

SCIENTIFIC AND ORGANIZATIONAL REPORT

of "Fluid Mechanics" Department for 2020

“STUDY OF THE INFLUENCE OF BOUNDARY LAYERS ON TRANSIENT PROCESSES UNDER HETEROGENEOUS FLUIDS FLOW”

During the reporting period, in accordance with the thematic plan, research was conducted in 4 areas:

Research work #1. Influence of electrokinetic processes on hydrodynamic parameters during fluid flow and filtration and development of the basics of characteristics control.

Researchers: corresponding member of ANAS Geylani Panakhov, Ph.D. Eldar Abbasov, Ph.D. Afet Yuzbashieva.

In the implemented studies, non-stationary effects in the hydrodynamics of heterogeneous fluids flow are studied. Possibility of control the resulting mass transfer processes, electrical conductivity, and gas distribution by both external and internal influences is shown.

The processes of electrokinetic phenomena under flow and filtration, electrical insulation in systems with electrical conductivity and sliding effects were identified and simulated. The possibility of changing the flow velocity profiles was shown and corresponding model and experimental estimates were made.

Research work #2. Investigation of mutual diffusion characteristics by various parameters of fluid viscosity and density in a porous medium.

Researchers: corresponding member of ANAS Geylani Panakhov, Ph.D. Eldar Abbasov, Ph.D. Gulshan Agayeva.

Diffusion and adsorption effects that accompany the fluids flow and filtration lead to a violation of additivity in the porous medium. The interdependence of processes is characterized by phase permeability, sorption interaction, and surface diffusion, which leads to changes in the parameters of boundary layers and adsorption characteristics in a porous medium.

Research work #3. Investigation of velocity pulsations that occur in the case of formation of diffusive boundary layers during the flow of mixtures.

Researchers: corresponding member of ANAS Geylani Panakhov, Parviz Museyibli.

The dependence of the density amplitude, wave propagation velocity, and mixing velocity on the concentration of the bubble volume in the pulsating flows of two-phase viscous bubble liquids in elastic semi-infinite pipes was estimated.

The obtained formulas can be the basis for calculating the wave attenuation rate, which can occur depending on the values of the amplitude, bubble concentration, and wave speed.

The basis of the accepted mathematical model is the model of homogeneous filtration taking into account convective diffusion. In the kinetics of the sorption process, the conservation of mass of matter is given as an equation.

Research work #4. Development of a statistical model of lens-type water sources in Azerbaijan.

Researchers: Prof. Yasin Rustamov

In the course of research, the degree of reliability of water reservoir elements was evaluated. The calculations were based on elements of the theory of mathematical statistics and probability theory, and the model selection was guided by the consideration of the flow randomness and the analogy with the turbulent fluids flow was used.

During the reporting period, 9 articles were published and 2 articles were submitted to the press. 1 received a positive review of the patent of the Republic of Azerbaijan.

1. Панахов Г.М., Аббасов Э.М., Балакчи В.Д. Водоизолирующие глиносодержащие композиции с регулируемыми характеристиками набухания // Azərbaycan Neft Təsərrüfatı, № 8, 2020. - S. 27 – 33.

2. Geylani M. Panahov, Eldar M. Abbasov, Afet O. Yuzbashiyeva, Parviz T. Museibli Flow control of fluids through porous media based on electrokinetic effects // *Tran. Natl. Acad. Sci. Azerb. Ser. Phys.-Tech. Math. Sci. Mechanics*, 40 (7), 28–36 (2020).

3. Museibli P.T. Mathematical modelling of effect of electrostatic field forming on hydraulic characteristics of two phase mixtures flow // *Advances and applications in mathematical sciences*, 2019, vol.19, no.1, pp. 21 - 32 (**Web of Science Core Collection: Emerging Sources Citation Index**). - çap olunub

4. Parviz T. Museibli On the electrostatic field in expansion dynamics of gas bubbles // «Вестник Самарского государственного технического университета, серия «Физико-математические науки», 2019, vol. 23, no. 4, pp. 756 – 763 <https://doi.org/10.14498/vsgtu1717> - (**Web of Science Core Collection: Emerging Sources Citation Index**). - çap olunub

5. Rüstəmov Y.İ., Əsgərova Ş.S. Асınoһur düzü torpaqlarının münbitliyinin qiymətləndirilməsi // *Azərbaycan Aqrar Elmi* , № 4, Bakı, 2019, səh. 9-13. http://aeim.gov.az/neshrlər_files/83433aqrarelmi%202019-4-merged.pdf

6. Rustamov Y., Gadjiev T., Yanqaliyeva A. The Behaviour of Solutions to Degenerate Double Nonlinear Parabolic Equations // *ICMSEM 2020, AISC 1190, Vol. 1, Moldova on July 30 - August 2, 2020*, pp. 447-459, Springer. https://doi.org/10.1007/978-3-030-49829-0_33

7. Rustamov Y., Gadjiev T., Askerova S. (2020) A Mathematical Model of Soil Fertility. In: Xu J., Duca G., Ahmed S., García Márquez F., Hajiyev A. (eds) *Proceedings of the Fourteenth International Conference on Management Science and Engineering Management. ICMSEM 2020. Advances in Intelligent Systems and Computing*, vol 1190. Springer, Cham - https://doi.org/10.1007/978-3-030-49829-0_38 - (**Scopus**). - çap olunub

8. Rustamov Y., Aliyev S. The optimal irrigation under water use decisions // *Сборник научных трудов Национального Университета Водного Хозяйства. Ровно, Украина, вып. 1-2, 2019*, стр. 74-78

9. Ibrahim J. Mamedov, Saida G. Panahova, Vusal H. Huseynov Mobility control under selective water isolation of highly permeable reservoirs by in-situ quasi-periodic foaming // Tran. Natl. Acad. Sci. Azerb. Ser. Phys.-Tech. Math. Sci. Mechanics, 39 (8), 36–43 (2019). - çap olunub.

