

ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)

ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫ
Satbayev University

Х А Б А Р Л А Р Ы

ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК
РЕСПУБЛИКИ КАЗАХСТАН
Satbayev University

N E W S

OF THE ACADEMY OF SCIENCES
OF THE REPUBLIC OF KAZAKHSTAN
Satbayev University

**SERIES
OF GEOLOGY AND TECHNICAL SCIENCES**

5 (449)

SEPTEMBER – OCTOBER 2021

THE JOURNAL WAS FOUNDED IN 1940

PUBLISHED 6 TIMES A YEAR

ALMATY, NAS RK

NAS RK is pleased to announce that News of NAS RK. Series of geology and technical sciences scientific journal has been accepted for indexing in the Emerging Sources Citation Index, a new edition of Web of Science. Content in this index is under consideration by Clarivate Analytics to be accepted in the Science Citation Index Expanded, the Social Sciences Citation Index, and the Arts & Humanities Citation Index. The quality and depth of content Web of Science offers to researchers, authors, publishers, and institutions sets it apart from other research databases. The inclusion of News of NAS RK. Series of geology and technical sciences in the Emerging Sources Citation Index demonstrates our dedication to providing the most relevant and influential content of geology and engineering sciences to our community.

Қазақстан Республикасы Ұлттық ғылым академиясы «ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы» ғылыми журналының Web of Science-тің жаңаланған нұсқасы Emerging Sources Citation Index-те индекстелуге қабылданғанын хабарлайды. Бұл индекстелу барысында Clarivate Analytics компаниясы журналды одан әрі the Science Citation Index Expanded, the Social Sciences Citation Index және the Arts & Humanities Citation Index-ке қабылдау мәселесін қарастыруда. Web of Science зерттеушілер, авторлар, баспашылар мен мекемелерге контент тереңдігі мен сапасын ұсынады. ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы Emerging Sources Citation Index-ке енуі біздің қоғамдастық үшін ең өзекті және беделді геология және техникалық ғылымдар бойынша контентке адалдығымызды білдіреді.

НАН РК сообщает, что научный журнал «Известия НАН РК. Серия геологии и технических наук» был принят для индексирования в Emerging Sources Citation Index, обновленной версии Web of Science. Содержание в этом индексировании находится в стадии рассмотрения компанией Clarivate Analytics для дальнейшего принятия журнала в the Science Citation Index Expanded, the Social Sciences Citation Index и the Arts & Humanities Citation Index. Web of Science предлагает качество и глубину контента для исследователей, авторов, издателей и учреждений. Включение Известия НАН РК. Серия геологии и технических наук в Emerging Sources Citation Index демонстрирует нашу приверженность к наиболее актуальному и влиятельному контенту по геологии и техническим наукам для нашего сообщества.

Бас редактор

ЖҰРЫНОВ Мұрат Жұрынұлы, химия ғылымдарының докторы, профессор, ҚР ҰҒА академигі, Қазақстан Республикасы Ұлттық Ғылым академиясының президенті, АҚ «Д.В. Сокольский атындағы отын, катализ және электрохимия институтының» бас директоры (Алматы, Қазақстан) Н = 4

Редакциялық алқа:

ӘБСАМЕТОВ Мәліс Құдысұлы (бас редактордың орынбасары), геология-минералогия ғылымдарының докторы, профессор, ҚР ҰҒА академигі, «У.М. Ахмедсафина атындағы гидрогеология және геоэкология институтының» директоры (Алматы, Қазақстан) Н = 2

ЖОЛТАЕВ Герой Жолтайұлы (бас редактордың орынбасары), геология-минералогия ғылымдарының докторы, профессор, Қ.И. Сатпаев атындағы геология ғылымдары институтының директоры (Алматы, Қазақстан) Н=2

СНОУ Дэниел, Ph.D, қауымдастырылған профессор, Небраска университетінің Су ғылымдары зертханасының директоры (Небраска штаты, АҚШ) Н = 32

ЗЕЛЬТМАН Реймар, Ph.D, табиғи тарих мұражайының Жер туралы ғылымдар бөлімінде петрология және пайдалы қазбалар кен орындары саласындағы зерттеулердің жетекшісі (Лондон, Англия) Н = 37

ПАНФИЛОВ Михаил Борисович, техника ғылымдарының докторы, Нанси университетінің профессоры (Нанси, Франция) Н=15

ШЕН Пин, Ph.D, Қытай геологиялық қоғамының тау геологиясы комитеті директорының орынбасары, Американдық экономикалық геологтар қауымдастығының мүшесі (Пекин, Қытай) Н = 25

ФИШЕР Аксель, Ph.D, Дрезден техникалық университетінің қауымдастырылған профессоры (Дрезден, Берлин) Н = 6

КОНТОРОВИЧ Алексей Эмильевич, геология-минералогия ғылымдарының докторы, профессор, РФА академигі, А.А. Трофимука атындағы мұнай-газ геологиясы және геофизика институты (Новосибирск, Ресей) Н = 19

АБСАДЫКОВ Бахыт Нарикбайұлы, техника ғылымдарының докторы, профессор, ҚР ҰҒА корреспондент-мүшесі, А.Б. Бектұров атындағы химия ғылымдары институты (Алматы, Қазақстан) Н = 5

АГАБЕКОВ Владимир Енокович, химия ғылымдарының докторы, Беларусь ҰҒА академигі, Жаңа материалдар химиясы институтының құрметті директоры (Минск, Беларусь) Н = 13

КАТАЛИН Стефан, Ph.D, Дрезден техникалық университетінің қауымдастырылған профессоры (Дрезден, Берлин) Н = 20

СЕЙТМҰРАТОВА Элеонора Юсуповна, геология-минералогия ғылымдарының докторы, профессор, ҚР ҰҒА корреспондент-мүшесі, Қ.И. Сатпаев атындағы Геология ғылымдары институты зертханасының меңгерушісі (Алматы, Қазақстан) Н=11

САҒЫНТАЕВ Жанай, Ph.D, қауымдастырылған профессор, Назарбаев университеті (Нұр-Сұлтан, Қазақстан) Н = 11

ФРАТТИНИ Паоло, Ph.D, Бикокк Милан университеті қауымдастырылған профессоры (Милан, Италия) Н = 28

«ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы».

ISSN 2518-170X (Online),

ISSN 2224-5278 (Print)

Меншіктеуші: «Қазақстан Республикасының Ұлттық ғылым академиясы» РҚБ (Алматы қ.).

