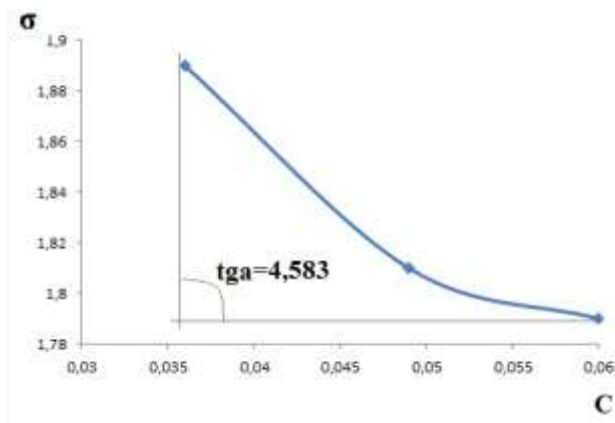


Figure 3. Surface tension graph of
PVJ/NaKMTs as a function of concentration

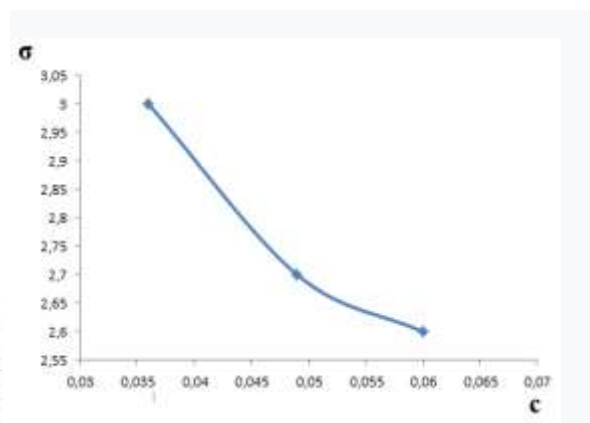


Figure 4. Graph of surface tension of PVC
aqueous solution as a function of
concentration

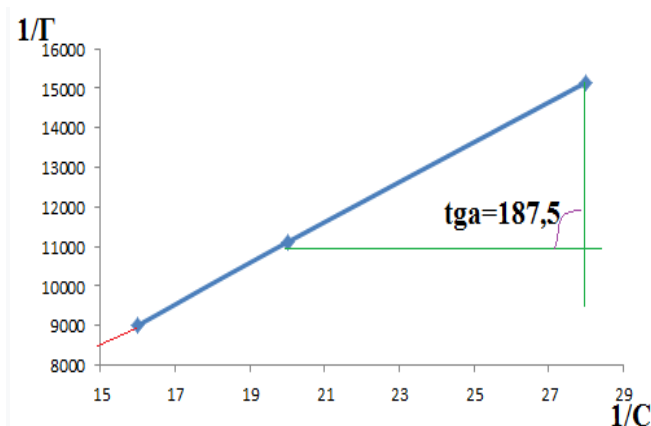


Figure 5. in the Langmuir equation isotherm determination graph

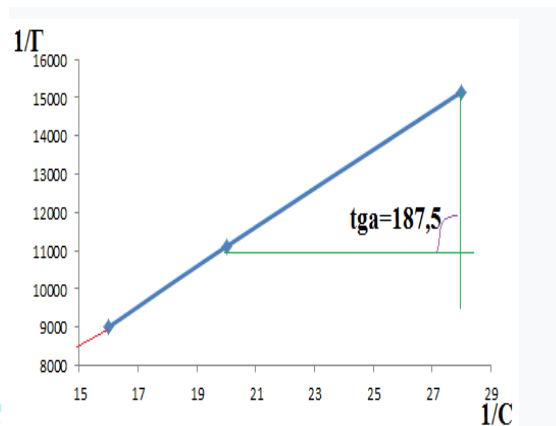


Figure 6. A graph for determining the micelle formation critical concentration (MICC).

