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

6 (456)

NOVEMBER – DECEMBER 2022

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. Webof 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.

«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/

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

«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 соеденений.*

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/

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

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/

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 6, Number 456 (2022), 169-184
https://doi.org/10.32014/2518-170X.247

UDC 665.6/.7: 665.733.

K.N. Orazbayeva[1], M.K. Urazgaliyeva[2], Zh.Zh. Moldasheva[3*], N.K. Shazhdekeyeva[4], D.O. Kozhakhmetova[5]

[1]Esil University, Astana, Kazakhstan;
[2]S. Utebayev Atyrau Oil and Gas University, Atyrau, Kazakhstan;
[3]L.N. Gumilyov Eurasian National University, Astana, Kazakhstan;
[4]Kh. Dosmukhamedov Atyrau University, Atyrau, Kazakhstan;
[5]University Shakarim, Semey, Kazakhstan.
E-mail: zhadira1985@mail.ru

PROBLEMS OF INCREASING THE DEPTH OF GEOLOGICAL EXPLORATION AND OIL REFINING IN KAZAKHSTAN AND APPROACHES TO THEIR SOLUTION

Abstract. At present, the depth of oil geoexploration and processing in Kazakhstani oil refineries has increased after the modernization, but still lags behind similar indicators in the United States and other countries with developed technology for deep oil refining and geological exploration of oil. In this regard, the introduction of promising methods and technologies for increasing the depth of oil refining and geoexploration in Kazakhstani oil refineries and geology is an urgent problem for the oil refining and geoexploration industries of the republic, as well as science and technology. To study and solve this problem, this paper uses analytical, experimental and statistical methods, physicochemical methods of analysis, as well as methods of geological exploration of oil and deep oil processing and acoustic methods.

The paper studies a cluster scheme for the development of oil geoexploration and oil refining industries in Kazakhstan and proposes a basic scheme for the formation of a cluster of geological and petrochemical industries of the republic. Methods and technologies for increasing the depth of oil geoexploration and its processing are analyzed. The technology of oil exploration and processing of heavy oil fractions, in which raw materials and catalyst will not be in contact, is justified as a promising technology for increasing the depth of oil geoexploration and processing of heavy oils, oil fractions. A technology is proposed for increasing the depth of oil geoexploration and oil refining through deep oil exploration and processing of heavy oil fractions based on cavitation technology. A scheme of the installation is presented and described, which makes it possible to effectively implement this technology of deep oil geoexploration and processing of heavy oil fractions based on electromagnetic oscillations and wide spectrum acoustic frequencies. The results of the study in the work can be applied in practice to increase the depth of oil geoexploration and oil refining by increasing the deep oil geoexploration and oil refining of heavy oil fractions.

Key words: Geoexploration, oil geology, depth of geoexploration and oil refining, oil refining, petrochemistry, heavy oil fractions, cavitation.

К.Н. Оразбаева[1], М.К. Уразгалиева[2], Ж.Ж. Молдашева[3*], Н.К. Шаждекеева[4], Д.О. Кожахметова[5]

[1]Esil University, Астана, Қазақстан;
[2]С. Өтебаев атындағы Атырау мұнай және газ университеті, Атырау, Казақстан;
[3]Л.Н. Гумилев атындағы Еуразия ұлттық университеті, Астана, Қазақстан;
[4]Х. Досмұхамедов атындағы Атырау университеті, Атырау, Казақстан;
[5]Семей қ. Шәкәрім атындағы университеті, Семей, Қазақстан.
E-mail: zhadira1985@mail.ru

ҚАЗАҚСТАНДА МҰНАЙ ГЕОЛОГИЯСЫ МЕН ОНЫ ӨҢДЕУ ТЕРЕҢДІГІН АРТТЫРУ МӘСЕЛЕЛЕРІ МЕН ОЛАРДЫ ШЕШУ ТӘСІЛДЕМЕЛЕРІ

Аннотация. Қазіргі уақытта қазақстандық мұнай геологиясында барланып, өндірілген мұнайды өңдеу өңдеу тереңдігі модернизациялаудан кейін біраз өсті, алайда әлі де АҚШ және мұнайды терең өңдеу технологиясы мен барлау геологиясы дамыған басқа елдердегі ұқсас көрсеткіштерден артта қалып отыр. Сондықтан қазақстандық мұнай өңдеу зауыттарында мұнай өңдеу тереңдігін арттырудың перспективалық әдістері мен технологияларын енгізу республиканың мұнай геологиясы мен оны өңдеу, мұнай-химия өнеркәсіптерінің, сондай-ақ ғылым мен техника үшін өзекті мәселе болып табылады. Аталған мәселені зерттеу және шешу үшін бұл зерттеу жұмысында аналитикалық, тәжірибелік-статистикалық әдістер мен талдаудың физика-химиялық әдістері, сондай-ақ мұнай геологиясы мен мұнайды терең өңдеу әдістері және акустикалық әдістер қолданылады.

Жұмыста Қазақстанның мұнай геологиясы және мұнай өңдеу өнеркәсібін дамытудың кластстерлік схемасы зерттеліп, республиканың мұнай-химия өнеркәсібінің класстерін қалыптастырудың принципиалдық схемасы ұсынылады. Мұнай геологиясы мен мұнай өңдеу тереңдігін арттыру әдістері мен технологиялары талданған. Шикізат пен катализатор байланыста болмайтын мұнайдың ауыр фракцияларын өңдеу технологиясы ауыр мұнайды, мұнай фракцияларын және мұнай өңдеу қалдықтарын өңдеу тереңдігін арттырудың перспективалы технологиясы ретінде негізделген. Кавитациялық технология негізінде мұнай геологиясы мен ауыр мұнай фракцияларын терең өңдеу есебінен мұнай өңдеу тереңдігін арттыру технологиясы ұсынылған. Геологияда электромагниттік тербелістер мен кең спектрлі акустикалық жиіліктер негізінде ауыр мұнай фракциялары мен мұнай өңдеу қалдықтарын терең өңдеу үшін осы технологияны тиімді жүзеге асыруға мүмкіндік беретін қондырғының схемасы ұсынылып, сипатталған. Электромагниттік тербелістер мен кең спектрлі акустикалық жиіліктер негізінде мұнай геологиясы мен ауыр мұнай фракциялары мен мұнай өңдеу қалдықтарын терең өңдеу үшін осы технологияны тиімді жүзеге асыруға мүмкіндік беретін қондырғының схемасы ұсынылып, сипатталған. Жұмыстың зерттеу нәтижелері мұнай геологиясы мен ауыр мұнай фракциялары мен қалдықтарын терең өңдеу есебінен мұнай барлау геологиясы және мұнай өңдеу тереңдігін арттыру үшін практикада қолданылуы мүмкін.

