

Brief information about the project

Name of the project	Development of fundamental and applied aspects of macromolecular design, function and practical applications of polyfunctional polymers with adjustable diphilic macrostructure
Relevance	One of the most priority scientific directions developed in recent years at the interface of chemistry and physics of polymers, medicine, biology and electronics is macromolecular design and functioning of so-called "smart" or stimulus-sensitive polymers capable of responding to minor changes in environmental parameters in a pre-programmed way. In this case, of special scientific and practical interest are thermosensitive polymers, aqueous solutions of which have a lower critical dissolution temperature due to the difilicity of their macrostructure. Such polymers have a pronounced surface activity, which makes them promising for use as highly effective foaming agents, emulsifiers, flocculants, solubilizers of physiologically active substances. In addition, organosoluble diphilic polymers of grafted type based on ethylene vinyl acetate copolymers can be used with high efficiency as depressor additives to regulate the rheological parameters of oil.
Purpose	Development of scientific bases of creation, functioning and practical application of polyfunctional polymers with adjustable amphiphilic macrostructure, possessing pronounced surface activity for use as highly effective foaming agents, emulsifiers, flocculants, solubilizers of physiologically active substances (PAS), depressor additives for oil, etc. The development of polyfunctional polymers with adjustable amphiphilic macrostructure, possessing pronounced surface activity.
Objectives	1. Study of the basic regularities of formation of water-soluble thermosensitive polymers with adjustable difilicity and establishment of features of their stimulus-sensitive behavior. 2. Development of the methodology for obtaining modified amphiphilic polymeric depressor additives (DA) by grafted radical copolymerization on the basis of ethylene vinyl acetate copolymers (EVA) to regulate the structural and rheological parameters of oil. 3. Study of complexation reactions of amphiphilic polymers in aqueous solutions with surface active substances (surfactants) and polyacrylic acid, study of physical and chemical properties of the formed polycomplexes. 4. Development and mastering of technological regulations for production of modified depressor additives by graft copolymerization using commercially available EVA-based depressor additives, development of prototypes and their transfer for testing. 5. Investigation of the efficiency of application of the obtained prototypes of new DA modified by EVA graft copolymerization for regulation of structural and rheological properties of oil, development of recommendations for practical use. 6. Investigation of the efficiency of using the obtained diphilic stimulus-sensitive polymers and their polycomplexes in the processes of foaming, emulsification, as well as solubilization of PAS, development of recommendations for practical use.
Expected and achieved results	Expected results: The project will develop fundamental and applied aspects of macromolecular design, function and application of

	thermosensitive polymers with adjustable structure difficulty in accordance with the project objective. At the same time, a wide range of thermosensitive polymers promising for use as highly effective foaming agents, emulsifiers, flocculants, solubilizers of physiologically active substances will be created. Besides, the essential expected result of the present project realization consists in development of scientific and applied bases of creation and application of modified polymeric depressor additives (DA) on the basis of grafted copolymers of ethylene vinyl acetate for use in technology of regulation of structural and rheological parameters of oil. At the same time, new highly effective DAs will be created, the use of which will significantly reduce energy costs for heating of pipelines that provide oil transportation in conditions of low temperatures. Achieved results: The formation patterns of thermoresponsive water-soluble polymers and their temperature-dependent behavior have been established. A method for obtaining modified depressant additives based on EVA has been developed and optimized. The mechanisms of complex formation between amphiphilic polymers, surfactants, and polyacrylic acid, along with their physicochemical properties, have been identified. The obtained results are confirmed by a publication in a high-ranking international journal (Q1).
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Usage	The results of the research on macromolecular design and functioning of polyfunctional polymers with regulated macrostructure difficulty can be used by researchers and specialists in the field of polymerization processes (target consumers are universities and research centers). The target consumers of EVA-based DAs modified by graft copolymerization are oil producing companies and organizations. Practical significance of the expected results of the project and the possibility of further commercialization are due to the fact that within the framework of its implementation will be developed highly efficient DAs, the use of which will significantly reduce energy costs for heating pipelines that provide oil transportation in low temperatures. RauanNTech LLP, which is the largest Kazakhstan producer of chemical reagents for oil and gas industry, is interested in commercialization of the project results.
Priority compared to real-world alternatives	Scientific novelty of the project, first of all, is conditioned by the fact that within the framework of its realization it is planned to obtain a number of new thermosensitive polymers with adjustable diphilic macrostructure. Such polymers due to their diphilicity, caused by the presence of hydrophobic and hydrophilic fragments in their macrostructure, have a pronounced surface activity, which determines the efficiency of their possible practical use as highly effective foaming agents, emulsifiers, flocculants, solubilizers of physiologically active substances and so on. Scientific novelty of the project is also conditioned by the fact that at its realization for the first time modification of commercially available EVA copolymers by graft copolymerization method will be carried out by means of substance initiation to increase the efficiency of their use as depressor additives for oils of different origin. Previously, this process was realized by radiation initiation. For the obtained new grafted EVA copolymers, high efficiency of their use as DAs was established. However, radiation initiation requires the use of special high-energy sources (linear electron gas pedal or gamma machine), which can significantly complicate the production technology of the target product and increase its cost. In this regard, it was decided to carry out graft copolymerization of monomers of different types on EVA using peroxide initiators for the first time within the framework of the present project.
List of publications with links to them	Dergunov S.A., Mun G.A., Yermukhambetova B.B., Alikulov A.Zh. Molecular and Structural Insights into the Thermoresponsive Behavior of Pyrrolidone-Based LCST Polymers in Aqueous Solution // European Polymer J. 240 (2025) 114343, Web of Science (Q1, IF=6,3); Percentile 86(Scopus). https://doi.org/10.1016/j.eurpolymj.2025.114343
Patents	-