

**ACADEMIC SCIENTIFIC
JOURNAL OF CHEMISTRY**

ISSN: 2224-5286 (Print)
ISSN: 2518-1491 (Online)

**№4
2025**

ISSN 2518-1491 (Online),
ISSN 2224-5286 (Print)



ACADEMIC SCIENTIFIC JOURNAL OF CHEMISTRY

4 (465)

October – December 2025

PUBLISHED SINCE JANUARY

1947 PUBLISHED 4 TIMES A YEAR

ALMATY, NAS RK

Editor in chief:

ZHURINOV Murat Zhurinovich, doctor of chemistry, professor, academician of NAS RK, President of NAS RK RPA, general director of JSC "D.V. Sokolsky Institute of fuel, catalysis and electrochemistry (Almaty, Kazakhstan) <https://www.scopus.com/authid/detail.uri?authorId=6602177960>, <https://www.webofscience.com/wos/author/record/2017489>

Editorial board:

ADEKENOV Sergazy Mynzhasarovich (deputy editor-in-chief) doctor of chemical sciences, professor, academician of NAS RK, director of the International Scientific and Production Holding «Phytochemistry» (Karaganda, Kazakhstan) <https://www.scopus.com/authid/detail.uri?authorId=7006153118>, <https://www.webofscience.com/wos/author/record/48648658>

AGABEKOV Vladimir Enokovich (deputy editor-in-chief), doctor of chemistry, professor, academician of NAS of Belarus, honorary director of the Institute of Chemistry of new materials (Minsk, Belarus) <https://www.scopus.com/authid/detail.uri?authorId=7004624845>, <https://www.webofscience.com/wos/author/record/28920574>

STRNAD Miroslav, head of the laboratory of the Institute of Experimental Botany of the Czech Academy of Sciences, professor (Olomouc, Czech Republic) <https://www.scopus.com/authid/detail.uri?authorId=36789185000>, <https://www.webofscience.com/wos/author/record/18379>

BURKITBAYEV Mukhambetkali, doctor of chemistry, professor, academician of NAS RK, (Almaty, Kazakhstan) <https://www.scopus.com/authid/detail.uri?authorId=8513885600>, <https://www.webofscience.com/wos/author/record/691218>

HOHMANN Judith, head of the department of pharmacognosy, faculty of Pharmacy, University of Szeged, director of the interdisciplinary center for Life sciences (Szeged, Hungary) <https://www.scopus.com/authid/detail.uri?authorId=7004457196>, <https://www.webofscience.com/wos/author/record/15630788>

ROSS Samir, Ph.D, professor, school of Pharmacy, National Center for scientific research of Herbal Products, University of Mississippi (Oxford, USA) <https://www.scopus.com/authid/detail.uri?authorId=7401610128>, <https://www.webofscience.com/wos/author/record/47926269>

KHUTORYANSKY Vitaly, Ph.D, pharmacist, professor at the University of Reading (Reading, England) <https://www.scopus.com/authid/detail.uri?authorId=35606915700>, <https://www.webofscience.com/wos/author/record/221621>

TELTAYEV Bagdat Burkhanbayuly, doctor of technical sciences, professor, academician of NAS RK, Ministry of Industry and infrastructure development of the Republic of Kazakhstan (Almaty, Kazakhstan) <https://www.scopus.com/authid/detail.uri?authorId=6506225641>, <https://www.webofscience.com/wos/author/record/72161>

PHARUK Asana Dar, professor at Hamdard al-Majid college of Oriental medicine, faculty of Oriental medicine, Hamdard University (Karachi, Pakistan) <https://www.scopus.com/authid/detail.uri?authorId=55884056900>, <https://www.webofscience.com/wos/author/record/1796996>

FAZYLOV Serik Drakhmetovich, doctor of chemistry, professor, academician of NAS RK, deputy director of the Institute of Organic Synthesis and Coal Chemistry (Karaganda, Kazakhstan) <https://www.scopus.com/authid/detail.uri?authorId=6701472056>, <https://www.webofscience.com/wos/author/record/1541357>

ZHOROBEKOVA Sharipa Zhorobekovna, doctor of chemistry, professor, academician of NAS of Kyrgyzstan, Institute of Chemistry and chemical technology of NAS KR (Bishkek, Kyrgyzstan) <https://www.scopus.com/authid/detail.uri?authorId=6602652060>, <https://www.webofscience.com/wos/author/record/31723468>

KHALIKOV Jurabay Khalikovich, doctor of chemistry, professor, academician of the Academy of Sciences of Tajikistan, V.I. Nikitin Institute of Chemistry AS RT (Tajikistan) <https://www.scopus.com/authid/detail.uri?authorId=6603735641>, <https://www.webofscience.com/wos/author/record/9567106>

FARZALIEV Vagif Medzhid ogly, doctor of chemistry, professor, academician of NAS of Azerbaijan (Azerbaijan) <https://www.scopus.com/authid/detail.uri?authorId=6601962486>, <https://www.webofscience.com/wos/author/record/21617033>

GARELIK Hemda, PhD in chemistry, president of the department of Chemistry and Environment of the International Union of Pure and Applied Chemistry (London, England) <https://www.scopus.com/authid/detail.uri?authorId=56010090400>, <https://www.webofscience.com/wos/author/record/29866743>

ACADEMIC SCIENTIFIC JOURNAL OF CHEMISTRY

ISSN 2518-1491 (Online),

ISSN 2224-5286 (Print)

Owner: «Central Asian Academic Research Center» LLP (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 № **KZ23VPY00121156**, issued 05.06.2025

Thematic scope: *organic chemistry, inorganic chemistry, catalysis, electrochemistry and corrosion, pharmaceutical chemistry and technology.*

Periodicity: 4 times a year.

<http://chemistry-technology.kz/index.php/en/arhiv>

© «Central Asian Academic Research Center» LLP, 2025

Editorial address: JSC «D.V. Sokolsky institute of fuel, catalysis and electrochemistry», 142, Kunayev str., of. 310, Almaty, 050100, tel. 291-62-80, fax 291-57-22, e-mail: orgcat@nursat.kz

Бас редактор:

ЖҰРЫНОВ Мұрат Жұрыңұлы, химия ғылымдарының докторы, профессор, ҚР ҰҒА академигі, РБҚ ҚР ҰҒА президенті, АҚ «Д.В. Сокольский атындағы Отын, катализ және электрохимия институтының» бас директоры (Алматы, Қазақстан) <https://www.scopus.com/authid/detail.uri?authorId=6602177960>, <https://www.webofscience.com/wos/author/record/2017489>

Редакция алқасы:

ӘДЕКЕНОВ Серғазы Мыңжасарұлы (бас редактордың орынбасары), химия ғылымдарының докторы, профессор, ҚР ҰҒА академигі, «Фитохимия» Халықаралық ғылыми-өндірістік холдингінің директоры (Қарағанды, Қазақстан) <https://www.scopus.com/authid/detail.uri?authorId=7006153118>, <https://www.webofscience.com/wos/author/record/48648658>