Қазақстан Республикасының Ақпарат және қоғамдық даму министрлігінің Ақпарат комитетінде 29.07.2020 ж. берілген № **KZ39VPY00025420** мерзімдік басылым тіркеуіне қойылу туралы куәлік.

Тақырыптық бағыты: *геология, мұнай және газды өңдеудің химиялық технологиялары, мұнай химиясы, металдарды алу және олардың қосындыларының технологиясы.*

Мерзімділігі: жылына 6 рет.

Тиражы: 300 дана.

Редакцияның мекен-жайы: 050010, Алматы қ., Шевченко көш., 28, 219 бөл., тел.: 272-13-19

<http://www.geolog-technical.kz/index.php/en/>

© Қазақстан Республикасының Ұлттық ғылым академиясы, 2021

Типографияның мекен-жайы: «Аруна» ЖК, Алматы қ., Мұратбаев көш., 75.

Главный редактор

ЖУРИНОВ Мурат Журинович, доктор химических наук, профессор, академик НАН РК, президент Национальной академии наук Республики Казахстан, генеральный директор АО «Институт топлива, катализа и электрохимии им. Д.В. Сокольского» (Алматы, Казахстан) Н = 4

Редакционная коллегия:

АБСАМЕТОВ Малис Кудысович, (заместитель главного редактора), доктор геолого-минералогических наук, профессор, академик НАН РК, директор Института гидрогеологии и геоэкологии им. У.М. Ахмедсафина (Алматы, Казахстан) Н = 2

ЖОЛТАЕВ Герой Жолтаевич, (заместитель главного редактора), доктор геолого-минералогических наук, профессор, директор Института геологических наук им. К.И.Сатпаева (Алматы, Казахстан) Н=2

СНОУ Дэниел, Ph.D, ассоциированный профессор, директор Лаборатории водных наук университета Небраски (штат Небраска, США) Н = 32

ЗЕЛЬТМАН Реймар, Ph.D, руководитель исследований в области петрологии и месторождений полезных ископаемых в Отделе наук о Земле Музея естественной истории (Лондон, Англия) Н = 37

ПАНФИЛОВ Михаил Борисович, доктор технических наук, профессор Университета Нанси (Нанси, Франция) Н=15

ШЕН Пин, Ph.D, заместитель директора Комитета по горной геологии Китайского геологического общества, член Американской ассоциации экономических геологов (Пекин, Китай) Н = 25

ФИШЕР Аксель, ассоциированный профессор, Ph.D, технический университет Дрезден (Дрезден, Берлин) Н = 6

КОНТОРОВИЧ Алексей Эмильевич, доктор геолого-минералогических наук, профессор, академик РАН, Институт нефтегазовой геологии и геофизики им. А.А. Трофимука СО РАН (Новосибирск, Россия) Н = 19

АБСАДЫКОВ Бахыт Нарикбаевич, доктор технических наук, профессор, член-корреспондент НАН РК, Институт химических наук им. А.Б. Бектурова (Алматы, Казахстан) Н = 5

АГАБЕКОВ Владимир Енокович, доктор химических наук, академик НАН Беларуси, почетный директор Института химии новых материалов (Минск, Беларусь) Н = 13

КАТАЛИН Стефан, Ph.D, ассоциированный профессор, Технический университет (Дрезден, Берлин) Н = 20

СЕЙТМУРАТОВА Элеонора Юсуповна, доктор геолого-минералогических наук, профессор, член-корреспондент НАН РК, заведующая лабораторией Института геологических наук им. К.И. Сатпаева (Алматы, Казахстан) Н=11

САГИНТАЕВ Жанай, Ph.D, ассоциированный профессор, Назарбаев университет (Нурсултан, Казахстан) Н = 11

ФРАТТИНИ Паоло, Ph.D, ассоциированный профессор, Миланский университет Бикокок (Милан, Италия) Н = 28

«Известия НАН РК. Серия геологии и технических наук».

ISSN 2518-170X (Online),

ISSN 2224-5278 (Print)

Собственник: Республиканское общественное объединение «Национальная академия наук Республики Казахстан» (г. Алматы).

Свидетельство о постановке на учет периодического печатного издания в Комитете информации Министерства информации и общественного развития Республики Казахстан № KZ39VPY00025420, выданное 29.07.2020 г.

Тематическая направленность: *геология, химические технологии переработки нефти и газа, нефтехимия, технологии извлечения металлов и их соединений.*

Периодичность: 6 раз в год.

Тираж: 300 экземпляров.

Адрес редакции: 050010, г. Алматы, ул. Шевченко, 28, оф. 219, тел.: 272-13-19

<http://www.geolog-technical.kz/index.php/en/>

© Национальная академия наук Республики Казахстан, 2021

Адрес типографии: ИП «Аруна», г. Алматы, ул. Муратбаева, 75.

Editor in chief

ZHURINOV Murat Zhurinovich, doctor of chemistry, professor, academician of NAS RK, president of the National Academy of Sciences of the Republic of Kazakhstan, general director of JSC “Institute of fuel, catalysis and electrochemistry named after D.V. Sokolsky» (Almaty, Kazakhstan) H = 4

Editorial board:

ABSAMETOV Malis Kudysovich, (deputy editor-in-chief), doctor of geological and mineralogical sciences, professor, academician of NAS RK, director of the Akhmedsafin Institute of hydrogeology and hydrophysics (Almaty, Kazakhstan) H = 2

ZHOLTAEV Geroy Zholtaevich, (deputy editor-in-chief), doctor of geological and mineralogical sciences, professor, director of the institute of geological sciences named after K.I. Satpayev (Almaty, Kazakhstan) H=2

SNOW Daniel, Ph.D, associate professor, director of the laboratory of water sciences, Nebraska University (Nebraska, USA) H = 32

Zeltman Reyman, Ph.D, head of research department in petrology and mineral deposits in the Earth sciences section of the museum of natural history (London, England) H = 37

PANFILOV Mikhail Borisovich, doctor of technical sciences, professor at the Nancy University (Nancy, France) H=15

SHEN Ping, Ph.D, deputy director of the Committee for Mining geology of the China geological Society, Fellow of the American association of economic geologists (Beijing, China) H = 25

FISCHER Axel, Ph.D, associate professor, Dresden University of technology (Dresden, Germany) H = 6

KONTOROVICH Aleksey Emilievich, doctor of geological and mineralogical sciences, professor, academician of RAS, Trofimuk Institute of petroleum geology and geophysics SB RAS (Novosibirsk, Russia) H = 19