Түйін сөздер: барлау геологиясы, мұнай геологиясы, мұнай барлау геологиясы мен мұнай өңдеу тереңдігі, мұнай өңдеу, мұнай химиясы, ауыр мұнай фракциялары, кавитация.

К.Н. Оразбаева[1], Ж.Ж. Молдашева[2], М.К. Уразгалиева[3*], Н.К. Шаждекеева[4], Д.О. Кожахметова[5]

[1] Esil University, Астана, Казахстан;
[2] С. Өтебаев атындағы Атырау мұнай және газ университеті, Атырау, Казақстан;
[3] Евразийский национальный университет имени Л.Н. Гумилев, Астана, Казахстан;
[4] Атырауский университет им. Х. Досмухамедова, Атырау, Казахстан;
[5] Университет имени Шакарим, Семей, Казахстан.
E-mail: zhadira1985@mail.ru

ПРОБЛЕМЫ УВЕЛИЧЕНИЯ ГЛУБИНЫ ГЕОЛОГОРАЗВЕДКИ НЕФТИ И НЕФТЕПЕРЕРАБОТКИ В КАЗАХСТАНЕ И ПОДХОДЫ К ИХ РЕШЕНИЮ

Аннотация. В настоящее время глубина геологоразведки нефти и переработки ее в казахстанских нефтеперерабатывающих заводах после проведенных модернизации выросла, но еще отстает от аналогичных показателей США и других стран с развитой технологией глубокой нефтепереработки и геологоразведки нефти. В связи с этим внедрение перспективных способов и технологии повышения глубины переработки и геологоразведки нефти в казахстанских нефтеперерабатывающих заводах и геологии является актуальной проблемой нефтеперерабатывающей и геологоразведочной отраслей республики, а также науки и технологии. Для исследования и решения данной проблемы в данной работе применяются аналитические, экспериментально-статистические методы, физико-химические методы анализа, а также методы геологоразведки нефти и глубокой переработки нефти и акустические методы.

В работе исследована кластерная схема развития отралей геологоразведки нефти и нефтепереработки Казахстана и предложена принципиальная схема формирования кластера геологической и нефтехимической отраслей республики. Проанализированы способы и технологии повышения глубины геологоразведки нефти и ее переработки. Технология геологоразвелдки нефти и переработки тяжелых нефтяных фракций, в которых сырье и катализатор не будут в контакте обоснованы как перспективная технология для повышения глубины геологоразведки нефти и переработки тяжелых нефтей, нефтяных фракциий. Предложена технология увеличения глубины геологоразведки нефти и нефтепереработки за счет глубокой разведки нефти и переработки тяжелых нефтяных фракций на основе кавитационной технологии. Приведена и описана схема установки, позволяющая эффективно реализовать данную технологию глубокой геологоразведки нефти и переработки тяжелых фракций нефти на основе электромагиниттных колебаний и акустических частот широкого спектра. Полученные результаты исследования в работе имеет имеет возможность применения на практике для повышения глубины геолоразведки нефти и нефтепереработки за счет увеличения глубокой геологоразведки нефти и нефтепереработки тяжелых нефтяных фракций.

Ключевые слова: георазведка, геология нефти, глубина геологоразведки и переработки нефти, нефтепереработка, нефтехимия, тяжелые нефтяные фракции, кавитация.

Introduction. A significant role in the development of the economy of any modern oil country is played by implementation of efficient ways of oil refining depth, technologies to improve it. So far, the oil refinery in the Republic of Kazakhstan has a much lower refining depth than in other developed countries, such as in the United States, where this figure exceeds 95% (Medieva, et al. 2017, Orazbayev, et al. 2020:498527). As a result of the upgrade of Kazakhstan's refineries jointly with foreign companies their oil refining depths have recently improved, in particular, the average oil refining depth has increased from 74.53% to 84.4%.

The depth of refining, the ratio of the commercial petroleum products volume produced to the volume of total raw material (oil) used, for example, determines how much of useful products are extracted from 1 ton of oil, and is the most important indicator of the efficiency of oil refineries. Therefore, deep oil refining allows efficient use of each ton of oil.

Despite the fact that as a result of the upgrades carried out the depth of oil refining has now increased at the Atyrau Oil Refinery by 86.4%, at the Shymkent Oil Refinery by 81.6%, and at the Pavlodar Petrochemical Plant up to 85% (Orazbayev, et al. 2019:182194, Kuznestov, 2022), these figures are still a decrease compared to the same indicators in developed countries. These plants are still dominated by volumes of hydrocarbons in the form of fuel oil and gas, which instead of further deep processing are still burnt away in power plants, thermal plants, a part of them is burnt away by flares. Whereas hydrocarbons in the form of fuel oil and gas are of great value in oil and gas chemistry and are an important raw material for products (Kaminsky, 2019).

Vertically integrated oil and gas companies in the USA, Canada and Western Europe derive most of their revenues not from sales of crude oil and gas, but from the deep processing thereof: tires and rubber products; plastics; fertilizers; synthetic fabrics and products; medication and agricultural pest control agents; jet and rocket fuels; natural and synthetic oils, etc. from sales on the world market.