АГАБЕКОВ Владимир Енокович (бас редактордың орынбасары), химия ғылымдарының докторы, профессор, Беларусь ҰҒА академигі, Жаңа материалдар химиясы институтының құрметті директоры (Минск, Беларусь) <https://www.scopus.com/authid/detail.uri?authorId=7004624845>, <https://www.webofscience.com/wos/author/record/28920574>

СТРНАД Мирослав, профессор, Чехия ғылым академиясының Эксперименттік ботаника институтының зертхана меңгерушісі (Оломоуц, Чехия) <https://www.scopus.com/authid/detail.uri?authorId=36789185000>, <https://www.webofscience.com/wos/author/record/18379>

БҮРКІТБАЕВ Мұхамбетқали, химия ғылымдарының докторы, профессор, ҚР ҰҒА академигі, (Алматы, Қазақстан) <https://www.scopus.com/authid/detail.uri?authorId=8513885600>, <https://www.webofscience.com/wos/author/record/691218>

ХОХМАНН Джулит, Сегед университетінің Фармацевтика факультетінің Фармакогнозия кафедрасының меңгерушісі, Жаратылыстану ғылымдарының пәнаралық орталығының директоры (Сегед, Венгрия) <https://www.scopus.com/authid/detail.uri?authorId=7004457196>, <https://www.webofscience.com/wos/author/record/15630788>

РОСС Самир, PhD, Миссисипи университетінің Өсімдік өнімдерін ғылыми зерттеу ұлттық орталығы, Фармация мектебінің профессоры (Оксфорд, АҚШ) <https://www.scopus.com/authid/detail.uri?authorId=7401610128>, <https://www.webofscience.com/wos/author/record/47926269>

ХУТОРЯНСКИЙ Виталий, философия докторы (PhD, фармацевт), Реддинг университетінің профессоры (Реддинг, Англия) <https://www.scopus.com/authid/detail.uri?authorId=35606915700>, <https://www.webofscience.com/wos/author/record/221621>

ТЕЛТАЕВ Бағдат Бұрханбайұлы, техника ғылымдарының докторы, профессор, ҚР ҰҒА академигі, Қазақстан Республикасы Индустрия және инфрақұрылымдық даму министрлігі (Алматы, Қазақстан) <https://www.scopus.com/authid/detail.uri?authorId=6506225641>, <https://www.webofscience.com/wos/author/record/72161>

ФАРУК Асана Дар, Хамдар аль-Маджида Шығыс медицина колледжінің профессоры, Хамдард университетінің Шығыс медицина факультеті (Карачи, Пәкістан) <https://www.scopus.com/authid/detail.uri?authorId=55884056900>, <https://www.webofscience.com/wos/author/record/1796996>

ФАЗЫЛОВ Серік Драхметұлы, химия ғылымдарының докторы, профессор, ҚР ҰҒА академигі, Органикалық синтез және көмір химиясы институты директорының ғылыми жұмыстар жөніндегі орынбасары (Қарағанды, Қазақстан) <https://www.scopus.com/authid/detail.uri?authorId=6701472056>, <https://www.webofscience.com/wos/author/record/1541357>

ЖОРОБЕКОВА Шарипа Жоробекқызы, химия ғылымдарының докторы, профессор, Кыргызстан ҰҒА академигі, ҚР ҰҒА Химия және химиялық технология институты (Бішкек, Кыргызстан) <https://www.scopus.com/authid/detail.uri?authorId=6602652060>, <https://www.webofscience.com/wos/author/record/31723468>

ХАЛИКОВ Джурабай Халикович, химия ғылымдарының докторы, профессор, Тәжікстан ҒА академигі, В.И. Никитин атындағы Химия институты (Душанбе, Тәжікстан) <https://www.scopus.com/authid/detail.uri?authorId=6603735641>, <https://www.webofscience.com/wos/author/record/9567106>

ФАРЗАЛИЕВ Вагиф Меджидоглы, химия ғылымдарының докторы, профессор, АҰҒА академигі (Баку, Әзірбайжан) <https://www.scopus.com/authid/detail.uri?authorId=6601962486>, <https://www.webofscience.com/wos/author/record/21617033>

ГАРЕЛИК Хемда, философия докторы (PhD, химия), Халықаралық таза және қолданбалы химия одағының Химия және қоршаған орта бөлімінің президенті (Лондон, Англия) <https://www.scopus.com/authid/detail.uri?authorId=56010090400>, <https://www.webofscience.com/wos/author/record/29866743>

«ACADEMIC SCIENTIFIC JOURNAL OF CHEMISTRY»

ISSN 2518-1491 (Online),

ISSN 2224-5286 (Print)

Меншіктенуші: «Орталық Азия академиялық ғылыми орталығы» ЖШС (Алматы қ.).

Қазақстан Республикасының Ақпарат және қоғамдық даму министрлігінің Ақпарат комитетінде 05.06.2025 ж. берілген № KZ23VPY00121156 мерзімдік басылым тіркеуіне қойылу туралы куәлік.

Тақырыптық бағыты: *органикалық химия, бейорганикалық химия, катализ, электрохимия және коррозия, фармацевтикалық химия және технологиялар.*

Мерзімділігі: жылына 4 рет.

<http://chemistry-technology.kz/index.php/en/arhiv>

© «Орталық Азия академиялық ғылыми орталығы» ЖШС, 2025

Редакцияның мекенжайы: 050100, Алматы қ., Қонаев к-сі, 142, «Д.В. Сокольский атындағы отын, катализ және электрохимия институты» АҚ, каб. 310, тел. 291-62-80, факс 291-57-22, e-mail:orgcat@nursat.kz

Главный редактор:

ЖУРИНОВ Мурат Журинович, доктор химических наук, профессор, академик НАН РК, президент РОО Национальной академии наук Республики Казахстан, генеральный директор АО «Институт топлива, катализа и электрохимии им. Д.В. Сокольского» (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=6602177960>, <https://www.webofscience.com/wos/author/record/2017489>

Редакционная коллегия:

АДЕКЕНОВ Сергазы Мынжасарович (заместитель главного редактора), доктор химических наук, профессор, академик НАН РК, директор Международного научно-производственного холдинга «Фитохимия» (Караганда, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=7006153118>, <https://www.webofscience.com/wos/author/record/48648658>

АГАБЕКОВ Владимир Енокович (заместитель главного редактора), доктор химических наук, профессор, академик НАН Беларуси, почетный директор Института химии новых материалов (Минск, Беларусь), <https://www.scopus.com/authid/detail.uri?authorId=7004624845>, <https://www.webofscience.com/wos/author/record/28920574>