ABSADYKOV Bakhyt Narikbaevich, doctor of technical sciences, professor, corresponding member of NAS RK, Bekturov Institute of chemical sciences (Almaty, Kazakhstan) H = 5

AGABEKOV Vladimir Enokovich, doctor of chemistry, academician of NAS of Belarus, honorary director of the Institute of chemistry of new materials (Minsk, Belarus) H = 13

KATALIN Stephan, Ph.D, associate professor, Technical university (Dresden, Berlin) H = 20

SEITMURATOVA Eleonora Yusupovna, doctor of geological and mineralogical sciences, professor, corresponding member of NAS RK, head of the laboratory of the Institute of geological sciences named after K.I. Satpayev (Almaty, Kazakhstan) H=11

SAGINTAYEV Zhanay, Ph.D, associate professor, Nazarbayev University (Nursultan, Kazakhstan) H = 11

FRATTINI Paolo, Ph.D, associate professor, university of Milano-Bicocca (Milan, Italy) H = 28

News of the National Academy of Sciences of the Republic of Kazakhstan. Series of geology and technology sciences.

ISSN 2518-170X (Online),

ISSN 2224-5278 (Print)

Owner: RPA «National Academy of Sciences of the Republic of Kazakhstan» (Almaty).

The certificate of registration of a periodical printed publication in the Committee of information of the Ministry of Information and Social Development of the Republic of Kazakhstan **No. KZ39VPY00025420**, issued 29.07.2020.

Thematic scope: *geology, chemical technologies for oil and gas processing, petrochemistry, technologies for extracting metals and their connections.*

Periodicity: 6 times a year.

Circulation: 300 copies.

Editorial address: 28, Shevchenko str., of. 219, Almaty, 050010, tel. 272-13-19

<http://www.geolog-technical.kz/index.php/en/>

© National Academy of Sciences of the Republic of Kazakhstan, 2021

Address of printing house: ST «Aruna», 75, Muratbayev str, Almaty.

NEWS

OF THE NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC OF
KAZAKHSTAN **SERIES OF GEOLOGY AND TECHNICAL SCIENCES**
ISSN 2224-5278

Volume 5, Number 449 (2021), 146-152

<https://doi.org/10.32014/2021.2518-170X.108>

UDC 622.276.6

Tileuberdi N.^{1*}, Zholtayev G.ZH.¹, Abdeli D.Zh.², Ozdoev S.M.¹

¹Satbayev University, Institute of Geological Sciences named after K.I. Satpaev, Almaty, Kazakhstan;

²Satbayev University, Institute of Geology, Oil and Mining, Department of Petroleum Engineering,
Almaty, Kazakhstan.

E-mail: Nureke-17@mail.ru

**INVESTIGATION OF DRAINAGE MECHANISM OF OIL FROM PORES OF
OIL SATURATED ROCKS USING NITROGEN AT THE LABORATORY CONDITION**

Abstract. The article comprises the selection of high-efficiency and cost-effective draining agents for the extraction of waste oil, which is becoming a global problem. The effectiveness of pushing residual oil with nitrogen in small cavities of the oil layer and in the capillary matrix was discussed.

The theory of the mechanism of pushing residual oil in the porous cavities using nitrogen and it is important to test in the laboratory.

The nitrogen is denser than oil; moreover it is gas which it can penetrate intensively at high pressures into cavities and capillary matrices, displacing residual oil from them along the cavities to the production wells.

In this laboratory experiment was used core samples from the North Karamandybas field after drying and then they are saturated with oil in the vacuum with weighting each ones. Then, a specially designed device was used to push oil using the nitrogen. It was concluded that the experience of pushing oil in oil-saturated cores samples with nitrogen has yielded positive results, using this method will be increased the oil recovery of the formation in the field. After analyzing the positive results of the laboratory work, the impact on the bottomhole formation zone in production wells allows to increase oil recovery of the formation, and also contributes to the recovery of residual oil from fine-porous cavities of the oil formation.

Key words: Nitrogen, oil, drainage agent, laboratory experiment, porosity, permeability, pore media of layers, cores, oil saturation.

Introduction. The paper has a strong focus on the use and study of modern methods to increase oil recovery, because there are many difficulties in the world regarding to this case. At present, the amount of technology used to increase oil recovery is only enough to extract half or less of the total geological reserves of oil in the field. When selecting injecting agents to increase oil recovery or reservoir pressure, emphasis is placed on the cost of the oil produced and the cost of using it.

It is obvious that in the process of extracting oil from production wells, the oil flow enters the bottom of the well through the cavities of terrigenous rocks. However, due to the capillary pressure and surface tension in these cavities, a certain amount of oil usually remains in these cavities.

With the help of a mathematical model it is possible to describe the process of displacement of oil by nitrogen from the cavities and capillary matrix in the rocks [1,4,5]. At the same time it is necessary to take into account the balance of forces acting on the residual oil in the small cavities and the capillary matrix. These can be: the pressure force of nitrogen, the gravitational force of the residual oil, the Archimedean force, the force of friction of the residual oil on the rock surface, and so on.

By injecting high-pressure nitrogen into the bedrock of the formation, it is possible to extract residual oil from the internal cavities of the rocks by pushing it to the bottom of production wells.

The efficiency of nitrogen injection into the oil reservoir during field development provides a real opportunity to extract residual oil from the porous cavities of the reservoir. Since this process is a lighter gas than oil in terms of nitrogen density, it penetrates quickly into small porous cavities and capillary tubes at high pressure and pushes oil through those cavities [2,3]. Therefore, the process of pumping oil with nitrogen at high pressure through small porous cavities and capillary tubes in the formation is considered to be due to the different densities of oil and gas.

Materials and methods. The task of laboratory research is to determine experimentally the main mechanism of nitrogen pushing of residual oil in the porous cavities of reservoir rocks and the rational mode and technological parameters of nitrogen injection into multilayer oil formations. The developed laboratory equipment is aimed at determining the mechanism of pushing oil in the porous cavities of the model by compressing the oil-saturated core with nitrogen on all sides.

The laboratory work process. The laboratory research work by Professor Abdeli D.J. was conducted in the laboratory of the Department of Petroleum Engineering, Satpaev University. In order to carry out the experiment of pumping oil with nitrogen in the laboratory, it is the first prepared in accordance with the core unit. After cutting the core, oil in accordance with the nitrogen by the pushing device, the porous cavities of the core are pre-cleaned in a special unit with high-pressure air by means of a compressor.