As the depth of primary oil and gas products (methane, ethane, ethylene, propane and other) processing increases and synthetic monomers, polymers and other chemical products as well as quality fuels, natural and synthetic petroleum oils, bitumens, cokes, etc. are produced, prices increase by 3-7 times (Moldasheva, et al. 2022).

In the economically developed countries such as the USA, Canada, Great Britain the oil most deeply refined is the oil, from which a large range of particularly valuable products is produced, such as petrochemicals, synthetic substances, paints, etc. And these products are essential for household and space equipment, modern new technologies, agriculture and other industries. Special attention might be drawn to natural and synthetic oils. This is due to the fact that these products are not produced in the Republic, they are delivered practically from abroad. Distillation and residual natural oils are obtained from petroleum waste, such as fuel oil, whereas synthetic oils are obtained through chemical synthesis of multigrain oil. The fuel oil is not used in the Republic for further production of oils, it is primarily used for boiler fuel, i.e. it is used inefficiently.

Oil and gas condensates recently discovered and developed in the Republic are characterized by high hydrogen sulfide and mercaptan sulfur content (Orazbayev, et al. 2020: 12351241). Therefore, elementary sulfur and purified feedstock are obtained at the Tengiz, Zhanazhol and Karachaganak oil and gas refineries, where the oil firstly undergo several stages of desulphurization. Elementary sulfur instead of further application is being accumulated on the territory of these plants and causes serious damage to the environment. Meanwhile, refined feedstock forms a mixture of high-quality light oil products and gases, which contains 75-85% of gasoline and diesel fractions. The above refineries produce only process and domestic gases from such feedstock, and the liquid part is mainly exported in the form of light oil, only a small part is sent to refineries for further processing (Kuanbayeva, et al. 2022).

Thus, under modern conditions the main line of economic and «green» development of Kazakhstan is an integrated deployment of raw materials, including oil resources and increase in the depth of their processing. The need for efficient development of the oil refining sector is also substantiated by the constant growth of demand on domestic and foreign markets for oil refinery products, which are the most important raw materials and energy source for many sectors of the national economy (Orazbayev, et al. 2020:10211036). Development of oil refining industry should be aimed at ensuring stable demand for petroleum products, efficient primary and deep oil refining processes and increasing the depth of oil refining through the reconstruction of existing facilities, implementation of new technologies (Kuanbayeva, et al. 2022). Therefore at present the provision of science-based approaches (techniques) and technologies to study and solve the problems of increasing the depth of oil refining in Kazakhstan is a relevant scientific and practical issue, which is especially important for the oil refining industry.

The purpose of this paper is to study the problems of increasing the depth of oil processing in Kazakhstan and to propose approaches to solution thereof.

In order to achieve the formulated goal, the following main tasks are being solved and studies are being carried out:

- study and description of the cluster scheme of development of oil refining and petrochemical industries in Kazakhstan;
- study of methods and technology to improve the depth of oil refining
- development of a technology to increase the depth of oil refining through deep processing of heavy oil fractions.

Research materials and methods. In this paper the research materials are analytical data and expert information on assessing the state of the oil refining industry development in the world, including Kazakhstan, as well as data on technologies and ways to increase the depth of oil refining (Orazbayev, et al. 2020:498507, Kaminsky, 2019, Orazbayev, et al. 2021, Sansyzbay, et al. 2021, Orazbayev, et al. 2020:113). In addition, results of acoustic cavitation application in the processes of deep refining of heavy oil fractions utilized to develop a technology and a unit to increase the depth of oil refining (Promtov, 2017) are used as research materials.

As it is known, cavitation is a physical process, in which bubbles (voids) are formed in liquids, followed by collapse of these bubbles and release of large amounts of energy (Dumitrash, et al. 2019). This energy can cause damage to various equipment, but it is also possible to deploy this energy beneficially in various processes, for example, acoustic cavitation can be used efficiently in petroleum refining processes. During acoustic cavitation there is a point increase in temperature and pressure by a significant amount. For efficient utilization of cavitation energy, a special cavitation unit should be constructed (Bytilin, 2022). This paper will propose an efficient technology to increase the depth of refining heavy oil fractions using cavitation unit with a generator of electromagnetic waves and beam distribution antenna.

Thus, this paper uses analytical, experimental-statistical methods and physical-chemical methods of analysis (Botev, et al. 2020, Israilova, et al. 2021, Rakhmetov, et al. 2022), as well as acoustic technology methods to study the problems of oil refining depth increase and to solve them (Promtov, 2017, Dumitrash, et al. 2019, Kapranov, 2018).

Results. 1) Cluster scheme of development of oil refining and petrochemical industries in Kazakhstan. Recently the issues of oil refining and chemical industry development according to the cluster scheme have been increasingly discussed in the country. It is the right direction. But in order to develop the cluster scheme it is necessary, first of all, to provide its primary chain with raw materials and substantiate economic efficiency of production of final target products competitive on the market.

Production of petrochemical raw materials is a promising operation line of Atyrau Oil Refinery; as the plant is located on the main oil deposit field of Kazakhstan the problem of recyclables will not arise today and in the nearest future. The Atyrau Oil Refinery is solving these issues in order to be independent from external sources of recyclables; for example, the facilities for aromatic hydrocarbons production - benzene and paraxylene - based on the new technologies have been built and put into operation. Benzene and paraxylene are the raw materials for the petrochemical industry. The facility for introduction of aromatic hydrocarbons integrates the Atyrau Oil Refinery into the single chain of petrochemical industry being developed in Kazakhstan.

The first integrated petrochemical facility for production of world-class basic petrochemical products designed for 1.25 million tons of products per year including 800 thousand tons of polyethylene and 450 thousand tons of polypropylene has been constructed in Kazakhstan. The basic diagram for development of the petrochemical cluster in Kazakhstan is shown in Figure 1.