СТРНАД Мiroслав, профессор, заведующий лабораторией института Экспериментальной ботаники Чешской академии наук (Оломоуц, Чехия), <https://www.scopus.com/authid/detail.uri?authorId=36789185000>, <https://www.webofscience.com/wos/author/record/18379>

БУРКИТБАЕВ Мухамбеткали, доктор химических наук, профессор, академик НАН РК, (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=8513885600>, <https://www.webofscience.com/wos/author/record/691218>

ХОХМАНН Джудит, заведующий кафедрой Фармакогнозии Фармацевтического факультета Университета Сегеда, директор Междисциплинарного центра естественных наук (Сегед, Венгрия), <https://www.scopus.com/authid/detail.uri?authorId=7004457196>, <https://www.webofscience.com/wos/author/record/15630788>

РОСС Самир, PhD, профессор Школы Фармации национального центра научных исследований растительных продуктов Университета Миссисипи (Оксфорд, США), <https://www.scopus.com/authid/detail.uri?authorId=7401610128>, <https://www.webofscience.com/wos/author/record/47926269>

ХУТОРЯНСКИЙ Виталий, доктор философии (Ph.D, фармацевт), профессор Университета Рединга (Рединг, Англия), <https://www.scopus.com/authid/detail.uri?authorId=35606915700>, <https://www.webofscience.com/wos/author/record/221621>

ТЕЛЫТАЕВ Багдат Бурханбайулы, доктор технических наук, профессор, академик НАН РК, Министерство Индустрии и инфраструктурного развития Республики Казахстан (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=6506225641>, <https://www.webofscience.com/wos/author/record/72161>

ФАРУК Ахсана Дар, профессор колледжа Восточной медицины Хамдарда аль-Маджида, факультет Восточной медицины университета Хамдарда (Карачи, Пакистан), <https://www.scopus.com/authid/detail.uri?authorId=55884056900>, <https://www.webofscience.com/wos/author/record/1796996>

ФАЗЫЛОВ Серик Драгметович, доктор химических наук, профессор, академик НАН РК, заместитель директора по научной работе Института органического синтеза и углехимии (Караганда, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=6701472056>, <https://www.webofscience.com/wos/author/record/1541357>

ЖОРОБЕКОВА Шарипа Жоробековна, доктор химических наук, профессор, академик НАН Кыргызстана, Институт химии и химической технологии НАН КР (Бишкек, Кыргызстан), <https://www.scopus.com/authid/detail.uri?authorId=6602652060>, <https://www.webofscience.com/wos/author/record/31723468>

ХАЛИКОВ Джарабай Халикович, доктор химических наук, профессор, академик АН Таджикистана, Институт химии имени В.И. Никитина АН РТ (Душанбе, Таджикистан), <https://www.scopus.com/authid/detail.uri?authorId=6603735641>, <https://www.webofscience.com/wos/author/record/9567106>

ФАРЗАЛИЕВ Вагиф Меджид оглы, доктор химических наук, профессор, академик НАНА (Баку, Азербайджан), <https://www.scopus.com/authid/detail.uri?authorId=6601962486>, <https://www.webofscience.com/wos/author/record/21617033>

ГАРЕЛИК Хемда, доктор философии (Ph.D, химия), президент Отдела химии и окружающей среды Международного союза чистой и прикладной химии (Лондон, Англия), <https://www.scopus.com/authid/detail.uri?authorId=56010090400>, <https://www.webofscience.com/wos/author/record/29866743>

«ACADEMIC SCIENTIFIC JOURNAL OF CHEMISTRY».

ISSN 2518-1491 (Online),

ISSN 2224-5286 (Print)

Собственник: Республиканское общественное объединение ТОО «Центрально-азиатский академический научный центр» (г. Алматы).

Свидетельство о постановке на учет периодического печатного издания в Комитете информации Министерства информации и общественного развития Республики Казахстан № KZ23VPY00121156, выданное 05.06.2025 г.

Тематическая направленность: *органическая химия, неорганическая химия, катализ, электрохимия и коррозия, фармацевтическая химия и технологии.*

Периодичность: 4 раз в год.

<http://chemistry-technology.kz/index.php/en/arhiv>

© ТОО «Центрально-азиатский академический научный центр», 2025

Адрес редакции: 050100, г. Алматы, ул. Кунаева, 142, АО «Институт топлива, катализа и электрохимии им. Д.В. Сокольского», каб. 310, тел. 291-62-80, факс 291-57-22, e-mail: orgcat@nursat.kz

CONTENTS

G.E. Azimbayeva, A.K. Kamysbayeva, G.N. Kudaibergenova, U.Zh. Beysenbiyeva, N.M. Kurbanbayeva Chromatographic analysis of ethanol obtained from topinambur tubers (<i>Helianthus Tuberosus</i>).....	13
B. Amiraliyev, N. Zhanikulov, B. Taimasov, M. Aitureev, B. Zhakipbayev Expanding the raw material base of mineral additives for the production of composite cements.....	27
A.M. Yegissinova, R.S. Taubayeva, R.K. Rakhmetullaeva, A.S. Seitkan, E.B. Satkozhaeva Physicochemical properties of thermoplastic starch/hemp biofilm produced by casting method.....	41
E.M. Yergaliyeva, K.B. Bazhykova, Zh.Zh. Kolbaeva, A. Duysen, V.V. Vazhev <i>In silico</i> prediction of PASS and ADME/Tox properties of novel 1,3,5-triazine derivatives for drug development.....	54
R.I. Jalmakhanbetova, S. Azatkyzy, G.K. Mukusheva Structure-directed ursolic acid modifications and their impact on biological activity.....	71
R.N. Zhanaliyeva, B.S. Imangaliyeva, M.A. Zharkınbekov, A.S. Ungarbayeva, R. Kozykeyeva Study of the kinetics and mechanism of molybdenum disulfide oxidation by sodium hypochlorite.....	87
O.S. Ilyassova, M. Zhumabek, G.N. Kaumenova, R.S. Orazbekova, B.S. Biyekeyev Hydrogenation of carbon dioxide on Ni-Co/ZrO ₂ catalysts for conversion into synthetic fuel components.....	100
K. Kalmakov, G. Turebekova, S. Yegemberdiyeva, U. Nuridinova, N. Dulat Catalytic cracking of vacuum gas oil from Kumkol oil in a fluidized bed catalyst unit.....	115
B.T. Kuderina, N.B. Kassenova, A.S. Khamitova, A.G. Zhaxybayeva, A.B. Abdrakhmanova Modification of the structure of oxide cathode materials to enhance the capacity and stability of li - ion batteries.....	128