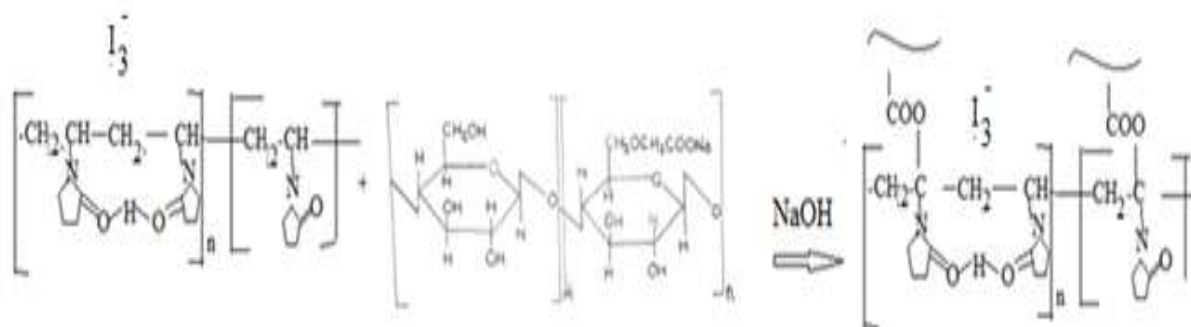
Table 1 Polymer complex adsorption isotherms

| PVC/NaKMTs % | C_m | n_0 (H ₂ O) | n | σ | $d\sigma/dc$ | G | $1/\Gamma$ | $1/C$ | G_∞ | K | MIC C |
|--------------|-------|--------------------------|-----|----------|--------------|---------------------|------------|-------|---------------------|------|-------|
| 0,5 | 0,06 | 78 | 49 | 1,78 | 4,58 | $1,1 \cdot 10^{-4}$ | 9009 | 16,6 | $1,2 \cdot 10^{-4}$ | 0,02 | 0,05 |
| 0,4 | 0,05 | | 47 | 1,81 | | $0,9 \cdot 10^{-4}$ | 11111 | 20,4 | | | |
| 0,3 | 0,04 | | 44 | 1,89 | | $0,6 \cdot 10^{-4}$ | 15152 | 27,7 | | | |

The diagrams above show the relationship between concentration and surface tension and adsorption in different solutions of PVC/NaKMTs. It can be seen that the ability to reduce the surface tension increases with the increase of the $-\text{CH}_2-$ group in NaKMTs. At the same time, adsorption is also increasing.

Based on the above diagrams, the size of the SAM molecule in the saturated adsorption layer was determined. The

saturated adsorption G is equal to the amount of SAS per unit surface area (m_2), so multiplying the saturated adsorption times the Avagadro number gives $G_\infty N$ the number of molecules per unit surface area. Using this, the level occupied by one molecule was found. The chemical transformation of the PVC/NaKMTs polymer complex can be seen in the following scheme:



The structure of the obtained polymer complex was proved by IR-spectroscopy. IR spectra of starting materials and final reaction products were recorded in order to determine the structure of polymer compounds containing functional groups of different nature and to determine the binding centers in polymer complex compounds.

In the Na-KMTs spectrum, there is an intense absorption region associated with the antisymmetric stretching vibrations of the C=O bond of the carboxyl ion in the

mid-frequency region of 1636 cm⁻¹ in the IR spectrum. C-O-C stretching vibrations occur in the range 1064-1137 cm⁻¹ with a line of average intensity at 1427 cm⁻¹, which shows characteristic vibrations of the CH₂-O-C group. A strong line with stretching vibrations of the hydroxyl group is observed in the spectrum at a long wavelength of 3256 cm⁻¹. The extended vibrations of the methylene group (S-N) of the ring are observed as a group of bands centered at 2006, 2115, 2301 cm⁻¹. (Figure 1).