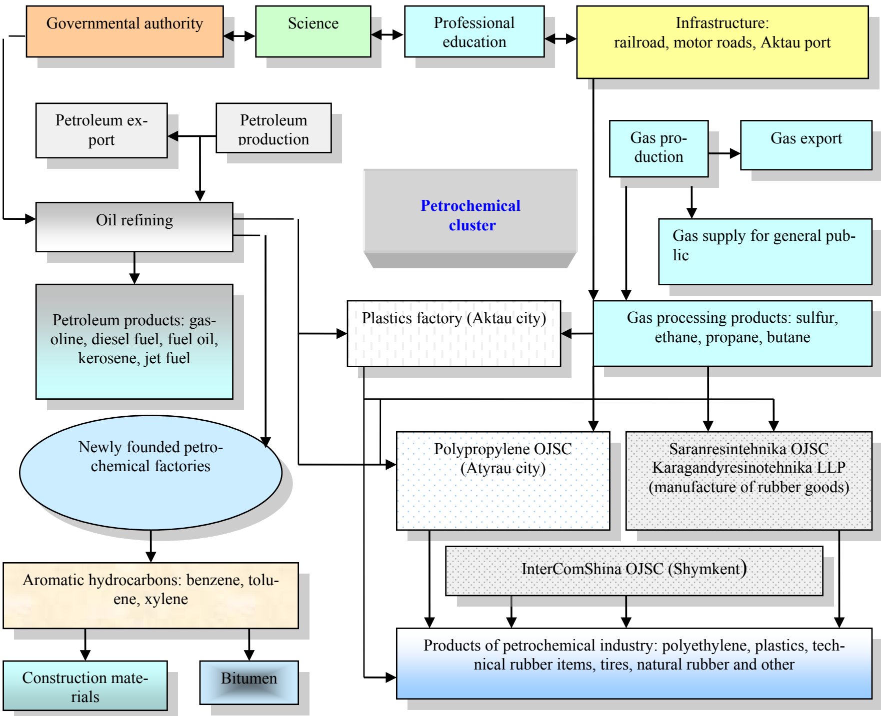


Figure 1 - Basic diagram of petrochemical cluster development.

2) Methods and technologies to increase the depth of oil refining. The issue of increasing the depth of oil refining is high on the agenda at all times. New technologies have appeared, some of which have been introduced into production and some of which have not. The technology described in this paper allows to receive annually large additional volumes of profit and to save hundreds of millions of tons of raw materials, completely providing the market with high-quality fuels and lubricants, motor fuel.

The general tendency in the oil industry is determined by the reduction of light oil reserves; recently heavy, viscous, sulfurous petroleum forms the basis of reserves. By means of widely used catalytic technologies it is impossible to bring the refining depth to 100% because heavy oil wastes can quickly poison and coke the active layer of any catalysts. Due to high content of metallic, sulfuric, nitrogen impurities and other harmful compounds in the feedstock the activity of catalysts declines fast, their pores get fixed, the surface of catalyst gets covered with tar and coke residues. All this reduces selectivity and efficiency of classical catalytic processes. Constant preparation and renewal of catalysts, quick replacement and disposal thereof increase additional capital and operating expenses, refining process and net cost of products being produced. Therefore deep processing of oil and oil wastes is currently a serious challenge.

The main peculiarity and advantage of the method and technology proposed in this paper is that heavy feedstock with a large number of various harmful compounds is not in direct contact with the catalyst. First the feedstock is subjected to non-catalytic soft cracking (e.g. thermal or thermo-mechanical cracking). The cracking process produces unsaturated hydrocarbons that may later condense limiting the refining depth. In order to achieve full and deep refining, increase the consumption of target light products and fractions it is necessary to complement the refining scheme with a device that saturates open bonds with atomic hydrogen or light radicals at minimum cost.

The problem can be solved by arranging a process scheme, in which the heavy feedstock with harmful impurities and the catalyst are not in contact so that the catalyst is not poisoned by harmful impurities and does not coke, which, in turn, ensures catalyst durability, there is no need to regenerate and replace it. With this purpose the molecular hydrogen or light hydrogen-containing media such as natural gases, part of the light fractions obtained in the refining process are sent to the catalyst reactor heated to a temperature necessary to produce active mono-atomic hydrogen or light radicals. This reactor forms a unit for the production of mono-atomic hydrogen or light radicals. The resulting active hydrogen or light radicals given their high reactive properties direct the liquid non-catalytic feedstock to the heating unit for the reaction. The hydrogen containing mixture saturated with hydrogen and the catalyst reactor can be heated by the heat of the heated feedstock or the heavy fractions subjected to processing. The pressure in the catalyst reactor should be higher than the pressure in the non-catalytic cracking reactor.

Hydrogen or light radicals can be obtained from high quality light fractions by saturating open bonds of unsaturated hydrocarbons. The light saturated hydrocarbons of the reaction are continuously removed from the process by light target products (compressed gas, gasoline, jet and diesel fuel, petrochemical products). In this process the amount of harmful impurities, e.g. sulfur impurities, is reduced during refining of the feedstock. In the course of processing the most of the sulfur goes to sulfuric acid, from which atomic sulfur and other useful products are obtained by well-known methods. The heavy fractions are sent for recycling. Processing of heavy fractions makes it possible to reach the processing depth of 100%. Molecular hydrogen that did not participate in reaction or light hydrogen saturated with hydrogen is sent for recycling in the beginning of the middle process. If necessary, some parts of the heavy fractions may be sent to obtain heavy marketable products (bitumen, coke and other). While the extraction of molecular hydrogen is currently considered to be one of the expensive processes, the use of natural or associated gas (which in most cases is flared) to produce atomic hydrogen or light radicals allows to minimize the cost of deep processing.

The technology has been tested on a small laboratory unit (Vyatkin, al et, 2017). As a result of tests the depth of heavy oil fractions refining reached 97-98%. Considering the generated condensation gases it can be concluded that the proposed technology can increase the refining depth up to 100%.