B.M. Kaldybaeva, D.M. Kenzhebekov, D.Zh. Janabayev, L.M. Ulyev, A. Zholshybek Improving the energy efficiency of oil treatment and stabilization units in the field.....	137
A.K. Kozybaev, Zh.D. Alimkulova, S.O. Abilkasova, G.O. Bugubaeva, S. Bubish Prospects for the use of water-soluble copolymers in industrial wastewater treatment processes.....	150
R.M. Kudaibergenova, A.R. Aitekova, N.S. Murzakasymova, A.S. Seitkan, N.A. Nurlybayeva Structural and compositional characteristics of cobalt ferrite nanoparticles.....	159
M. Nazhipkyzy, A. Ashiraly, A. Aitugan, A. Aikenova Fabrication of lignin-based fibrous composites by electrospinning for energy storage applications.....	170
U. Nazarbek, Y. Raiymbekov, P. Abdurazova, G. Kambarova Molecular dynamics modeling of solubility in aqueous systems: temperature dependence and solvation effects.....	184
Zh.Zh. Nurtazina, Zh.S. Kassymova, L.K. Orazzhanova, B. Łeska, N.B. Kiarstanova Efficiency of modified medium for pigment and antioxidant biosynthesis in <i>Chlorella Vulgaris</i>	197
G.M. Ormanova, A.A. Anarbayev, B.N. Kabylbekova, Zh.E. Khusanov Construction of a solubility isotherm in a four-component mutual $\text{CaSO}_4\text{-NaCl-H}_2\text{O}$ system.....	212
Zh.B. Rakhimberlinova, A. Zhorabek, A. Bailen, M. Kaiyrbaeva, A. Mendibayeva Investigation of the possibilities of obtaining ultradispersed copper particles in aqueous solutions.....	227
A. Takibayeva, L. Sultanova, A. Tussupova, Z. Omar, A. Amanzholova Mechanism, features of the amination reaction in a series of lupane triterpenoids.....	239
G. Toleutay, R.N. Tuleyeva, A. Taubatyrova, N.N. Gizatullina Recent advances in the application of lignin for biobased packaging materials.....	250
Kh. Khimersen, T.K. Jumadilov, A. Imangazy, G.T. Dyusseмбаeva, B. Totkhuskyzy Features of the interaction of polyelectrolytes with gallium ions in aqueous media.....	266

МАЗМҰНЫ

Г.Е. Азимбаева, А.К. Камысбаева, Г.Н. Кудайбергенова, Ұ.Ж. Бейсенбиева, Н.М. Курбанбаева Топинамбур жемісінен (<i>Helianthus Tuberosus</i>) алынған этанолдың хроматографиялық анализі.....	13
Б. Амиралиев, Н. Жаникулов, Б. Таймасов, М. Айтуреев, Б. Жакипбаев Композициялық цемент алу үшін минералды қоспалардың шикізат базасын кеңейту.....	27
А.М. Егисина, Р.С. Таубаева, Р.К. Рахметуллаева, А.С. Сейткан, Э.Б. Саткожаева Құю әдісі арқылы алынған термопластикалық крахмал/ конопля биоленкасының физика-химиялық қасиеттері.....	41
Э.М. Ергалиева, К.Б. Бажыкова, Ж.Ж. Кольбаева, А.Б. Дуйсен, В.В. Важев <i>In silico</i> PASS және ADME/Tox бағдарламалары арқылы дәрілік заттар әзірлеу үшін 1,3,5-триазиннің жаңа туындыларының қасиеттерін болжау.....	54
Р.И. Джалмаханбетова, С. Азатқызы, Г.К. Мукушева Урсол қышқылының құрылымдық-бағытталған модификациялары және олардың биологиялық белсенділікке әсері.....	71
Р.Н. Жаналиева, Б.С. Имангалиева, М.А. Жаркинбеков, А.С. Унгарбаева, Р. Қозыкеева Молибден дисульфидін натрий гипохлоритімен тотықтырудың кинетикасы мен механизмін зерттеу.....	87
О.С. Ильясова, М. Жумабек, Г.Н. Кауменова, Р.С. Оразбекова, Б.С. Биекеев Көмірқышқыл газын синтетикалық отын компоненттеріне айналдыру үшін Ni-Co/ZrO ₂ катализаторларында гидрлеу.....	100
К.К. Калмаков, Г.З. Туребекова, С.Ж. Егембердиева, У.Е. Нуридинова, Н.Н. Дулат Құмкөл мұнайынан алынған вакуум газойлін катализатордың қайнау қабатындағы қондырғыда каталитикалық крекингтеу.....	115
Б.Т. Кудерина, Н.Б. Касенова, А.С. Хамитова, А.Г. Жаксыбаева, А.Б. Абдрахманова Li - ионды аккумуляторлардың сыйымдылығы мен тұрақтылығын арттыру үшін оксидті катод материалдарын модификациялау.....	128

Б.М. Калдыбаева, Д.М. Кенжебеков, Д.Ж. Джанабаев, Л.М. Ульев, А. Жолшыбек Кәсіпшілікте мұнайды дайындау және тұрақтандыру қондырғысының энергия тиімділігін арттыру.....	137
А.Қ. Қозыбаев, Ж.Д. Әлімқұлова, С.О. Әбілқасова, Г.О. Бугубаева, Ш. Бүбіш Өндірістік ағынды суларды тазарту процестерінде суда еритін сополимерлерді қолдану перспективалары.....	150
Р.М. Құдайбергенова, А.Р. Айтекова, Н.С. Мурзакасымова, А.С. Сейтқан, А.Н. Нұрлыбаева Кобалт феррит нанобөлшектерінің құрылымдық және құрамдық сипаттамасы.....	159
М. Нажипқызы, А. Ашіралы, А. Айтуған, А. Айкенова Энергия сақтау жүйелерінде қолдануға арналған лигнин негізіндегі талшықты композиттерді электроспиннинг әдісімен алу.....	170
У. Назарбек, Е. Райымбеков, П. Абдуразова, Ғ. Қамбарова Су жүйелеріндегі ерігіштіктің молекулалық динамикалық модельдеуі: температураға тәуелділік және еріткіштің әсері.....	184
Ж.Ж. Нуртазина, Ж.С. Касымова, Л.К. Оразжанова, Л. Богуслава, Н.Б. Қиарстанова <i>Chlorella Vulgaris</i> құрамындағы пигменттер мен антиоксиданттардың биосинтезі үшін модификацияланған қоректік ортаның тиімділігі.....	197
Г.М. Орманова, А.А. Анарбаев, Б.Н. Кабылбекова, Ж.Е. Хусанов Төрт компонентті CASO ₄ -NaCl-H ₂ O өзара әрекеттесу жүйесіндегі ерігіштік изотермасын тұрғызу.....	212
Ж.Б. Рахимберлинова, А. Жорабек, А. Байлен, М. Қайырбаева, Ә. Мендібаева Сулы ерітінділердегі мыстың ультродисперсті бөлшектерін алу мүмкіндіктерін зерттеу.....	227
А. Такибаева, Л. Султанова, А. Тусупова, З. Омар, А. Аманжолова Лупан тритерпеноидтар қатарындағы аминдену реакциясының механизмі, ерекшеліктері.....	239

