Brief information about the project

Title	ИРН AP23489431 «Parallel physics-informed neural networks for solving oil displacement problems» (0124PK00389)
Relevance	The oil industry is one of the most important sectors of the global economy, where efficient oil extraction plays a crucial role in meeting the energy needs of society. However, the process of oil recovery is often accompanied by complex physical phenomena, such as multiphase fluid flow in porous media, where accounting for the influence of certain parameters during numerical simulation on computational grids can be challenging. In this context, Physics-Informed Neural Networks (PINNs) represent universal approximators that are used for modeling complex physical phenomena. This approach offers a more flexible and accurate alternative for simulating intricate physical processes, which can significantly enhance the efficiency and accuracy of problem-solving in the oil and gas industry.
Goal	The goal of this project is to develop parallel Physics-Informed Neural Networks for solving oil displacement problems in various spatial settings (1D, 2D, and 3D).
Tasks	- Review and analyze the use of PINNs and parallel PINNs for solving partial differential equations (PDEs). - Develop algorithms for solving two-phase flow problems based on the Buckley–Leverett model in 1D, 2D, and 3D using PINNs. - Develop parallel PINNs for solving two-phase flow problems based on the Buckley–Leverett model in 1D, 2D, and 3D.
Expected and Achieved Results	Within the framework of this project, algorithms will be developed to solve two-phase flow problems based on the Buckley–Leverett model in 1D, 2D, and 3D using PINNs. The following tasks will be completed: 1) A review and analysis of the application of PINNs for solving partial differential equations will be conducted. 2) A review and analysis of the application of parallel PINNs for solving partial differential equations will be carried out. In particular, MPI technology and distributed computing on graphics processing units (GPUs) will be considered. 3) Algorithms will be developed for solving 1D, 2D, and 3D two-phase flow problems based on the Buckley–Leverett model using PINNs. 4) Parallel PINNs will be developed for solving 1D, 2D, and 3D two-phase flow problems based on the Buckley–Leverett model. 5) The developed PINN models will be tested on 1D, 2D, and 3D problems.

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Publications list with links to them	S. D. Bekele, Y. Kenzhebek and T. Imankulov, "On the Effectiveness of Kolmogorov—Arnold Networks for Enhanced Oil Recovery Prediction in Polymer Flooding," 2024 7th International Conference on Algorithms, Computing and Artificial Intelligence (ACAI), Guangzhou, China, 2024, pp. 1-6, doi: 10.1109/ACAI63924.2024.10899678.
Patent information	