In this technology the heavy feedstock is not in direct contact with the catalyst, therefore the catalyst is not poisoned and coked, there is no need for catalyst regeneration and replacement, the process becomes easier and its reliability increases, the cost of process and equipment decreases significantly, i.e. the capital and operating costs decrease, the processing depth can reach 100%. Whereas raw materials are saved during production of the required volume of target marketable products; in other words, application of the described technology enables optimal utilization of raw material resources.

3) Technology and unit for increasing oil refining depth through deep processing of heavy oil fractions

Let us consider a method of deep processing of petroleum containing heavy fractions and devices of realization thereof. When processing heavy oil fractions in order to obtain additional white oil products the method of thermal decomposition of heavy oil fractions in the presence of known catalytic cracking – catalyst - is widely used. However this known method can not increase the yield of light oil products by more than 5478% due to the limited activity and selectivity of the catalyst used, besides the method is expensive and difficult to implement. Other method is known, which involves refining by sequential separation of fractions of hydrocarbon raw materials using electromagnetic energy at a frequency of 300 MHz-300 GHz. The disadvantage of this method is the inability to fully use the raw materials in the course of processing due to the tension of electromagnetic space. There are methods of impacting the petroleum products by ionized radiation (by neutron flux or emission of γ-radiation) and subsequent products processing by Catalonian cracking. But application of this approach in production is inefficient because of complexity, complexity of process control, and its application is dangerous.

Thus, as a result of analysis of approaches and equipment to increase the depth of refining of heavy oil fractions the following research issues can be raised: increase of productivity of industrial processing of heavy oil fractions in large volumes; simplification of technological process of cracking of heavy oil fractions, reduction of power inputs while maintaining the quality of the final product.

To solve the set issues when applying the known methods of refining of heavy oil fractions the feedstock is fed into the refining zone, the feedstock is subjected to a wave impact in the frequency spectrum. Then the affected products are treated by thermal cracking and final products are obtained from the phase in the form of steam. And the novelty of the proposed approach lies in the fact that in the processing medium the wave effect is performed within a wide frequency range from acoustic to radiation frequency, and the thermal cracking of the affected products occurs in the mode of primary oil refining.

In the primary oil refining mode thermal cracking occurs at atmospheric pressure and maximum heating temperature of 360°C. Processing of heavy oil fractions at the proposed frequency of a wide spectrum (in the range from acoustic frequency to radiation frequency) has a simultaneous mechanical and chemical effect on the molecules of the processed raw materials, as a result of which their activity increases. As a consequence of this the intermolecular bonds weaken considerably and the processed raw materials are effectively prepared for further decomposition into lighter fractions. This results in the conditions for a considerable simplification of the process of thermal cracking of the feedstock, in particular the critical parameters of temperatures of boiling, evaporation, decomposition of the feedstock, which activity increases because of the weakening of intermolecular bonds. As a result of this the heavy oil fractions processed by the wave effect at wide spectral frequencies can be decomposed into lighter fractions under the standard conditions of the primary oil processing, in particular under atmospheric pressure and a maximum temperature of oil heating of 360°C. Such mode of processing considerably facilitates decomposition of heavy fractions into lighter ones, and the depth of processing reaches the level of catalytic cracking.

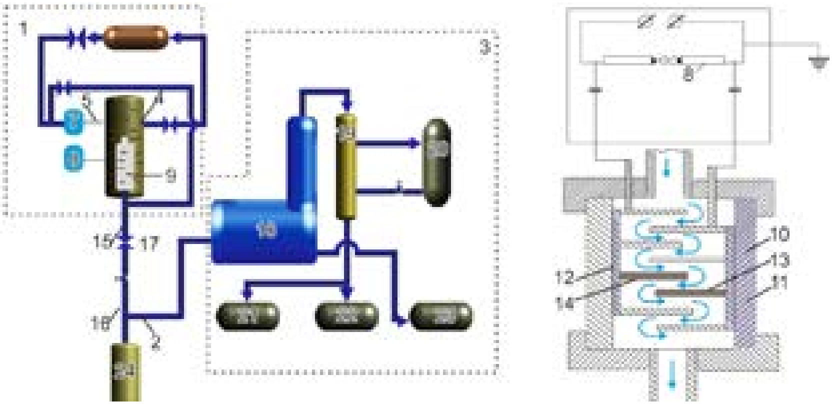
In order to solve the indicated problems the unit for processing of heavy oil fractions is proposed. The unit consists of: a device for processing of initial raw materials made in the form of an operating tank; generator and emitter of oscillations; a device for separation of the final product. The generator of vibration and its radiator are referred to new devices among them, which devices are made in the form of a radiator and the generator of acoustic oscillations electrically connected with the radiating antenna located in the operating tank, and the generator of additional electromagnetic oscillations. The device for obtaining end products consists of a cracking boiler of derivative products, connected with a dephlegmator-distillator, and a container for collection of finished products and cracking waste.

The generator of electromagnetic oscillations can be made in the form of a device for obtaining electroshock fire. An electrocentrifugal pump installed on the vessel inlet pipe is used as a generator of acoustic oscillations, and a pipe of feedstock into the container is utilized as an appliance for distribution of acoustic oscillations.

Efficient conditions for physical and chemical changes of molecules of heavy oil-containing fractions have been created along with the cavitation effect on the processing raw materials by means of the device design recommended for processing of initial raw materials in the unit, in particular by means of nodes impacting the processing medium with a wide range of emitting, modulated frequencies. This can be explained as follows. The electromagnetic waves emanating from the electromagnetic generator are transmitted to the radiating antenna made as per the proposed design in the form of two circuits in the operating tank, where the processed raw material is located. A region of wide transmission frequency spectrum is formed in this radiating antenna. And due to the difference in electrochemical potentials in the metal plates and their alternation with each other their catalytic effect on formation of infrared waves is provided. Besides, the dielectric body of the radiating antenna (due to the properties of the dielectric and the piezoelectric effect) converts the electromagnetic waves of the infrared spectrum into a spectrum of very high frequency waves.

