Brief information about the project

Name of the project	AP19679741 «Application of information technologies in bioenergy for 3D modeling of biofuel combustion».
Relevance	The global energy crisis, which has engulfed the oil, gas and coal industries, is directly related to the growth of the world's population, the intensive development of technology and the growing level of energy consumption. Rising prices for traditional fuels and environmental requirements for environmental protection require a transition to alternative energy and the search for biofuels from renewable resources. The project focuses on the use of information technology for research on liquid biofuel combustion in the internal combustion engines. The obtained results are of practical importance, as they relate to the transition to new energy and to the increase of combustion efficiency of alternative fuels obtained from biological waste.
Purpose	Application of information technologies and new CFD modeling software packages to research the combustion of liquid fuels (traditional petroleum diesel and biodiesel) in internal combustion engines and to determine the optimal parameters of the efficient combustion process that reduce emissions of harmful substances into the atmosphere.
Objectives	To achieve the aim, the following main objectives will be solved: 1. An analysis of foreign studies on the development of alternative energy sources that can ensure the energy and environmental security of the planet will be carried out and prospects for the rational use of biofuels will be indicated. 2. An analysis of the technological process of fuel combustion in internal combustion engines (ICE) will be carried out. Taking into account the geometry and dimensions of the real combustion chamber, the location of nozzles and fuel injection systems, its geometric 3D CFD model will be developed to reproduce the combustion process of traditional petroleum diesel and biodiesel under various operating conditions and liquid fuel injection methods. 3. A physical and mathematical model of the process of burning liquid fuels will be developed. This model consists of the laws of conservation of mass, momentum, energy and concentration of fuel components and products of its combustion. The model also considers the non-isothermal, multi-phase and turbulence of the medium, multi-stage and the optimal number of global chemical reactions of fuel and oxidizer interaction and the formation of harmful substances. Moreover, modern models of injection, disintegration, dispersion, evaporation of liquid fuel droplets and tracking their trajectories in the space of the internal combustion engine chamber will be applied. 4. The CFD modeling software package will be optimized for conducting computational experiments to study the combustion processes of various types of liquid fuels in internal combustion engines.

	5. Computational experiments will be performed on the combustion of traditional petroleum diesel and biodiesel in internal combustion chambers. The influence of the initial conditions of the process (initial temperature of the oxidizer, pressure, mass and velocity of injected liquid drops) on the height of the temperature plume, on the distribution of temperature and concentration of carbon oxides in the combustion chamber will be shown. 6. A computer software package will be developed for highly informative volumetric visualization of the obtained data and 3D graphical interpretation of the results of the research, with the help of which one can obtain: - graphs of the dependence of the height of the temperature flame, temperature and concentration of carbon oxides on the initial temperature of the oxidizer, pressure, mass and injection rate of liquid fuels; - 3D images of temperature fields, concentrations of carbon oxides and dispersion of liquid fuel droplets by temperature and by radius throughout the entire volume of the internal combustion engine chamber. The obtained results will be compared with the experimental data available in the literature. 7. The optimal parameters of the process of efficient combustion of traditional petroleum diesel and biodiesel will be determined, ensuring the minimization of emissions of harmful substances into the atmosphere. General recommendations will be proposed for the optimal organization of the process of burning liquid fuels in internal combustion engines.
Expected and achieved results	- A physical and mathematical model of the combustion of liquid fuels will be developed, taking into account the non-isothermal, multi-phase and turbulence of the medium, the multi-stage chemical reactions of the interaction of fuel and oxidizer and the formation of harmful substances, the model will use models of injection, decay, dispersion, evaporation of fuel droplets and tracking their trajectories in the chamber ICE; - A geometric 3D computer model of a real ICE chamber will be developed to reproduce the process of liquid fuel combustion; - Computational experiments will be carried out on the combustion of traditional petroleum diesel and biodiesel in internal combustion chambers; the influence of the initial conditions of the process (initial temperature of the oxidizer, pressure, mass and velocity of injected liquid drops) on the height of the temperature flame, on the distribution of temperature and concentration of carbon oxides in the combustion chamber will be shown; - A software package will be developed for highly informative volumetric visualization of the obtained data and 3D graphical interpretation of the research results; - The obtained results will be compared with the experimental data available in the literature; the optimal parameters of the process of efficient combustion of traditional petroleum diesel and biodiesel

	will be determined, ensuring the minimization of emissions of harmful substances into the atmosphere. The results are of theoretical and practical significance, contribute to a deep understanding of the complex physical and technological processes occurring in internal combustion chambers, which makes it possible to provide important recommendations for their design.
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List of publications with links to them	1. S. Bolegenova, A. Askarova, Sh. Ospanova, N. Pilipenko, Zh. Shortanbayeva, A. Aldiyarova Simulation of atomization and ignition of high-pressure jet stream // Recent Contributions to Physics. -2023. – No. 3, Vol. 86. – P. 67-76.
Patents	-