Г. Төлеутай, Р.Н. Тулеева, А. Таубатырова, Н.Н. Гизатуллина

Лигниннің бионегізді қаптама материалдарында қолданылуының

соңғы жетістіктері.....250

Х. Химэрсэн, Т.К. Джумадилов, А. Имангазы, Г.Т. Дюсембаева,

Б. Тотхусқызы

Полиэлектролиттердің галлий иондарымен су ортасында әрекеттесу

ерекшеліктері.....266

СОДЕРЖАНИЕ

Г.Е. Азимбаева, А.К. Камысбаева, Г.Н. Кудайбергенова, У.Ж. Бейсенбиева, Н.М. Курбанбаева Хроматографический анализ этанола полученного из клубней топинамбура (<i>Helianthus Tuberosus</i>).....	13
Б. Амиралиев, Н. Жаникулов, Б. Таймасов, М. Айтурсев, Б. Жакипбаев Расширение сырьевой базы минеральных добавок для получения композиционных цементов.....	27
А.М. Егисинова, Р.С. Таубаева, Р.К. Рахметуллаева, А.С. Сейткан, Э.Б. Саткожаева Физико-химические свойства термопластичной биопленки из крахмала/конопли, полученной методом литья.....	41
Э.М. Ергалиева, К.Б. Бажыкова, Ж.Ж. Кольбаева, А.Б. Дуйсен, В.В. Важев IN SILICO PASS и ADME/TOX прогнозирование свойств новых производных 1,3,5-триазина для разработки лекарств.....	54
Р.И. Джалмаханбетова, С. Азаткызы, Г.К. Мукушева Структурно-направленные модификации урсоловой кислоты и их влияние на биологическую активность.....	71
Р.Н. Жаналиева, Б.С. Имангалиева, М.А. Жаркинбеков, А.С. Унгарбаева, С. Бердібекова Изучение кинетики и механизма окисления дисульфида молибдена гипохлоритом натрия.....	87
О.С. Ильясова, М. Жумабек, Г.Н. Кауменова, Р.С. Оразбекова, Б.С. Биекеев Гидрирование диоксида углерода на Ni-Co/ZrO ₂ катализаторах для преобразования в компоненты синтетического топлива.....	100
К.К. Калмаков, Г.З. Туребекова, С.Ж. Егембердиева, У.Е. Нуридинова, Н.Н. Дулат Каталитический крекинг вакуумного газойля Кумкольской нефти на установке псевдоожиженным слоем катализатора.....	115
Б.Т. Кудерина, Н.Б. Касенова, А.С. Хамитова, А.Г. Жаксыбаева, А.Б. Абдрахманова Модификация структуры оксидных катодных материалов для повышения ёмкости и стабильности Li-ион аккумуляторов.....	128

Б.М. Калдыбаева, Д.М. Кенжебеков, Д.Ж. Джанабаев, Л.М. Ульев, А. Жолшыбек Повышение энергоэффективности установки подготовки и стабилизации нефти на промысле.....	137
А.К. Козыбаев, Ж.Д. Алимкулова, С.О. Абилкасова, Г.О. Бугубаева, Ш. Бубиш Перспективы использования водорастворимых сополимеров в процессах очистки промышленных сточных вод.....	150
Р.М. Кудайбергенова, А.Р. Айтекова, Н.С. Мурзакасымова, А. Сейткан, А.Н. Нурлыбаева Структурно-композиционные характеристики наночастиц феррита кобальта.....	159
М. Нажипкызы, А. Аширалы, А. Айтуган, А. Айкенова Получение волокнистых композитов на основе лигнина методом электроспиннинга для применения в системах хранения энергии.....	170
У. Назарбек, П. Абдуразова, Ғ. Қамбарова, Е. Райымбеков Молекулярно-динамическое моделирование растворимости в водных системах: температурная зависимость и эффекты сольватации.....	184
Ж.Ж. Нуртазина, Ж.С. Касымова, Л.К. Оразжанова, Л. Богуслава, Н.Б. Қиарстанова Эффективность модифицированной среды для биосинтеза пигментов и антиоксидантов в <i>Chlorella Vulgaris</i>	197
Г.М. Орманова, А.А. Анарбаев, Б.Н. Кабылбекова, Ж.Е. Хусанов Построение изотермы растворимости в четырехкомпонентной взаимной системе $\text{CaSO}_4\text{-NaCl-H}_2\text{O}$	212
Ж.Б. Рахимберлинова, А. Жорабек, А. Байлен, М. Кайырбаева, А. Мендибаева Исследование возможностей получения ультрадисперсных частиц меди в водных растворах.....	227
А. Такибаева, Л. Султанова, А. Тусупова, З. Омар, А. Аманжолова Механизм, особенности протекания реакции аминирования в ряду лупановых тритерпеноидов.....	239

Г. Толеутай, Р.Н. Тулеева, А. Таубатырова, Н.Н. Гизатуллина

Последние достижения в применении лигнина для биополимерных

упаковочных материалов.....250

Х. Химэрсэн, Т.К. Джумадилов, А. Имангазы, Г.Т. Дюсембаева,

Б. Тотхусқызы

Особенности взаимодействие полиэлектролитов с ионами галлия

в водной среде.....266

© **B.M. Kaldybaeva^{1*}, D.M. Kenzhebekov¹, D.Zh. Janabayev², L.M. Ulyev³,
A. Zholshybek¹, 2025.**

¹M. Auezov South Kazakhstan University, Shymkent, Kazakhstan;

²Shymkent University, Shymkent, Kazakhstan;

³ National Research Tomsk Polytechnic University, Tomsk, Russia.

E-mail: kaldybaeva.b@mail.ru

IMPROVING THE ENERGY EFFICIENCY OF OIL TREATMENT AND STABILIZATION UNITS IN THE FIELD

Kaldybaeva Botagoz — PhD, associate professor, M. Auezov South Kazakhstan University, Shymkent, Kazakhstan,

E-mail: kaldybaeva.b@mail.ru, <https://orcid.org/0000-0002-1570-2107>;

Kenzhebekov Doskhan — Master, senior teacher, M. Auezov South Kazakhstan University, Shymkent, Kazakhstan,

E-mail: doskhan_349@mail.ru, <https://orcid.org/0000-0002-6367-5975>;

Janabayev Dauren — PhD of Shymkent University, Shymkent, Kazakhstan,

E-mail: janabaev19@mail.ru, <https://orcid.org/0000-0002-6522-0536>;

Ulyev Leonid — Doctor of Technical Sciences, Professor, National Research Tomsk Polytechnic University, Tomsk, Russia,

E-mail: ulyevlm@tpu.ru, <https://orcid.org/0000-0002-2732-6444>;

Zholshybek Ayan — Master, teacher, M. Auezov South Kazakhstan University, Shymkent, Kazakhstan,

E-mail: ayan-97.zh@mail.ru, <https://orcid.org/0000-0003-4535-9730>.