The offered approach and deployment of the unit allow to deeply process heavy oil fractions quickly and without extensive energy consumption. The unit implementing the proposed technology consists of the following devices (Fig. 2, a): 1 device for processing of initial raw materials; it is connected by pipeline 2 with the device for separation of final products 3 device for feedstock processing comprising of 4 vertical operating vessels, 6 buffer tanks for processed oil-containing medium, inbuilt pipe branch; 5. Electrical lighting used as a generator of acoustic oscillations 7. Electric pump is used to pump the initial feedstock from the buffer tank 4 to the operating tank 6. Here the walls of the operating tank 4, inbuilt gasket 5 and pipes are used as an acoustic oscillation output device. In addition they include electroshock discharges located within the operating tank zone 4 to the feedstock processing device, and a generator of electromagnetic vibrations 8 made in the form of a radiating antenna 9 (Fig. 2, b) (Orazbayev, et al. 2020: 1021-1036, Vyatkin, al et, 2017).

The radiator within the radiating antenna 9 consists of a ciliary body 10 consisting of two circuits 11 and 12. Each circuit consists of plates 13 and 14 on which the horizontal parallax is located. The plates can be made in any shape: round, square, etc. To increase the contact of processed heavy oil fractions with the surface of the antenna plates the perforation holes are made in the plates. The plates in the circuit (13,14) are made of different metals with different electronegativities, for example, plates 11 of circuit 13 are made of nickel, and plates 12 of circuit 14 are made of brass. Such pairs may be made of the following metals: zinc-lead, silicon-germanium and other. The circuit plates 13 of circuit 11 are arranged crosswise (by overlapping) between the circuit plates 12 of circuit 14. The body (9) of the radiating antenna (10) is made of a dielectric material (e.g., ceramic) having piezoelectric properties. Circuits 11 and 12 are connected to the electromagnetic oscillation generator (8).



a) b)

Figure 2 - Structural layout of the unit for processing of heavy oil fractions (a), electromagnetic oscillation generator and radiating antenna (b)

Pipeline of the pipe branch 15 for processed products production (2) is connected to the final product separator 3. For this purpose an electromagnetic valve 16 and a shut-off valve 17 are installed in the pipeline (2). The end product release device (3) includes a dephlegmator-distiller 19 and a cracking boiler 18 connected to a cooling water tank (refrigerator) 20. The lower part of the dephlegmator-distiller (19) is connected with a container of accumulation of light fractions of the processed product 21, 22, the lower part of the boiler (19) is connected with the coking unit 23. To control the technological process and ensure its safety the unit can be equipped with programmable control unit (24).

The proposed method of processing heavy oil fractions is carried out as follows. From the buffer tank (6) heavy oil fractions (e.g. fuel oil, waste engine oils, etc.) are built into the operating tank (4) by the pump (7) through the inlet pipe branch (5).

Acoustic oscillations (cavitation) occurring during pump operation are transmitted to the raw material from the wall of the pipe, pipe branch and the walls of the operating tank. Whereas the source of electric discharge - generator of electromagnetic oscillations (8) is switched on, an electric spark occurs at a frequency of about 300-400 Hz. Arising electromagnetic oscillations are transferred to metal plates 13 and 14 of the circuits 11, 12 of the radiating antenna (9). The plates convert these oscillations into a frequency spectrum within the infrared range, and the body of the radiating antenna (10) converts the electromagnetic waves into a spectrum of very high frequencies. The electromagnetic oscillations are modulated by the very high frequency spectrum resulting in a spring-loaded acoustic wave front of an additional spring-loaded plastic wave front and a dissipation (change) of compression energy takes place. This type of energy affects the processed feedstock in the radiating antenna region (9). The hydroacoustic wave front being generated by the acoustic oscillations generator, in turn, receives an additional impulse as it passes through the antenna (9), which transmits oscillations of a wide spectrum (from medium to radiation range) and whose frequency is a catalyst of the effect. Thus, the raw material being processed is simultaneously subjected in the operating vessel (4) to mechanical and chemical impact, which weakens the intermolecular bonds of the raw material. The heavier the fraction, the stronger the intermolecular bonds are, so the release of these bonds is considered to be important at this stage of feedstock processing - to obtain an active intermediate product of processing for splitting the heavy fractions into lighter fractions.

The feedstock activated by the frequency is sent to the final product unit (3) for thermal cracking to decompose the feedstock into lighter fractions. For this purpose the activated feedstock is pumped by the pump (16) from the operating tank (4) through the open mechanism (17) into the cracking boiler (18), where the standard temperature and pressure (temperature and atmospheric pressure up to 360°C) are supplied sufficiently for primary oil processing. The raw material activated in the predetermined mode in the cracking boiler breaks up into light fractions, the obtained fractions are collected in the form of steam into the dephlegmator-distiller (19), where the steam is condensed by means of a refrigerator (20). The condensed light fractions are collected in the storage tanks 21 and 22. Part of the raw materials not evaporated as a result of thermal processing is sent from boiler 18 to the coke unit to obtain commercial (construction, road) bitumens.

Discussion. The results of studies and tests of the proposed and described technologies showed that the depth of processing within the proposed technology is not less than that of catalytic cracking technology, and energy costs are by 2 2,5 times less than those of that technology. Whereas the requirements to the thermal stability of the equipment are reduced significantly. The technological process of refining is considerably simplified: a catalyst and its regeneration are not required; generation of high temperatures and pressures also does not require provision thereof. High quality of the final product is ensured.

For thermal processing of heavy oil fractions, it is recommended to have a unit for processing of Binder feedstock (containing an operating tank of initial feedstock) and a unit for obtaining end products (consisting of a tank for separation of processed feedstock, for cooling and condensation of end products, accumulation of end products and of non-decomposed products of thermal cracking).