In the laboratory, the mechanism of pushing oil in the core with nitrogen is carried out as follows. After the porous cavities of the core are cleaned with high-pressure air, the core is first measured with an analytical laboratory scale. Then, the porous cavities of the core are soaked in oil in a special container for 10-12 hours to saturate it with oil.

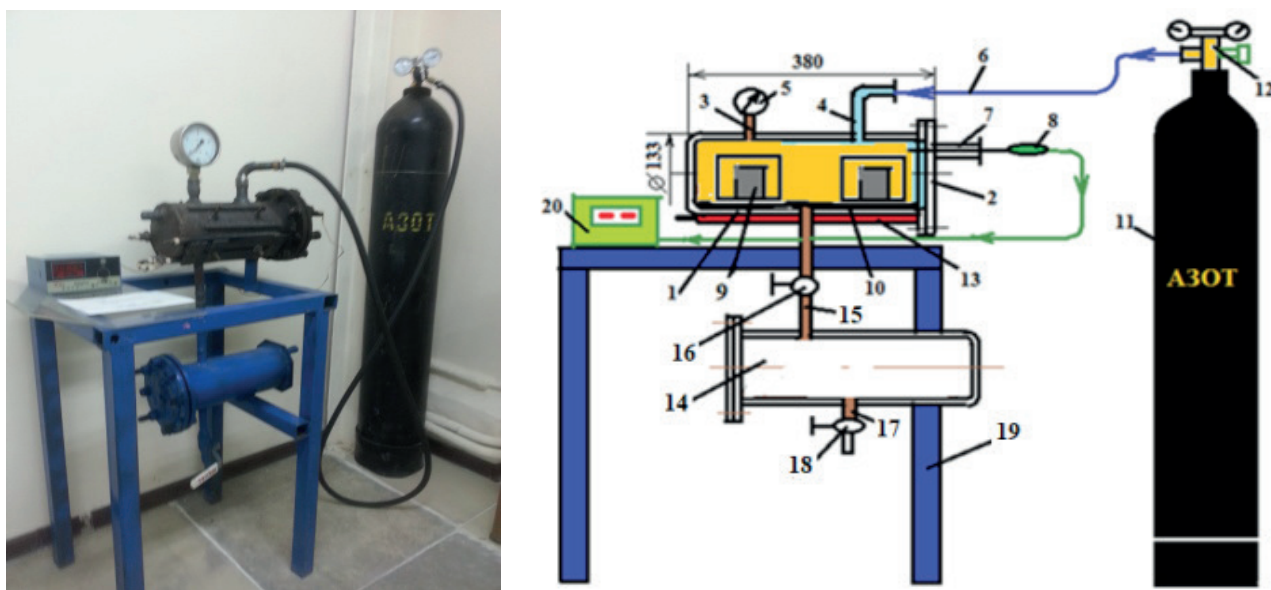


Figure 1. Schematic illustration (a) and general view (b) of the laboratory device.

By the order, to remove air bubbles in the porous cavities of the core and fill it with oil, it is placed in a special chamber and a vacuum is created with the help of a compressor. Thus, the core is completely saturated with oil [6,7,8].

The fig.1 shows a schematic and general view of a laboratory device consisting of a horizontal cylindrical housing with a vertical lid (2). The cylindrical body has a diameter of 127 mm and a length of 400 mm. The cover of the case is fastened with bolts on both sides with a paronite float, which ensures the strength of the working chamber. Two tubes (3) and (4) are attached to the top of the cylindrical housing, which are equipped with a manometer (5) and a rubber hose (6). The cover shall be fitted with a cell (7) on the inside of the working chamber of the housing, through which the clogged side enters, and on the open side of the cell is placed a thermometer sensor (8). An oil-soaked core (9) is placed in a special beaker (10) inside the working chamber. At the bottom of the glass there is an empty space, which is covered with a mesh canopy. The working chamber is connected to the nitrogen cylinder (11) by means of a rubber hose through a manometer editor (12). The pressure of nitrogen inside the cylinder is 15 MPa. An electric heater (13) is mounted under the cylindrical housing, which is used to create a layer temperature inside the working chamber. Below the cylindrical housing is installed a storage chamber (14), which has a connecting tube (15) and a switch (16). The warehouse is equipped with a chamber output tube (17) and a switch (18). The cylindrical housing and storage chamber are mounted on a stand (19). The temperature sensor is connected to the thermometer (20).

During the laboratory work, the cavities are cleaned with air, the weight of the oil-soaked core is weighed on an analytical balance and placed in the working chamber of the device. The cover of the working chamber is tightly closed and fastened with bolts. The valve of the nitrogen cylinder is opened slowly until the required

pressure inside the working chamber is reached. When the pressure required for nitrogen injection is reached, the nitrogen cylinder tap closes. The core is left in the working chamber for about 1 day. The oil pushed with nitrogen from the cavities of the core will collect in the empty space at the bottom of the glass. After setting the core for a day under the influence of nitrogen pressure, the tap of the working chamber is opened and nitrogen is released. The cover of the cylindrical housing is opened and removed from the working chamber with a core glass. The core is then weighed on an analytical laboratory scale and recorded in a special log. The weight of oil obtained by pushing nitrogen from the cavities of the core is determined by calculation.

Analysis of the results of laboratory work. Nitrogen injection of core oil was performed on five cores and repeated three times. The oil required for the experiment was imported from the North Karamandybas field, with an average density of 0.850 g / cm³ and a viscosity of 5.08 mPa / s. Experimental work was carried out on the first unit, an experimental laboratory unit for the formation of the mechanism of pumping oil in the cavities of the model with nitrogen under the influence of the collector rock - the core. The second unit was designed to form a mechanism to push the oil-saturated core from one side to the other with nitrogen.

Firstly, after cleaning the cavities with air at high pressure, the core is weighed on an analytical laboratory scale. To saturate the core cavities with oil, soak them in a glass of oil for 10-12 hours. Then, in order to remove air bubbles in the cavities, the oil is completely saturated in a vacuum, which is placed in a special chamber and a vacuum is created in the working chamber with the help of a compressor.

Results. Then, in order to remove air bubbles in the cavities, the oil is completely saturated in a vacuum, for which it is placed in a special chamber and a vacuum is created in the working chamber with the help of a compressor. Finally, the first special unit for pushing the oil in the core with nitrogen will repeatedly push the oil with nitrogen. The obtained results are recorded in a special log and the necessary calculations are made.

