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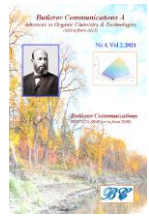

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Rheological behavior of cryogels based on polyelectrolyte complexes of carbixmethylcellulose with poly-*N,N*-diallyl-*N,N*-dimethylammonium chloride

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Keywords: sodium salt of carboxymethyl cellulose, poly-*N,N*-diallyl-*N,N*-dimethylammonium chloride, cryogels, accumulation modulus, loss modulus, highest Newtonian viscosity.

Abstract

The article is devoted to the study of the rheological parameters of cryogels based on polyelectrolyte complexes of carbixmethylcellulose with poly-*N,N*-diallyl-*N,N*-dimethylammonium chloride with different initial concentrations of polyelectrolytes. Analysis of the viscosity curves of cryogels based on individual carbixmethylcellulose and complexes with different molar ratios showed that all gels exhibit non-Newtonian flow behavior, which is characteristic of pseudoplastic liquids with weak intermolecular interactions. The greatest effect of cryostructuring, which is expressed in a significant increase in viscosity, is observed for a gel with a concentration of initial components of 0.5% and a molar ratio of 0.2, upon freezing for 2 days. It was found that for a number of the studied polymer systems, the yield point is reached, which indicates the formation of a three-dimensional network of physical bonds of macromolecules. From the analysis of the frequency dependences of the rheological parameters of the complex viscosity ή*, the storage modulus G' and the loss modulus G" for cryogels based on podielectrolyte complexes, it follows that the structure of the formed cryogels is a weakly crosslinked network of physical bonds, despite the fact that be a strong electrostatic interaction. For cryogels based on carbixmethylcellulose, the storage modulus becomes larger than the loss modulus, i.e. cryogels begin to behave like elastic-viscous bodies at an oscillation frequency of more than 1 Hz, and for cryogels based on complexes – at an oscillation frequency of less than 1 Hz. Mechanically stable cryogels were obtained on the basis of podielectrolyte complexes of carbixmethylcellulose with poly-*N,N*-diallyl-*N,N*-

dimethylammonium chloride at small molar ratios of the starting components, which can be recommended for biomedical applications.

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References

[1] V.A. Kabanov. Polyelectrolyte complexes in solution and in bulk. *Russian Chemical Reviews*. **2005**. Vol.74. No.1. P.3-20. DOI: 10.1070/RC2005v074n01ABEH001165

[2] B.D. Emmanuel, N.Y. Abu-Thabit, N.C. Ngwuluka. Responsive polyelectrolyte complexes based on natural polysaccharides for drug delivery application. *Stimuli Responsive Polymeric Nanocarriers for Drug Delivery Applications*. **2018**. Vol.1. P.267-287. DOI: https://doi.org/10.1016/B978-0-08-101997-9.00014-X.

[3] E.V. Vorob'eva, N.P. Krut'ko. Polymer complexes in water and salt environments. *Minsk: Belarusian Science*. **2010**. 175p.

[4] E. Maretti, B. Pavan, C. Rustichelli, M. Montanari, A. Dalpiaz, V. Iannuccelli, E. Leo. Chitosan/Heparin Polyelectrolyte Complexes as ion-paring approach to encapsulate Heparin in orally administrable SLN: in vitro evaluation. *Colloids and Surfaces A: Physicochemical and Engineering Aspects.* **2021**. Vol.608. DOI: https://doi.org/10.1016/j.colsurfa.2020.125606

[5] S. Maiti, S. Jana, B. Laha. Cationic polyelectrolyte–biopolymer complex hydrogel particles for drug delivery. *Design and Development of New Nanocarriers*. **2018**. P.223-256. DOI:10.1016/b978-0-12-813627-0.00006-5

[6] M.M. Davoodi, S.M. Sapuan, D. Ahmad, A. Aidy, A. Khalina, M. Jonoobi. Concept selection of car bumper beam with developed hybrid bio-composite material. *Mater. Design*. **2011**. Vol.32. No.10. P.4857-4865.

[7] M.V. Bazunova, R.A. Mustakimov, N.V. Dmitrieva, D.R. Dayanova, and A.A. Bazunov. Study of the physical and chemical properties of materials based on polymer complexes of some water-soluble polymers. *Butlerov Communications*. **2020**. Vol.62. No.5. P.91-96. DOI: 10.37952/ROI-jbc-01/20-62-5-91 (Russian)

[8] J.L. Xian Latest Advances in Antibacterial Materials. *Journal of Molecular and Engineering Materials*. **2017**. Vol.5. No.1. P.1740001. DOI: https://doi.org/10.1142/S2251237317400019

[9] V.I. Lozinsky. Cryogels on the basis of natural and synthetic polymers: preparation, properties and areas of implementation. *Russ. Chem. Rev*. **2002**. Vol.71. No.163. P.489-511.

[10] F.M. Plieva, A. Oknianska, E. Degerman, I.Y. Galaev, B. Mattiasson. Biocompatible polysaccharide-based cryogels. *Biomater. Sci., Polym. Ed.* **2006**. Vol.17. P.1075.

[11] P. Arvidsson, F.M. Plieva, V.I. Lozinsky, I.Y. Galaev, B. Mattiasson, Direct chromatographic capture of enzyme from crude homogenate using immobilized metal affinity chromatography on a continuous supermacroporous adsorbent. *J. Chromatogr. A*. **2003**. Vol.986. P.275.

[12] E.R. Bakirova, M.V. Bazunova, A.A. Bazunov, R.A. Mustakimov. Study of the formation conditions and properties of polyelectrolyte complexes based on carboxymethylcellulose and polydiallyldimethylammonium chloride. *Bulletin of the Technological University*. **2019**. Vol.22. No.9. P.41-45. (Russian)

[13] R.Y. Lazdin, V.V. Chernova, M.V. Bazunova, V.P. Zakharov, E.I. Kulish. Possibility of producing semisolid dosage forms based on aqueous solutions of chitosan succinamide in the presence of modification additives. *Russian Journal of Applied Chemistry*. **2020**. Vol.93. No.1. P.65-71. DOI: 10.1134/S1070427220010073

[14] M.S. Lisanevich, and R.Yu. Galimzyanova. Study of the effect of radiation sterilization on the properties of polypropylene for injection molded medical products. *Butlerov Communications*. **2020**. Vol.64. No.11. P.149-153. DOI: 10.37952/ROI-jbc-01/20-64-11-149. (Russian)
[15] M.V. Bazunova, A.S. Shurshina, R.Y. Lazdin, E.I. Kulish. Tixotropic properties of solutions of some polysaccharides. *Russian Journal of Physical Chemistry B.* **2020**. Vol.14. No.4. P.685-690. DOI: 10.1134/S199079312004003X
[16] Marina V. Bazunova, Anna Yu. Silantyeva, Robert A. Mustakimov. Rheological behavior of cryogels based on polyelectrolyte complexes of carbixmethylcellulose with poly-N,N-diallyl-N,N-dimethylammonium chloride. *Butlerov Communications.* **2021**. Vol.68. No.10. P.89-97. DOI: 10.37952/ROI-jbc-01/21-68-10-89 (Russian)