The particular feature of the proposed efficient method and the unit for thermal processing of heavy oil fractions is:

before the thermal cracking the raw material is exposed to the wave impact within a wide spectrum in the range from acoustic frequency to the radiation frequency in the pre-processing zone, afterwards the wave impacted product in the standard mode of primary oil processing is sent to thermal cracking at atmospheric pressure and temperature of up to 360°C;

the feedstock processing device has a generator and an acoustic oscillation generator connected with an additional operating tank, and a generator of electromagnetic oscillations;

electromagnetic oscillation generator is made in form of two outlet circuits, each of which consists of horizontal, parallel perforated metal plates, firmly glued to the body wall, located in the ciliary body. The said circuits are made of metals characterized by different electronegativity, whereas the plates of one circuit are placed between the plates of the other circuit; the radiator body is made of dielectric material with piezoelectric properties;

the device of end product release is made in the form of a cracking boiler with an output connected to a dephlegmator-distillator with an output connected to capacities of finished products and not decomposed products of cracking.

The advantages of the proposed method and technology of efficient refining of heavy oil fractions include the possibility of increasing the depth of heavy oils refining under the standard conditions of primary oil refining, i.e. under atmospheric pressure and maximum temperature of oil heating equal to 360^{o}C. Thus, it makes it possible to significantly save energy.

Conclusion. The problems of increasing the depth of oil refining have been studied and an efficient approach to their solution has been proposed on the basis of cavitation technology. As a result of the conducted research the following main findings and conclusions have been obtained:

the cluster scheme of development of the oil refining and petrochemical industries of Kazakhstan has been studied and described. The principal layout for development of the petrochemical industry cluster has been proposed;

methods and technologies for increasing the depth of oil refining have been studied and described. The technology of developing schemes for refining processes of heavy oil fractions, in which schemes the feedstock and the catalyst will not be in contact, may be noted as a promising one.

a method to increase the depth of oil refining by deep processing of heavy oil fractions on the basis of cavitation technology has been proposed and described. The layout of the unit has been shown and described, which efficiently ensures deep processing of heavy oil fractions on the basis of cavitation technology.

The proposed technology of deep refining of heavy oil fractions provides refining depth not lower in comparison with technology of catalytic cracking, and energy consumption is more than twice less. The received results of research have potential of application in the field of increasing the depth of oil refining due to deep processing of heavy oil fractions and residues.

Acknowledgment. *The work was performed with the financial support of the National Committee of the Ministry of Education and Science of the Republic of Kazakhstan under grant financing No AP08855680 Intelligent decision support system for controlling the operating modes of the catalytic reforming unit.*

Information about authors:

Kulman Nakhanovna Orazbayeva – Professor of the Department of Management Esil University, Doctor of Technical Sciences, Professor, Republic of Kazakhstan, Nur-Sultan city, st. Zhubanov, 7, tel: 77011742473, e-mail: kulman_o@mail.ru , ORCID: https://orcid.org/0000-0002-1741-7553;

Meiramgul Kadyrbaevna Urazgaliyeva – Senior Lecturer of the S.Utebayev Atyrau Oil and Gas University, Atyrau sity, st. Baimukhanov, 45a, Republic of Kazakhstan, tel: +77781720278, e-mail: mira_090578@mail.ru , ORCID: https://orcid.org/0000-0002-3622-2356;

Zhadra Zholamanovna Moldacheva – Doctoral student of the Department of Information Systems of the Gumilyov Eurasian National University, Republic of Kazakhstan, Nur-Sultan city, st. Pushkin, 11, tel: +77758021151, e-mail: zhadira1985@mail.ru , ORCID https://orcid.org/0000–0002–0559–3410;

Nurgul Kydyrbaevna Shazhdekeyeva – Associate Professor of the Department of Mathematics and Methods of Teaching Mathematic of the Atyrau University named after Kh. Dosmukhamedov, Candidate of Physical and Mathematical Sciences, Republic of Kazakhstan, Atyrau city, Studenchesky Ave., 1, tel.: +77755601626, e-mail: n.shazhdekeeva@mail.ru ,ORCID& https://orcid.org/ 0000-002-6282-8124;

Dinara Oshanovna Kozhakhmetova – PhD, Department of Automation and Information Technology, Republic of Kazakhstan, Semey city, st. st. Glinka, 20 “a”, tel. +77072136494, e-mail: dinara_kozhahmetova@mail.ru , ORCID: https://orcid.org/0000-0001-5342-274X.

REFERENCES

Botev L., Johnson P. (2020) Applications of statistical process control in the management of unaccounted for gas. Journal of Natural Gas Science and Engineering. 76(2), 103194. 31-38. DOI 10.1016/j.jngse.2020.103194 (in Eng.).

Bytilin K. (2022) Cavitation units for the petrochemical industry [Кавитационные установки для нефтехимической промышленностию] https://carmen62.ru/kavitatsionnye-ustanovki-dlya-neftehimicheskoy-promyshlennosti/ (date of access: 09/08/2022). (In Russian).

Dumitrash P.G., Bologa M.K., Kuchuk T.V., Shemyakova T.D. (2019) Cavitation technologies for dispersion and homogenization. Electronic processing of materials [Кавитационные технологии при диспергировании и гомогенизации]. 4(3),102-107. https://cyberleninka.ru/article/n/kavitatsionnye-tehnologii-pri-dispergirovanii-i-gomogenizatsii (In Russian).

Israilova S., Mukhanova A., Yesikova T., Koishybayeva M. (2021) Business process verification with integrated simulation methods: Focus on customer engagement». Journal of Theoretical and Applied Information Technology, 99(21),5112–5124. https://www.scopus.com/record/display.uri?eid=2-s2.0-85119293137&origin=resultslist&sort=plf-f (in Eng.).

Kaminsky E.F. (2019) Deep oil refining: technological aspects [Глубокая переработка нефти: технологические аспекты]. Oil and gas. Moscow. Russia, p.370. ISBN 9-767-08337-0. (In Russian).

