SCIENTIFIC AND ORGANIZATIONAL REPORT

of the Fluid Mechanics Department
for 2025

Topic: Development of theoretical and applied foundations of unsteady non-equilibrium processes during the joint flow of heterogeneous systems.

During the reporting period, in accordance with the thematic research plan, the following work was carried out:

1. Investigation of the influence of capillary forces on phase equilibria in porous media.
2. Investigation of the influence of liquid composition on phase transformations and flow processes in porous media. Mechanisms of dissolution of gas mixtures in fluids.
3. Development of theoretical and practical foundations for increasing the efficiency of flow and filtration processes through the dissolution of gases in liquid fluids.

During 2025, the following scientific works were published (3 journal articles, 2 conference proceedings, and 5 conference abstracts), and 3 articles were submitted to journals included in the Scopus Q1 and Q2 quartiles:

1. Yindi Zhang, Shadrack Adjei Takyi, Zhengqin Sheng, Lei Zhenhua, Weiwei Han, Paitoon Tontiwachwuthikuld, Geylani Panahov. Innovative techno-economic optimization and evaluation of carbon dioxide capture: A novel approach to energy efficiency and cost reduction // *Energy Conversion and Management*, Volume 348, Part B, 2026, 120695. (Q1, Scopus, Web of Science).

2. Panahov G., Abbasov E., Agayeva G., Mamedov I. (2024). Control of the capillary instability process during hydrodynamic impact on the reservoir // *ANAS Transactions*, Mechanics Series, Physical-Technical and Mathematical Sciences, Vol. 44, No. 8, pp. 37–57.

3. Bakhtiyarov S., Bakhtizin R., Yuzbashiyeva A. (2024). Solution of some inverse kinetic problems of complex chemical reactions // *ANAS Transactions*, Mechanics Series, Physical-Technical and Mathematical Sciences, Vol. 44, No. 8, pp. 3–6.

4. Panahov G. M., Abbasov E. M., Salmanova G. M. Pulsating flow of a thixotropic fluid in a circular pipe // Proceedings of the International Conference within the framework of scientific and educational cooperation between China and Russia “One Belt, One Road” *International Cooperation in Science and Technology: A Look into the Future*, Hainan, November 5–10, 2024, pp. 8–10.

5. Panahov G. M., Abbasov E. M., Museibli P. T., Kazimova A. Kh. Flow control of fluids in porous media taking into account electrokinetic effects // Proceedings of the International Conference within the framework of scientific and educational cooperation

between China and Russia “One Belt, One Road” *International Cooperation in Science and Technology: A Look into the Future*, Hainan, November 5–10, 2024, pp. 23–25.

6. Abbasov E. M. Technology of suffosion treatment of the near-wellbore zone of an oil reservoir // *New Ideas in Earth Sciences*: in 9 volumes. Proceedings of the XVII International Scientific and Practical Conference. Moscow: MGRI, Vol. 4, 2025, pp. 141–144 (online).

7. Panahov G. M., Museibli P. T., Balakchi V. D. Regulation of reservoir sweep efficiency by displacement using physicochemical methods // *New Ideas in Earth Sciences*: in 9 volumes. Proceedings of the XVII International Scientific and Practical Conference. Moscow: MGRI, Vol. 4, 2025, pp. 144–148 (online).

8. Geylani M. Panahov, Parviz T. Museibli, Aynur Kh. Kazimova. Model basis of electrokinetic processes in complex heterogeneous systems // Proceedings of the International Conference *Modern Problems of Mathematics and Mechanics*, Baku, September 3–6, 2025, p. 256.

9. Geylani M. Panahov, Gulnar M. Salmanova, Gulshan R. Agayeva. Investigation of the influence of periodic pressure gradient on the displacement process in pipes using viscoelastic systems // Proceedings of the International Conference *Modern Problems of Mathematics and Mechanics*, Baku, September 3–6, 2025, p. 259.