First of all, five cores required for the experiment were developed, their weight before oil saturation was 85.05, 91.54, 83.80, 89.01, 88.60, respectively. After saturating them with oil in a special vacuum chamber at a pressure of 0.7 bar, the average weight on a special laboratory scale was 95.47, 102.08, 91.42, 102.16, 96.24. Thus, the average saturation weight of the cores was 10.42, 10.54, 7.62, 13.15, 7.51, respectively (Table 1).

Table 1 - Average of parameters for rock cores in the experiment

	Repetition	Number of rock cores				
		1	2	3	4	5
Wight (g) of oil before saturation	1					
	2	85,05	91,54	83,80	89,01	88,60
	3					
Pressure (bar) in a vacuum		0,7	0,7	0,7	0,7	0,7
Wight (g) of oil after saturation	1	95,65	104,50	93,84	105,38	99,39
	2	96,61	101,30	90,17	101,44	92,81
	3	94,16	100,45	90,27	99,67	96,53
	average	95,47	102,08	91,42	102,16	96,24
Saturation (g)	1	10,6	12,96	10,04	16,37	10,39
	2	11,56	9,76	6,37	12,43	4,21
	3	9,11	8,91	6,47	10,66	7,93
	average	10,42	10,54	7,62	13,15	7,51

From the obtained data, the oil saturation is the same in all samples and their oil saturation is 7.51 - 13.15 g. can be seen between (Fig. 2). It is observed that the oil saturation of the 1st, 2nd and 4th cores is higher than that of the 3rd and 5th cores (Figure 2).

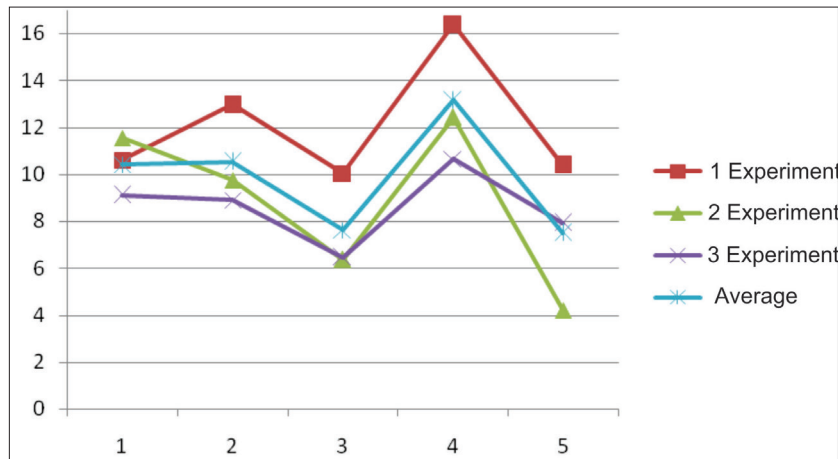


Figure 2. Diagram of oil saturated cores samples

Laboratory work was carried out to push the oil-saturated core, first in Unit 1 in Figure 17, and then in Unit 2 in Figure 15. Laboratory work was repeated 3 times in Unit 1 and 2 times in Unit 2. The chamber pressure was 5 MPa in both units. Including the results obtained at both units, the average values of oil saturation of the cores were 95.39, 101.82, 91.32, 101.48, 95.58, respectively (Table 2). The average weight of cores after nitrogen injection was 90.07, 96.68, 87.01, 96.53, 93.48, respectively. Thus, the weight of oil pushed as a result of nitrogen injection averaged 5.32, 5.14, 4.31, 5.55, 3.10 grams, respectively (Figure 3).

Table 2 - Results of the laboratory work on the injection of nitrogen into the porous cavities of the core in the reservoir rocks.

	№	Repetition	Number of rock cores				
			1	2	3	4	5
Weight of oil saturated cores before pushing with nitrogen (g)	1	1	95,65	104,50	93,84	105,38	99,39
		2	96,61	101,30	90,17	101,44	92,81
		3	94,16	100,45	90,27	99,67	96,53
	2	1	95,35	101,20	91,27	100,54	98,40
		2	95,18	101,65	91,08	100,39	90,77
			Average	95,39	101,82	91,32	101,48
Pressure in a vacuum (mPa)			5	5	5	5	5
Weight of oil saturated cores after pushing with nitrogen (g)	1	1	90,03	99,87	89,24	100,01	95,21
		2	90,28	95,96	86,79	95,13	90,80
		3	89,93	95,61	86,22	94,12	92,46
	2	1	90,05	95,24	87,35	98,77	99,74
		2	90,06	96,72	85,47	94,63	89,19
			Average	90,07	96,68	87,01	96,53
Wight of oil after the drainage (g)	1	1	5,62	4,63	4,60	5,37	4,18
		2	6,33	5,34	3,38	6,31	1,01
		3	4,23	4,84	4,05	5,55	4,07
	2	1	5,30	5,96	3,92	4,77	4,66
		2	5,12	4,93	5,61	5,76	1,58
			Average	5,32	5,14	4,31	5,55
Percentage of oil yield (%)	1	1	53	35	46	33	39
		2	55	55	53	51	48
		3	47	55	62	52	51
	2	1	51	62	53	42	48
		2	51	49	77	51	72
			Average	51,4	51,2	58,2	45,8

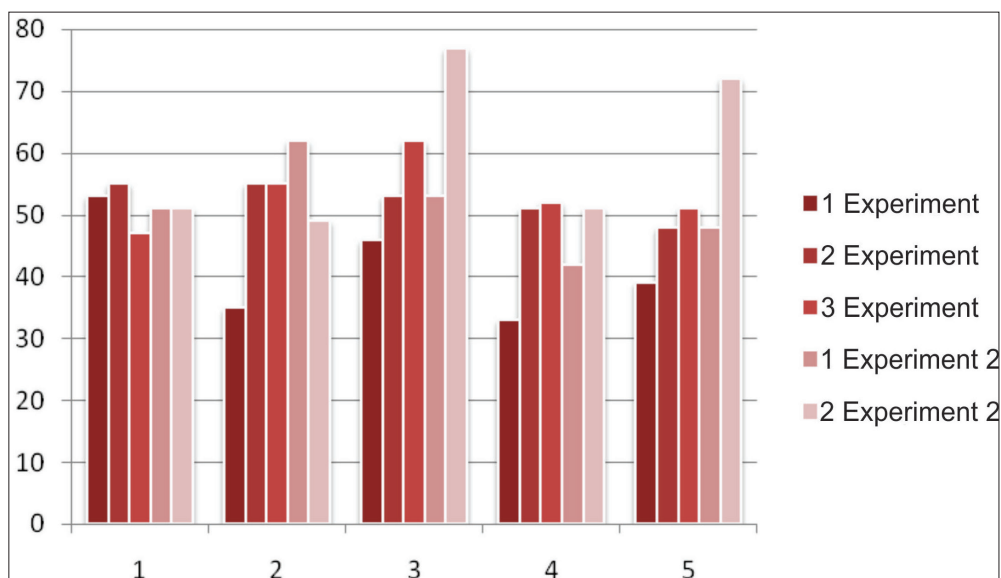


Figure 3. Percentage of oil in oil-saturated core pushed with nitrogen in Units 1 and 2

Discussion. As a result of experimental studies in the laboratory, the proportion of oil pushed with nitrogen from the porous cavities of the oil-saturated core was 45.8 - 58.2%, and it was found that the effectiveness of the push depends on the duration of action and pressure.