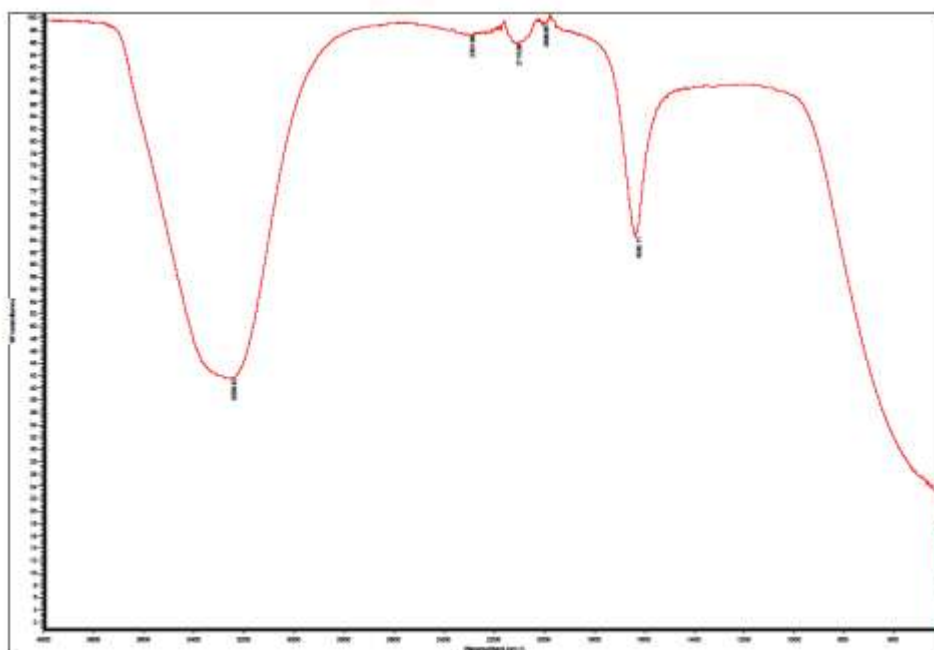


Figure 1. IR spectrum of Na-KMTs

In the mid-frequency region of 1636 cm⁻¹ in the PVJ spectrum, there is an intense absorption region associated with the antisymmetric stretching vibrations of the C=O bond of the carboxyl ion in the IR spectrum. The symmetric stretching vibrations of this group appeared as a broad band of average intensity at 1294 cm⁻¹. A strong line with stretching vibrations of the hydroxyl group was observed in the spectra in the long-wavelength range of 3250 cm⁻¹. Extended vibrations of the methylene group (S-N) of the ring were observed as a group of bands

centered at 2006, 2116, 2300 cm⁻¹. (Figure 2).

The IR spectrum of the VJ/Na-KMTs complex differed from the IR spectrum of the initial compounds. The structure of the IR spectrum of the PVJ/Na-KMTs complex and the IR spectrum of the starting compounds showed a significant increase up to 1636 cm⁻¹. Here, COO-bonds, NN₂, C-N absorption areas also underwent significant changes, in the case of COO-, the wavelength shifted by ~ 23 cm⁻¹, and in the same area, C=O bonds were observed to shift to 1711 cm⁻¹. Symmetrical vibrations of $\nu_s(\text{NH}_2)$ -group

povidone iodine appeared at 3250 cm^{-1} for $\nu_s(\text{NH}_2)$, respectively. The deformation vibrations of this group (NH_2) were recorded in the short-wave region at 1636 cm^{-1} with a shift relative to the position in the IR spectrum of free povidone iodine. showed that there are chemical changes due to the interaction between the COO

group of Na-KMTs and the CH_2 group of PVJ. It also indicated a shift of the band of stretching vibrations of the C-H bond in povidone-iodine. In the IR spectrum of the complex, the positions of the domains of other functional groups have undergone significant changes.