10. Geylani M. Panahov, Eldar M. Abbasov, Renqi Jiang *In-situ generation of carbon dioxide to form a gas-liquid slug for the hard-to-recover oil displacement* // Acta Geotechnica, Springer – çapa təqdim olunub.

11. Azizaga Kh. Shakhverdiev, Geylani M. Panahov, Renqi Jiang, Eldar M. Abbasov *In-situ CO₂ generation technology as the method for residual oil recovery* // Journal of Petroleum Science and Technology, Taylor and Francis - çapa təqdim olunub.

Abstracts:

1. Pənahov Q.M., Məmmədov İ.C., Sarıyeva G.M. Məsaməli mühitlərdə köçmə məsələləri və onların həlləri // Ümummilli Lideri Heydər Əliyevin anadan olmasının 97-ci ildönümünə həsr olunmuş «Riyaziyyat, Mexanika və onların tətbiqləri» adlı Respublika Elmi Konfransın Tezislər Toplusu.

2. Rustamov Y., Aliyev S. Conference of sequence of multidimensional branching random processes // Республиканская конференция посвященная 97-летию Г. Алиева, Бизнес Университет, Баку, 2020.

3. Abbasov E.M., Panahova S.Q., Mirzəyeva Ü.F. Heterogen sistemlərin axınlarında temperatur və təzyiqli dəyişmələrinin adsorbsiya prosesində rolu // Ümummilli Lideri Heydər Əliyevin anadan olmasının 97-ci ildönümünə həsr olunmuş «Riyaziyyat, Mexanika və onların tətbiqləri» adlı Respublika Elmi Konfransın Tezislər Toplusu.

4. In-situ CO₂ carbon dioxide generation - an innovative technology for enhanced oil recovery (Ibrahim S. Guliyev, Geylani M. Panahov, Eldar M. Abbasov Azerbaijan National Academy of Sciences, Baku, Azerbaijan, Azizaga Kh. Shakhverdiev, Russian State Geological Exploration University named after S. Ordzhonikidze, Moscow, Russian Federation, Sayavur I. Bakhtiyarov New Mexico

Institute of Mining and Technology, Renqi Jiang Hurrah Energy Group, Tianjin, China) // 23rd World Petroleum Congress, USA, December 6-10, 2020.

5. Panahov G.M., Abbasov E.M., Balakchi V.D. Water-shutoff clay-containing compositions with adjustable swelling characteristics // 21st European Improved Oil Recovery Symposium, 19-22 April 2021 in Vienna, Austria.

6. Panakhov G.M., Abbasov E.M. In-situ carbon dioxide CO₂ generation for sweep efficiency improvement and oil recovery increase // 21st European Improved Oil Recovery Symposium, 19-22 April 2021 in Vienna, Austria.

Department scientists corresponding member of ANAS Geylani Panahov and associate professor Eldar Abbasov took part in the Republican scientific conference "Mathematics, mechanics and applications" dedicated to the 97th anniversary of the birth of National leader of the Azerbaijani people Heydar Aliyev, organized by the Mechanics and Mathematics Department of BSU on May 20-21, 2020.

In the reporting period, the next issue of the ANAS Transactions (issue Mechanics) journal (Vol. 40, № 7, 2020) was published.

During the report, the Department continued research and industrial implementation of the created technological developments. Department Head, corresponding member of ANAS Geylani Panakhov and leading researcher, Ph.D. Eldar Abbasov developed and submitted to the Vetsovetpetro oil company (Vietnam Socialist Republic) technological regulations for the application of developed solutions for cleaning of offshore gas pipelines. It is planned to conduct a field operation on the next stage of investigations.

During the reporting period, Department employees carried out technological operations on the oil production improvement on the 3 production wells of Binagadi Oil Company.

On June 11, 2020, Department head Geylani Panahov and Eldar Abbasov, , developed and implemented a new technological method for putting into operation

tested on the producing well #1702 of “Global Energy” International Oil Company.



Photo 1. Oil field operation at the Binagadi Oil Company”

At a meeting held in SOCAR in February 2020, the proposals made by the Department's scientists regarding to the gas pipelines cleaning were discussed. On may 28, at a meeting with representatives of the relevant divisions of SOCAR – N. Narimanov, "Oil Rocks", "Absheronneft", "Gum Adasy" Oil Production Enterprises, a presentation of scientific and technical developments and technologies that have been widely implemented both in Azerbaijan and outside the Republic was held. After an exchange of views between the Institute's scientists and other participants of the meeting on the part of Azneft, a decision was made to implement the Institute's developments at SOCAR oil fields, and a corresponding Protocol of intent was adopted informing about problems arising in the main pipelines of the “Azerigaz” pipeline system.

Corresponding member of ANAS Geylani Panakhov supervised the scientific work of 3 dissertants and 1 master's student. Parviz Museyibli, a dissertation candidate in the Department of M.Sc., completed and submitted the dissertation work to the Dissertation Council. Master Ibrahim Mammadov defended his master's thesis online and is currently taking exams to the doctoral courses.

During the reporting period, corresponding member of ANAS Geylani Panahov participated in the defense of diplomas as the Chairman of the State examination Commission of Baku State University.

Corresponding member of ANAS Geylani Panahov, Prof. Yasin Rustamov and Associate Professor Eldar Abbasov conducted various courses for masters of IMM and BSU.

During the reporting period, a project was submitted for a research grant under the competitive Program of the Science Development Foundation under the President of the Azerbaijan Republic.

Department Head,

corresponding member of ANAS

Geylani Panahov