10. Eldar M. Abbasov, Afet O. Yuzbashiyeva, Ibrahim J. Mamedov. Heat distribution resulting from gas generation in porous media // Proceedings of the International Conference *Modern Problems of Mathematics and Mechanics*, Baku, September 3–6, 2025, p. 236.

11. Geylani M. Panahov, Ramil N. Bakhtizin, Eldar M. Abbasov, Gulnar M. Salmanova. Unsteady flow of thixotropic oil in circular tubes // *Journal of Engineering Mathematics*, 2025.

12. Geylani M. Panahov, Eldar M. Abbasov, Parviz T. Museibli, Ibrahim J. Mamedov, Yindi Zhang. Improvement of conformance control by periodic formation of blocking precipitates generated via in situ gas-generation reactions // *Surface and Interfaces Journal*, 2025.

13. G. M. Panakhov, S. I. Bakhtiyarov, D. A. Siginer, E. M. Abbasov, V. H. Guseynov. Hydrodynamic features of two-phase oil–gas flow in pipelines // *International Journal of Engineering Sciences*, 2025.

In 2025, Issue No. 7 of Volume 45 of the *ANAS Transactions* journal (Mechanics Series) was published; Issue No. 8 is being prepared for publication.

Corresponding Member of the National Academy of Sciences of Azerbaijan, Professor Geylani Panahov, and Doctor of Philosophy in Engineering Eldar Abbasov were on a scientific mission from May 20 to May 25, 2025, at the Gazpromneft Scientific and Technical Center (St. Petersburg) at the invitation of Corresponding Member of the Russian Academy of Natural Sciences, Professor, Doctor of Technical Sciences Mars Hasanov.

During the visit, possibilities for applying new methods and technologies developed in the Department of Fluid and Gas Mechanics, as well as issues of enhanced oil recovery at fields in Azerbaijan and Russia, were discussed.

Fig. 1 and 2. Scientific seminar at the Gazpromneft Scientific and Technical Center, St. Petersburg, Russian Federation

Corresponding Member of the National Academy of Sciences of Azerbaijan, Professor Geylani Panahov, supervised 4 PhD candidates and 1 master's student.

Doctor of Philosophy in Engineering, Associate Professor Eldar Abbasov defended his doctoral dissertation for the degree of Doctor of Technical Sciences on the topic *"Development of rheokinetic foundations for the application of heterogeneous fluids in oil and gas production processes"* at Dissertation Council ED 2.03 of the Azerbaijan State University of Oil and Industry. The dissertation was approved by the Higher Attestation Commission under the President of the Republic of Azerbaijan.

Junior Researcher Ibrahim Mamedov passed a preliminary discussion of his dissertation for the degree of Doctor of Philosophy at a joint scientific seminar of the Departments of Fluid and Gas Mechanics, Applied Mathematics, and Theory of Plasticity and Elasticity.

Member of the National Academy of Sciences of Azerbaijan, Professor Geylani Panahov, delivers a lecture course on *Fluid Mechanics* at Baku State University; Doctor of Philosophy in Engineering, Associate Professor Eldar Abbasov, supervised the industrial training of undergraduate students of the Department of Theoretical Mechanics and Continuum Mechanics at Baku State University.

APPLIED RESEARCH

Model laboratory studies conducted on the cleaning of the near-wellbore zone of production wells using a new suffosion method showed that, along with factors such as a reduction in interfacial tension and changes in rock wettability, the dissolution of gases in a liquid medium during the interaction of gas-releasing and gas-generating aqueous solutions plays an important role in CO_2 impact processes in the near-wellbore zone.

Based on these results, a technological method was developed and successfully applied at the Binagadi Oil field in production wells No. 220100 and No. 223107. The results of pilot industrial tests demonstrated high production efficiency of the method and confirmed an increase in average daily liquid production from 0.5 m^3 to 4.3–4.7 m^3/day.

Fig. 3–4. Technological operations at production wells No. 220100 and 223107 of the Binagadi Oil field

Head of the Department
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