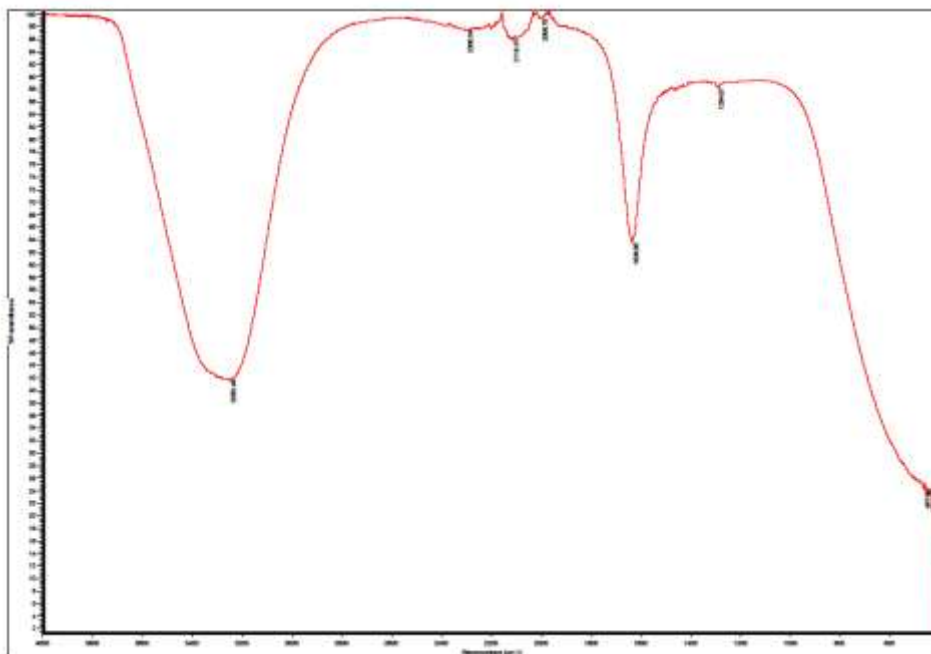


Figure 2. PVC IR spectrumII

The presence of intermolecular hydrogen bonds between functional groups was

shown by Na-KMTs 2006, 2115, 2301 cm^{-1} and povidone-iodine at 2000, 2116, 2300 cm^{-1} . (Figure 3)

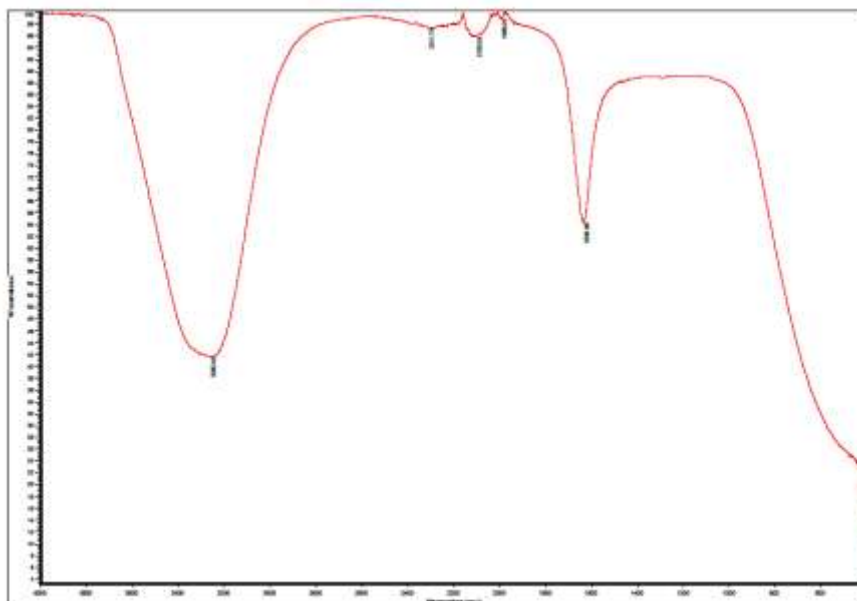


Figure 3. IR spectrum of PVJ/Na-KMTs complex

2. Conclusion

Thus, it was found that two polyelectrolytes Na-KMTs carboxylate anions and the interaction of the methylene group in povidone-iodine with a mobile hydrogen atom lead to chemical changes, and PVJ-N-methylene KMTs polycomplexes are formed in aqueous solutions.

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