Because nitrogen has a much lower density than oil and is a gas, it enters the porous cavities and capillary tubes in the formation at high pressure and pushes the oil in that space downward under the same pressure. Therefore, the process of pushing oil in porous cavities and capillary tubes with nitrogen at high pressure can be considered as a difference in the density of oil and gas.

Conclusion. In this case, it can be concluded that the technology of nitrogen injection into the oil reservoir actually increases the oil recovery of the reservoir. This technology can be used to treat the edge of production wells with nitrogen, as well as nitrogen injection routes to maintain formation pressure from injection wells.

Due to this, nitrogen is denser than oil and is a gas, so it enters the cavities and capillary matrix at high pressure and displaces the residual oil from them along the cavities to the production wells. Therefore, the process of pushing residual oil with nitrogen in high-pressure cavities is due to the different densities of oil and gas.

Тілеуберді Н.^{1*}, Жолтаев Г.Ж.¹, Абделі Д.Ж.², Оздоев С.М.¹

¹Сәтбаев университеті, Қ.И. Сәтбаев атындағы геологиялық ғылымдар институты, Алматы, Қазақстан;

² Сәтбаев университеті, Алматы, Қазақстан.
E-mail: Nureke-17@mail.ru

ЛАБОРАТОРИЯЛЫҚ ЖАҒДАЙДА ҚАБАТТЫҢ КЕУЕКТІ ҚУЫСТАРЫНДАҒЫ МҰНАЙДЫ АЗОТПЕН ИТЕРУДІҢ МЕХАНИЗМІН ЗЕРТТЕУ

Аннотация. Мақалада әлемдік проблемаға айналып отырған қабаттағы қалдық мұнайды алу кезінде қолданылатын өнімділігі жоғары әрі экономикалық тиімді болатын айдау агенттерін таңдау мәселелері қарастырылды. Мұнайлы қабаттың жіңішке қуыстарындағы және капиллярлы матрицадағы қалдық мұнайды азотпен итерудің тиімділігі талқыланды.

Қабаттың кеуекті қуыстарындағы қалдық мұнайды азотпен итеру барысындағы механизмін ашудың теориясы айтыла келе, оны зертханалық жағдайда жасап көрудің маңызды екендігі баяндалады.

Азот мұнайға қарағанда тығыздығы төмен және газ болғандықтан, жоғары қысымда қуыстар мен капиллярлық матрицаға интенсивті түрде еніп, олардан қалдық мұнайды қуыстардың бойымен өндіру ұңғымаларына қарай ығыстырады деуге болады. Сол себепті, жоғары қысымда қуыстарда қалдық мұнайды азотпен итеру барысы мұнай мен газдың тығыздығының әртүрлі болуы себебінен жүзеге асады.

Лабораториялық жағдайда қабаттың кеуекті қуыстарындағы мұнайды азотпен итеру кезінде қолданылатын құрылғылардың жұмыс жасау механизмі таныстырылды. Солтүстік Қарамандыбас кенорнынан алынған керндердің алдымен құрғақтай және вакуумда мұнаймен қаныққаннан кейінгі салмақтары жеке-жеке өлшеніп алынды. Одан кейін арнайы дайындалған құрылғының көмегімен азотпен итеру жұмыстары жүргізілді. Мұнайға қаныққан керндердегі мұнайды азотпен итеру тәжірибесінен оң нәтижелер алынып, іс жүзінде кеорындарында қабаттың мұнайбергіштігін арттыруға мүмкіндік береді деп қорытынды жасалынды. Жүргізілген лабораториялық жұмыстан алынған оң нәтижелерді сараптай келе, өндіру ұңғыларының түп аймағына азотпен әсер ету арқылы мұнайлы қабаттың жіңішке кеуекті қуыстарындағы қалдық мұнайды шығарып алу тәсілі ретінде қолданып, қабаттың мұнайбергіштігін арттыруға мүмкіндік береді деп тұжырым жасауға болады.

Түйінді сөздер: азот, мұнай, айдау агенті, лабораториялық зерттеу, кеуектілік, өткізгіштік, қабаттың кеуекті қуысы, керн, мұнаймен қанығу.

Тілеуберді Н.^{1*}, Жолтаев Г.Ж.¹, Абделі Д.Ж.², Оздоев С.М.¹

¹Сатпаев университет, Институт геологических наук имени К.И. Сатпаева, Алматы, Қазақстан;

²Сатпаев университет, Алматы, Қазақстан.

E-mail: Nureke-17@mail.ru

ИССЛЕДОВАНИЕ МЕХАНИЗМА ВЫТЕСНЕНИЯ НЕФТИ АЗОТОМ В ПОРИСТЫХ ПОЛОСТЯХ ПЛАСТА В ЛАБОРАТОРНЫХ УСЛОВИЯХ

Аннотация. В статье рассмотрены вопросы выбора высокопроизводительных и экономически эффективных перекачивающих агентов, применяемых при извлечении остаточной нефти пласта, ставшей мировой проблемой. Обсуждалась эффективность вытеснения остаточной нефти азотом в небольших полостях нефтеносного слоя и в капиллярной матрице.

Изложена теория вскрытия механизма вытеснения остаточной нефти азотом в пористых полостях пласта и изложена важность его разработки в лабораторных условиях.

Поскольку азот имеет меньшую плотность, чем нефть и является газом, можно сказать, что при высоком давлении он интенсивно проникает в полости и капиллярную матрицу, вытесняя из них остаточную нефть по полостям в сторону добывающих скважин. Поэтому при высоком давлении процесс вытеснения остаточной нефти азотом в полости осуществляется из-за различной плотности нефти и газа.