Kapranov B.I., Korotkov M.M. (2018) Acoustic methods of control and diagnostics [Акустические методы контроля и диагностики]. Publishing House of Tomsk Polytechnic University. 2nd ed. Tomsk. Russia. p. 188. ISBN: 5-98298-202-4 (In Russian).

Kuznestov A.G. (2022) Everything about the depth of oil refining, calculation formula, indicators [Все о глубине переработки нефти, формула расчета, показатели]. Electronic resource. Access mode: https://musorish.ru (accessed 5.09.2022) (In Russian).

Medieva G.A., Chigarkina O.A., Ashimakhun A.A. (2017) Oil refining in Kazakhstan: problems of increasing resource efficiency [Нефтепереработка в Казахстане: проблемы повышения ресурсоэффективности]. Fundamental research. 11(2). 425-429. URL: https://fundamental-research.ru/ru/article/view?id=41961 (in Russ.).

Moldasheva Zh,., Orazbayeva K., Abdugulova Zh., Utenova B., Kodanova Sh. (2022) Method of Developing Models of Chemical and Technological Systems of Oil Refining Under Uncertainty // NEWS of the National Academy of Sciences of the Republic of Kazakhstan Series of geology and technical sciences 4(454), 152-170 https://doi.org/10.32014/2022.2518-170X.207. (in Eng.).

Orazbayev B., Assanova B., Bakiyev M., Krawczyk J., Orazbayeva K. (2020) Methods of model synthesis and multi-criteria optimization of chemical-engineering systems in the fuzzy environment. Journal of Theoretical and Applied Information Technology 31st March 2020. 98(06). 1021-1036. https://www.scopus.com/record/display.uri?eid=2-s2.0-85083790104&origin=resultslist&sort=plf-f (in Eng.).

Orazbayev B., Kozhakhmetova D., Wójtowicz R., Krawczyk J. (2020) Modeling of a Catalytic Cracking in the Gasoline Production Installation with a Fuzzy Environment. Energies. 13(18), 4736. -P. 1-13**.** doi:10.3390/en13184736 (in Eng.).

Orazbayev B.B., Orazbayeva K.N., Utenova B.T. (2014) Development of mathematical models and modeling of chemical engineering systems under uncertainty // Theoretical Foundations of Chemical Engineering. 48(2), 138–148. DOI: 10.1134/S0040579514020092 (in Eng.).

Orazbayev B.B., Ospanov Y.A., Orazbayeva K.N., Serimbetov B.A. (2019) Multicriteria optimization in control of a chemical-technological system for production of benzene with fuzzy information // Bulletin of the Tomsk Polytechnic University, Geo Assets Engineering. 330(7).182194. (in Russ.). DOI 10.18799/24131830/2019/7/2194 (In Russian).

Orazbayev B.B**.**, Shangitova Zh.Ye., Kurmangaziyeva L.T., Kodanova Sh.K. (2020) The study of the main parameters affecting the efficiency of Claus reactor and construction of linguistic models for assessing the quality of produced sulfur. Journal of Sulfur Chem., 2020, 21(5), 498507. https://doi.org/10.1080/17415993.2020.1759603 (in Eng.).

Orazbayev B.B., Shangitova Z.Y., Orazbayeva K.N., Serimbetov B.A., Shagayeva A.B. (2020) Studying the Dependence of the Performance Efficiency of a Claus Reactor on Technological Factors with the Quality Evaluation of Sulfur on the Basis of Fuzzy Information. //Theoretical Foundations of Chemical Engineering. 54(6), 1235–1241. DOI: 10.1134/S0040579520060093

Kuanbayeva B., Rakhmetov M., Turkmenbayev A., Abdykerimova E, Tumysheva A. (2022), The effectiveness of using interactive computer models as methodological tools in science school education.

orld Trans. on Engng. and Technol. Educ., 20, 4, 306-311. URL: http://www.wiete.com.au/journals/WTE&TE/Pages/TOC_V20N4.html. (in Eng.).

Promtov M.A. (2017) Change in the fractional composition of oil during hydropulse cavitation treatment [Изменение фракционного состава нефти при гидроимпульсной кавитационной обработке]. Bulletin of the Tomsk State Technical University Transactions TSTU. 23(3) 412-419. DOI: 10.17277/vestnik.2017.03 (In Russian).

Rakhmetov M., Sadvakassova A., Saltanova G., Yessekenova A. (2022) Usage and effectiveness of educational platforms in Kazakhstan during the Covid-19 pandemic., World Transactions on Engineering and Technology Education. 20(3), 226–231. URL: https://www.scopus.com/record/display.uri?eid=2-s2.0-85136288448&origin=resultslist&sort=plf-f .

Sansyzbay L.Zh., Orazbayev B.B., Wojcik W. (2020) Development and Analysis of Models for Assessing Predicted Mean Vote Using Intelligent Technologies. International Journal of Fuzzy Logic and Intelligent Systems. 20(4), 324-335. http://doi.org/10.5391/IJFIS.2020.20.4.324 (in Eng.).

Vyatkin A.V., Ivanov O.Yu., Kalin V.L. etc. (2017) Method for processing heavy oil-containing fractions and installation for its implementation [Способ переработки тяжелых нефтесодержащих фракций и установка для его осуществления]. Patent of Ecotech LLC. Perm. Russia. Request 2002121848/04, RU 2 215 775 C1 (In Russian).

CONTENTS

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.geolog-technical.kz/index.php/en/
ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)

Директор отдела издания научных журналов НАН РК *А. Ботанқызы*
Заместитель директор отдела издания научных журналов НАН РК *Р. Жәлиқызы*
Редакторы: *М.С. Ахметова, Д.С. Аленов*
Верстка на компьютере *Г.Д. Жадыранова*

Подписано в печать 06.12.2022.
Формат 70х90$^{1}/_{16}$. Бумага офсетная. Печать – ризограф.
20,0 п.л. Тираж 300. Заказ 6.

Национальная академия наук РК
050010, Алматы, ул. Шевченко, 28, т. 272-13-19