Abstract. The article discusses improving the energy efficiency of an oil treatment and stabilization facility in the field using pinch analysis methods. Pinch analysis as a methodology for minimizing the energy consumption of a process involves calculating thermodynamically justified amounts of energy consumption and approaching them by optimizing heat transfer processes, energy supply methods, and process characteristics. Pinch analysis is used in various industries, in particular in oil and gas processing, petrochemistry and the chemical industry, and can be used both in designing new technological facilities and in solving problems of optimizing the operation of existing industries, taking into account the principles of energy conservation. The Total Site energy system is a complex facility that is part of large industrial enterprises or industrial parks. As a rule, these are energy production facilities that convert various types of fuels into heat and electricity, providing basic processes. The main scientific hypothesis is to find a compromise between full energy recovery at facilities, taking into account

operational and capital costs. In this paper, the object of research is the heat exchange system of an oil stabilization unit located in a field with production of 34200 thousand tons of crude oil per year. The thermal and energy integration of the oil stabilization and treatment plant has been carried out. As a result of the project's implementation, the energy consumption of external hot energy sources will decrease by 213.4 MW, or 55%. Greenhouse gas emissions will decrease by about 71%. The discounted payback period is about 11 months from the moment the reconstruction project reaches its target capacity.

Keywords: Heat exchangers, composite curves, energy efficiency, Pinch analysis, cost optimization, crude oil

This research was funded by the Committee of Science of the Ministry of Science and Higher Education of the Republic of Kazakhstan (IRN AP26104837 – Improving the energy efficiency of oil and gas production facilities by integrating processes during preparation and production)

© Б.М. Калдыбаева^{1*}, Д.М. Кенжебеков¹, Д.Ж. Джанабаев², Л.М. Ульев³,
А. Жолшыбек¹, 2025.

¹М. Әуезов атындағы Оңтүстік Қазақстан университеті, Шымкент, Қазақстан;

²Шымкент Университеті, Шымкент, Қазақстан;

³Томск Политехникалық Ұлттық зерттеу университеті, Томск, Ресей.

E-mail: kaldybaeva.b@mail.ru

КӘСІПШІЛІКТЕ МҰНАЙДЫ ДАЙЫНДАУ ЖӘНЕ ТҰРАҚТАНДЫРУ ҚОНДЫРҒЫСЫНЫҢ ЭНЕРГИЯ ТИІМДІЛІГІН АРТТЫРУ

Калдыбаева Ботағоз — PhD, М. Әуезов атындағы Оңтүстік Қазақстан университетінің қауымдастырылған профессоры, Шымкент, Қазақстан,

E-mail: kaldybaeva.b@mail.ru; <https://orcid.org/0000-0002-1570-2107>;

Кенжебеков Досхан — магистр, М. Әуезов атындағы Оңтүстік Қазақстан университетінің аға оқытушысы, Шымкент, Қазақстан,

E-mail: doskhan_349@mail.ru; <https://orcid.org/0000-0002-6367-5975>;

Джанабаев Даурен — PhD, Шымкент университетінің аға оқытушысы, Шымкент, Қазақстан,

E-mail: janabaev19@mail.ru; <https://orcid.org/0000-0002-6522-0536>;

Ульев Леонид — техника ғылымдарының докторы, профессоры, Томск политехникалық ұлттық зерттеу университеті, Томск, Ресей,

E-mail: ulyevlm@tpu.ru; <https://orcid.org/0000-0002-2732-6444>;

Жолшыбек Аян — магистр, М. Әуезов атындағы Оңтүстік Қазақстан университетінің оқытушысы, Шымкент, Қазақстан,

E-mail: ayan-97.zh@mail.ru; <https://orcid.org/0000-0003-4535-9730>.

Аннотация. Мақалада пинч-талдау әдістерін қолдана отырып, кәсіпшілікте мұнайды дайындау және тұрақтандыру қондырғысының энергия тиімділігін арттыру қарастырылады. Пинч-талдау процестің энергия тұтынуын азайту әдістемесі ретінде жылу беру процестерін, энергиямен жабдықтау әдістерін және технологиялық процестердің сипаттамаларын оңтайландыру арқылы

энергия тұтынудың термодинамикалық негізделген көлемін есептеуді және оларға жақындауды қамтамасыз етеді. Пинч-талдау әртүрлі салаларда, атап айтқанда мұнай және газ өңдеу, мұнай - химия және химия өнеркәсібінде қолданылады және жаңа технологиялық объектілерді жобалауда да, энергияны үнемдеу принциптерін ескере отырып, қолданыстағы өндірістердің жұмысын оңтайландыру мәселелерін шешуде де қолданылады. Total site энергетикалық жүйесі ірі өнеркәсіптік кәсіпорындардың немесе индустриялық парктердің құрамына кіретін күрделі нысан болып табылады. Әдетте, бұл әр түрлі отынды жылу мен электр энергиясына айналдыратын, негізгі процестерді қамтамасыз ететін энергия өндіретін объектілер. Негізгі ғылыми гипотеза операциялық және күрделі шығындарды ескере отырып, объектілерде энергияны толық қалпына келтіру арасында ымыраға келу болып табылады. Бұл жұмыста зерттеу объектісі жылына 34 200 мың тонна шикі мұнай өндіретін кәсіпшілікте орналасқан мұнайды тұрақтандыру қондырғысының жылу алмасу жүйесі болып табылады. Жұмыста мұнайды тұрақтандыру және дайындау қондырғысының жылу-энергетикалық интеграциясы орындалды. Жобаны енгізу нәтижесінде сыртқы ыстық энергия тасымалдаушылардың энергия тұтынуы 213,4 МВт-қа немесе 55% - ға төмендейді. Парниктік газдар шығарындылары шамамен 71% - ға төмендейді. Дисконтталған өтелу мерзімі қайта құру жобасы берілген қуатқа шыққан сәттен бастап шамамен 11 ай шамасын құрайды.

Түйін сөздер: Жылуалмастырғыш аппараттар, құрама қисықтар, энергия тиімділігі, Pinch талдауы, шығындарды оңтайландыру, шикі мұнай

Бұл зерттеуді Қазақстан Республикасы Ғылым және жоғары білім министрлігінің Ғылым комитеті қаржыландырды (ИРН АР26104837 – Дайындау және өндіру кезіндегі процестерді интеграциялау арқылы мұнай және газ өндіру объектілерінің энергия тиімділігін арттыру).

© Б.М. Калдыбаева^{1*}, Д.М. Кенжебеков¹, Д.Ж. Джанабаев², Л.М. Ульев³,
А. Жолшыбек¹, 2025.