В лабораторных условиях был представлен механизм работы устройств, применяемых при вытеснении нефти азотом в пористых полостях пласта. Керн, извлеченный из скважин Северный Карамандыбас, исследовался сначала в сухом вакууме и после насыщения нефтью показатели измеряли отдельно. Затем с помощью специально подготовленного устройства были проведены работы по вытеснению нефти азотом. Получены положительные результаты из опыта вытеснения нефти азотом из нефтенасыщенных кернов, сделан вывод о том, что на практике это позволяет повысить нефтеотдачу пласта. Проанализировав положительные результаты проведенной лабораторной работы, воздействие на призабойную зону пласта в добывающих скважинах позволяет увеличить нефтеотдачу пласта, также способствует извлечению остаточной нефти из тонкопористых полостей нефтяного пласта.

Ключевые слова: азот, нефть, агент нагнетания, лабораторные исследования, проницаемость, пористость пласта, керн, нефтенасыщенность.

Information about the authors:

Tileuberdi N. – Satbayev University, Institute of Geological Sciences named after K. I. Satbayev, Almaty, Kazakhstan; Nureke-17@mail.ru; <https://orcid.org/0000-0003-0781-2434>;

Zholtayev G.Zh. – Satbayev University, Institute of Geological Sciences named after K. I. Satbayev, Almaty, Kazakhstan; zholtaev.geroy@mail.ru, <https://orcid.org/0000-0003-0167-0412>;

Abdeli D.Zh. – Satbayev University, Institute of Geology, Oil and Mining, Department of Petroleum Engineering, Almaty, Kazakhstan. d.abdeli@mail.ru, <https://orcid.org/0000-0002-1753-4952>;

Ozdoyev S.M. – Satbayev University, Institute of Geological Sciences named after K. I. Satbayev, Almaty, Kazakhstan; Ozdoyevsultan@mail.ru; <https://orcid.org/0000-0003-0262-1583>

REFERENCES

1. P.P. Ermakov, N.A. Eremin. Nitrogen injection into porous media for enhanced oil recovery [Nagnetanie azota v poristye sredy dlja uvelichenija neftiotdachi] // *Geology, geophysics and oil field development*. 1996 (11). Moscow.P. 45-51 (in Russ.).
2. S. Siregar, A.D. Hidayaturobbi, B.A. Wijaya, S.N. Listiani, T. Adiningrum. Laboratory Experiments on Enhanced Oil Recovery with Nitrogen Injection // *Journal of Engineering and Technological Sciences Institut Teknologi Bandung*. Vol. 39 B, No. 1, 2007, 20-27 Received May 29th, 2006.
3. A. Jamaluddin et al., “An investigation of asphaltene instability under nitrogen injection,” in *Proc. SPE International Petroleum Conference and Exhibition in Mexico*, 2002.
4. Ignatiev N.A., Sintsov I.A. Experience and prospects of nitrogen injection in the oil and gas industry [Opyt i perspektivy zakachki azota v neftegazovoj promyshlennosti] // *Fundamental research*. - 2015. - No. 11-4. - P. 678-682 (in Russ.).
5. D.A. Hudgins, F.M. Lave, and F.T. Chung, “Nitrogen miscible displacement of light crude oil: a laboratory study,” *SPE Reservoir Engineering*, 1990, vol. 5, no. 1, pp. 100-106.
6. S.M. Ozdoyev, N. Tileuberdi. Geological prerequisites for increasing oil production at the North Karamandybas field // *News of National Academy of Sciences of the Republic of Kazakhstan. Series of geology and technical sciences*. ISSN 2224-5278, Vol. 4, Number 424 (2017), Алматы, 2017. pp.276-280.
7. DONG Wei, JIAO Jian, XIE Shijian, LYU Cuiyan, CUI Gang, MENG Jie. Cumulative production curve method for the quantitative evaluation on the effect of oilfield development measures: A case study of the nitrogen injection pilot in Yanling oilfield, Bohai Bay Basin // *Petroleum exploration and development*. 2016, 43(4): P. 672–678.
8. Ozdoyev S.M., Abduev N.S., Popov V.A., Tileuberdi N., Dong M.H.; Common and differing geological features of the Alakol and Chinese Dzungarian troughs in view of their oil-and-gas prospects; *News of the National Academy of Sciences of the Republic of Kazakhstan, Series of Geology and Technical Sciences*; 2019, 4 (436) ,pp.6; DOI: [10.32014/2019.2518-170X.92](https://doi.org/10.32014/2019.2518-170X.92) .

МАЗМҮНЫ-СОДЕРЖАНИЕ-CONTENTS

Abuova R.Zh., Ten E.B., Burshukova G.A. STUDY OF VIBRATION PROPERTIES OF CERAMIC-METAL NANOSTRUCTURAL TIN-CU COATINGS WITH DIFFERENT COPPER CONTENT 7 AND 14 AT. % ON CHROMIUM-NICKEL-VANADIUM STEELS.....	6
Abetov A., Kudaibergenova S. INTEGRATED RESEARCH OF SUFFOSION AND KARST PROCESSES AT THE KOGCF BY GEOLOGICAL AND GEOPHYSICAL AND GEODESIC METHODS.....	14
Amangeldykyzy A., Kopobayeva A.N., Bakyt A., Ozhigin D.S., Blyalova G.G. MINERALOGY AND GEOCHEMISTRY OF THE SHUBARKOL DEPOSIT JURASSIC COALS.....	23
Dikanbayeva A.K., Auyeshov A.P., Satayev M.S., Arynov K.T., Yeskibayeva Ch.Z. RESEARCHING OF SULFURIC ACID LEACHING OF MAGNESIUM FROM SERPENTINES.....	32
Duisen G.M., Aitzhanova D.A. NATURAL RESOURCE POTENTIAL OF KAZAKHSTAN AND CENTRAL ASIAN COUNTRIES: PROSPECTS OF USE.....	39
Edygenov E.K., Vassin K.A. ELECTROMAGNETIC VEHICLE WITH AUTOMATED CONTROL SYSTEM FOR SURFACE MINING OPERATIONS.....	47
Ismailov B.A., Dossaliev K.S. TECHNOLOGICAL REGULATIONS OF CONDITIONS IN PRODUCTION OF FERTILIZER MIXTURES “ZHAMB-70”.....	54
Issagaliyeva A.K., Istekova S.A., Aliakbar M.M. GEOPHYSICAL DATA COMPLEX INTERPRETATION TECHNIQUES FOR STUDIES OF THE EARTH CRUST DEEP HORIZONS IN THE NORTH CASPIAN REGION.....	61
Mekhtiyev A.D., Soldatov A.I., Neshina Y.G., Alkina A.D., Madi P.Sh. THE WORKING ROOF ROCK MASSIF DISPLACEMENT CONTROL SYSTEM.....	68
Mustafayev Zh.S., Kozykeeva A.T., Tursynbayev N.A., Kireychev L.V. APPLIED MODEL OF ENVIRONMENTAL SERVICES - DEVELOPMENT OF ECOLOGICAL AND ECONOMIC DRAINAGE SYSTEM OF TRANSBOUNDARY RIVER BASINS (on the example of the Talas river basin).....	77
Petr Hajek, Baimaganbetov R.S. GEOSTABILIZATION OF ECOLOGICAL EQUILIBRIUM AS A RESULT OF FOREST FIRES.....	84
Salikhov N.M., Pak G.D., Shepetov A.L., Zhukov V.V., Seifullina B.B. HARDWARE-SOFTWARE COMPLEX FOR THE TELLURIC CURRENT INVESTIGATION IN A SEISMICALLY HAZARDOUS REGION OF ZAILIYSKY ALATAU.....	94