¹Южно-Казахстанский университет им. М. Ауэзова, Шымкент, Казахстан;

²Шымкентский Университет, Шымкент, Казахстан;

³ Национальный исследовательский Томский политехнический университет,
Томск, Россия.

E-mail: kaldybaeva.b@mail.ru

ПОВЫШЕНИЕ ЭНЕРГОЭФФЕКТИВНОСТИ УСТАНОВКИ ПОДГОТОВКИ И СТАБИЛИЗАЦИИ НЕФТИ НА ПРОМЫСЛЕ

Калдыбаева Ботагоз — PhD, ассоциированный профессор Южно – Казахстанского университета имени М. Ауэзова, Шымкент, Казахстан,
E-mail: kaldybaeva.b@mail.ru, <https://orcid.org/0000-0002-1570-2107>;

Кенжебеков Досхан — магистр, старший преподаватель Южно – Казахстанского университета имени М. Ауэзова, Шымкент, Казахстан,

E-mail: doskhan_349@mail.ru; <https://orcid.org/0000-0002-6367-5975>;

Джанобаев Даурен — PhD, старший преподаватель Шымкентского университета, Шымкент, Казахстан,

E-mail: janabaev19@mail.ru; <https://orcid.org/0000-0002-6522-0536>.

Ульев Леонид — доктор технических наук, профессор Национального исследовательского Томского политехнического университета, Томск, Россия,

E-mail: ulyevlm@tpu.ru; <https://orcid.org/0000-0002-2732-6444>;

Жолшыбек Аян — магистр, преподаватель Южно – Казахстанского университета имени М. Ауэзова. Шымкент, Казахстан,

E-mail: ayan-97.zh@mail.ru; <https://orcid.org/0000-0003-4535-9730>.

Аннотация. В статье рассматривается повышение энергоэффективности установки подготовки и стабилизации нефти на промысле с использованием методов пинч-анализа. Пинч-анализ как методология минимизации энергопотребления предусматривает расчёт термодинамически обоснованных объёмов потребления энергии и приближение к ним путём оптимизации процессов теплопередачи, методов энергоснабжения и параметров технологических процессов. Данная методика находит широкое применение в различных отраслях — в нефте- и газопереработке, нефтехимии и химической промышленности — и может использоваться как при проектировании новых технологических объектов, так и при решении задач оптимизации работы действующих производств с учётом принципов энергосбережения. Энергосистема Total Site представляет собой сложный объект, являющийся частью крупных промышленных предприятий или индустриальных парков. Как правило, это теплоэнергетические комплексы, преобразующие различные виды топлива в тепло и электроэнергию и обеспечивающие ключевые технологические процессы. Основная научная гипотеза исследования заключается в поиске компромисса между максимальной рекуперацией энергии и необходимыми операционными и капитальными затратами. В данной работе объектом исследования является система теплообмена установки стабилизации нефти, расположенной на промысле с добычей 34 200 тыс. т сырой нефти в год. Проведена теплоэнергетическая интеграция установки стабилизации и подготовки нефти. По результатам анализа показано, что внедрение проекта позволит снизить потребление внешних горячих энергоносителей на 213,4 МВт, что составляет около 55 %. Выбросы парниковых газов уменьшатся примерно на 71 %. Дисконтированный срок окупаемости составляет около 11 месяцев с момента выхода проекта реконструкции на проектную мощность.

Ключевые слова. Теплообменные аппараты, составные кривые, энергоэффективность, Pinch-анализ, оптимизация затрат, сырая нефть

Исследование выполнено при финансовой поддержке Комитета науки Министерства науки и высшего образования Республики Казахстан (ИРН AP26104837–Повышение энергоэффективности объектов нефтегазодобывающей промышленности путем интеграции процессов при подготовке и добыче)

Introduction. To increase energy efficiency and reduce costs in the oil refining industry, it is necessary to develop comprehensive methods for integrating industrial

processes and start directly with oil and gas production. It is necessary to develop an energy-efficient method of targeted energy delivery to the well to prevent oil paraffination, and it is also necessary to develop energy-efficient methods for preparing and stabilizing crude oil during production and energy-efficient integrated methods for liquefying associated petroleum gas (Smit et al., 2000; Khusanov et al., 2017). When solving the problems of increasing the energy efficiency of technical systems, the issues of thermodynamic optimization of processes occurring in the elements of thermal power equipment and in thermal power systems themselves are primarily considered. One of the most effective methods of parametric optimization of thermal energy processes is pinch analysis or the method of integration of thermal processes (Tovar-Facio et al., 2020; Carmona-Martínez et al., 2023). However, one of the main limitations of the pinch method is its focus on the enthalpy approach to the analysis and optimization of heat fluxes in the system under consideration.

In connection with the above, there is a need to develop such a method of thermodynamic analysis and improvement of technical systems that would combine the advantages of the exergetic method and the method of structural and parametric optimization of thermal processes based on pinch analysis. Increased energy efficiency in the manufacturing industry can be achieved through new processes, production chain upgrades, better process integration, etc. But inter-factory integration (Klemeš et al. 1997) and inter-industry integration are still under development, and some results may be applicable to the low-carbon industry (Kuznetsov et al., 2022). The concept was first established (Dhole et al. 1993) and later updated by many authors and various aspects of biomass integration (Amiri et al. 2021), including centralized cooling (Liew et al., 2015), process modification (Chew et al., 2015), modernization of the heat exchanger network (Čuček et al., 2015) and others.

The use of exergetic analysis is important for assessing the stability of chemical processes, as it demonstrates potential losses in the energy system. This has been proven for the Total Site with the Omega Total Site Profile for calculating exergetic fracture and losses in individual processes (Mehdizadeh, et al., 2022). Combined with the general optimization algorithm, this resulted in a 24% reduction in exergy destruction in the specific example. The exergetic approach has also been used for multiple back-pressure steam turbines and optimal design of heat and electricity cogeneration systems (Pirmohamadi et al., 2019). The cogeneration potential of Total Site energy systems is crucial because it determines the amount of heat that can be converted to electricity. Varbanov et al. He presented methods for modeling steam turbines and gas turbines, which were integrated into models of utility cogeneration systems and synthesis of individual utility systems (Klemeš et al. 1997). Targeting for cogeneration was evaluated using commercial software and proved the feasibility of the approach (Ren et al., 2018). The efficiency of steam turbines should be improved, for example, optimization of the model has demonstrated high energy savings, shaft productivity and profitability of the bio-processing plant (Pyrgakis et al., 2020). The potential of cogeneration can also be used by the local energy sector to reduce energy consumption and improve energy efficiency and cogeneration of electricity (Lee et al., 2020). Optimization of the

local energy sector is mainly carried out using mathematical programming (MP) to use seasonal total energy storage at the facility (Liew, et al., 2018), increase efficiency in conditions of uncertainty (Sun et al., 2017), etc.