Saukhimov A.A., Ceylan O., Baimakhanov O.D., Shokolakova Sh.K. REDUCING POWER AND VOLTAGE LOSSES IN ELECTRIC NETWORKS OF OIL FIELDS USING THE MOTH FLAME OPTIMIZATION ALGORITHM.....	103
Soltanbekova K.A., Assilbekov B.K., Zolotukhin A.B., Akasheva Zh.K., Bolysbek D.A. RESULTS OF LABORATORY STUDIES OF ACID TREATMENT OF LOW-PERMEABILITY ROCK CORES.....	113
Surimbayev B., Bolotova L., Shalgymbayev S., Razhan E. RESEARCH OF THE COMPLEX STAGE-BY-STAGE SCHEME OF GRAVITY SEPARATION OF GOLD ORE.....	124
Temirbekov N.M., Los V.L., Baigereyev D.R., Temirbekova L.N. MODULE OF THE GEOINFORMATION SYSTEM FOR ANALYSIS OF GEOCHEMICAL FIELDS BASED ON MATHEMATICAL MODELING AND DIGITAL PREDICTION METHODS.....	137
Tileuberdi N., Zholtayev G.ZH., Abdeli D. Zh., Ozdoev S.M. INVESTIGATION OF DRAINAGE MECHANISM OF OIL FROM PORES OF OIL SATURATED ROCKS USING NITROGEN AT THE LABORATORY CONDITION.....	146
Tleulesov A.K., Suyundikov M.M., Shomanova Zh.K., Akramov M.B., Suiindik N.M. ASSESSMENT OF QUALITATIVE AND QUANTITATIVE ELEMENTAL COMPOSITION OF WASTE IN THE TERRITORY OF SLUDGE COLLECTOR OF PAVLODAR ALUMINIUM PLANT.....	153
Turgumbayev J.J., Turgunbayev M.S. PREDICTION OF THE CUTTING RESISTANCE FORCE OF THE SOIL CONTAINING STONY FRACTIONS.....	161
Uakhitova B., Ramatullaeva L., Imangazin M., Taizhigitova M., Uakhitov R. ON THE STATE OF INDUSTRIAL INJURIES OF WORKERS IN INDUSTRIAL ENTERPRISES OF THE AKTUBINSK REGION.....	170
Sherov K.T., Sikhimbayev M.R., Absadykov B.N., Karsakova N.Zh. Myrzakhmet B. METROLOGICAL ENSURING ACCURACY OF MEASUREMENT OF ANGLES V-SHAPED SURFACES GUIDE PARTS OF MACHINES FOR PETROCHEMICAL AND GEOLOGICAL EXPLORATION INDUSTRY.....	176

Publication Ethics and Publication Malpractice in the journals of the National Academy of Sciences of the Republic of Kazakhstan

For information on Ethics in publishing and Ethical guidelines for journal publication see <http://www.elsevier.com/publishingethics> and <http://www.elsevier.com/journal-authors/ethics>.

Submission of an article to the National Academy of Sciences of the Republic of Kazakhstan implies that the described work has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis or as an electronic preprint, see <http://www.elsevier.com/postingpolicy>), that it is not under consideration for publication elsewhere, that its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere in the same form, in English or in any other language, including electronically without the written consent of the copyright-holder. In particular, translations into English of papers already published in another language are not accepted.

No other forms of scientific misconduct are allowed, such as plagiarism, falsification, fraudulent data, incorrect interpretation of other works, incorrect citations, etc. The National Academy of Sciences of the Republic of Kazakhstan follows the Code of Conduct of the Committee on Publication Ethics (COPE), and follows the COPE Flowcharts for Resolving Cases of Suspected Misconduct (http://publicationethics.org/files/u2/New_Code.pdf). To verify originality, your article may be checked by the Cross Check originality detection service <http://www.elsevier.com/editors/plagdetect>.

The authors are obliged to participate in peer review process and be ready to provide corrections, clarifications, retractions and apologies when needed. All authors of a paper should have significantly contributed to the research.

The reviewers should provide objective judgments and should point out relevant published works which are not yet cited. Reviewed articles should be treated confidentially. The reviewers will be chosen in such a way that there is no conflict of interests with respect to the research, the authors and/or the research funders.

The editors have complete responsibility and authority to reject or accept a paper, and they will only accept a paper when reasonably certain. They will preserve anonymity of reviewers and promote publication of corrections, clarifications, retractions and apologies when needed. The acceptance of a paper automatically implies the copyright transfer to the National Academy of Sciences of the Republic of Kazakhstan.

The Editorial Board of the National Academy of Sciences of the Republic of Kazakhstan will monitor and safeguard publishing ethics.

Правила оформления статьи для публикации в журнале смотреть на сайтах:

[www:nauka-nanrk.kz](http://www.nauka-nanrk.kz)

<http://www.geolog-technical.kz/index.php/en/>

ISSN 2518-170X (Online),

ISSN 2224-5278 (Print)

Редакторы: *М.С. Ахметова, А. Ботанқызы, Д.С. Аленов, Р.Ж. Мрзабаева*
Верстка на компьютере *Г.Д.Жадыранова*

Подписано в печать 15.08.2021.
Формат 60x881/8. Бумага офсетная. Печать – ризограф.
4,6 п.л. Тираж 300. Заказ 4.