The article (Boldyryev et al. 2023) presents a new extension of the common site method, which takes into account the optimal amount of energy that can be saved at the inter-factory level. The approach uses the construction of general profiles of an object with a real temperature, takes into account heat transfer with intermediate utility and determines the potential of cogeneration within the enthalpy blocks of the total heat recovery of the object. The total annual cost was determined based on the Total Site Pinch concept, which makes it possible to find the optimal temperature regime between the temperature profiles of the facility. The results can be used for detailed design of the facility's energy system and further development of Total Site methods.

In (Boldyryev et al. 2023), an update of the super-targeting procedure is proposed, taking into account the separation of flows and mixing in the compression problem. An original algorithm for constructing composite curves is proposed for analyzing the distribution of technological flows and flow separation in subsystems above/below compression before designing a network of heat exchangers. This was then used in the super target planning procedure to refine capital expenditures. The proposed methodology can be used for preliminary design of the heat exchanger network in order to better determine the optimal ΔT_{min} , capital cost targets and verify the optimal change for various energy prices.

The document (Boldyryev et al., 2023) presents a methodology for evaluating electrified options for the processing industry based on methods of systematic process integration. Improved heat recovery and focus on electrified utilities were achieved using a Large Composite Curve and analysis of the main technological flows. The processing of liquefied natural gas is analyzed and the electrified heating network is evaluated. This approach can be used to further develop options for decarbonization of industry and targeting of electricity in processing industries.

Materials and methods

The main methods (Smit et al., 2000) of optimizing energy consumption in an industrial enterprise are as follows: – operational improvements that optimize the technological process; – a higher percentage of heat recovery due to increased thermal integration of the technological process (this includes pinch analysis); - the introduction of new technologies that increase the efficiency of equipment operation.

To assess energy efficiency and increase it at oil and gas treatment and processing enterprises, a number of methods and techniques are used to achieve the target values of optimal energy consumption. These include: pinch analysis; energy efficiency benchmarking methodology; hyperstructure optimization; stochastic optimization. The methods of pinch analysis find the greatest application in relation to the industries of the industry (Kuznetsov et al., 2022).

Total Site is a concept that covers the management and optimization of all aspects of work in a field or production facility, including extraction, processing, storage and resource allocation. When using the Total Site concept, all operations — from oil production to its refining — are considered as a single system (Boldyryev et al., 2023).

Pinch analysis as a methodology for minimizing the energy consumption of a process involves calculating thermodynamically justified amounts of energy consumption and approaching them by optimizing heat transfer processes, energy supply methods, and process characteristics. Pinch analysis is used in various industries, in particular in oil and gas processing, petrochemistry and the chemical industry, and can be used both in designing new technological facilities and in solving problems of optimizing the operation of existing industries, taking into account the principles of energy conservation (Boldyryev et al., 2023).

The Total Site energy system is a complex facility that is part of large industrial enterprises or industrial parks. As a rule, these are energy production facilities that convert various types of fuels into heat and electricity, providing basic processes. There is also heat distribution, cogeneration, and cooling. The utility can be supplied to the main processes from the utility system of the facility or another process due to the utilization of waste heat. The main scientific hypothesis is to find a compromise between full energy recovery at the facilities, taking into account the operational and capital costs of TSHR. This method extends the supertargeting procedure, which is used for individual processes and at the Total Sites level. However, TSHR is a more complex system and requires additional consideration to reformulate the overall objectives and systemic consideration. The initial idea was to apply the concept of supertargeting (Linnhoff et al., 1986) to shared profiles (TSP), but some functions limit such an extension. These are heat exchange using intermediate utilities (IMUS), the presence of zones for generating electricity, shifted temperature TSP, unified ΔT_{min} of utility systems, and others. This study will determine the total annual cost (TAC) of TSHR as a function of the total ΔT_{min} at the site and investigate the behavior of this function over a wide range of arguments and provide recommendations for cost-effective design of the TS heat exchange network.

The method is based on the decomposition of TSP into enthalpy blocks, taking into account real temperatures. Real temperatures make it possible to use certain IMUS in enthalpy blocks and maximize TS heat recovery (Boldyryev et al., 2023). In addition, heat and electricity (CHP) cogeneration will be considered within the framework of enthalpy units that maximize electricity generation. The next steps involve combining enthalpy blocks to reduce the number of IMU levels (Boldyryev et al., 2023), and hence heat exchangers and cogeneration zones. Capital expenditures and TAC targeting are applied to find the most cost-effective solution for TSHR.

When applying process integration, the following rules should be followed:

- heat transfer through pinch should not be carried out;
- for the area above the pinch, there should be no external cooling system.;
- for the area below the pinch, there should be no heat supply to the system from external sources.

In this case, the technological object is considered as a system with the allocation of structural units and the establishment of relationships between them. The above example, in particular, is characterized by the presence of a number of parallel operating devices of the same type – separators, settling tanks, and electric dehydrogenators; at the same time, the stages of the target process are carried out sequentially.

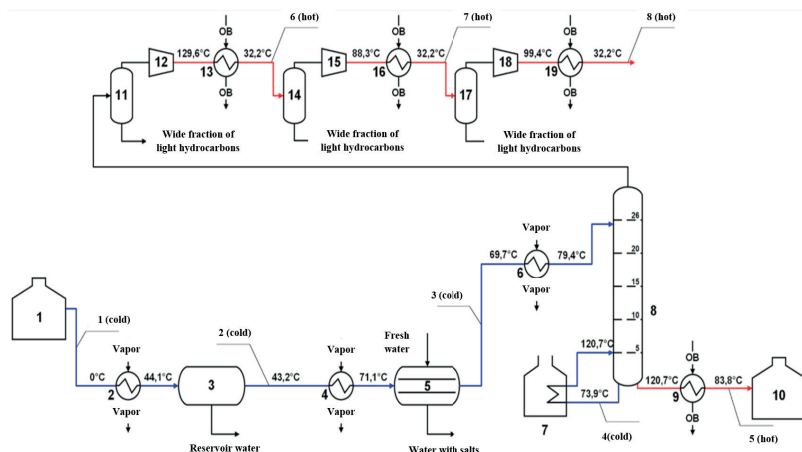
When analyzing the schemes, it is necessary to determine all the flows of matter and energy – internal (within the system) and external (flows going beyond the system and coming from systems external to the system under study), followed by determining the energy characteristics of internal and external flows. To do this, perform material calculations and, based on knowledge of the temperature parameters of the processes, determine the enthalpies of the flows with the release of hot and cold flows. The analysis of the heat exchange system and the collection of data on technological flows, obtaining flow properties and data on operating and capital costs will be carried out directly at the research facility (in the field), using an instrumental survey (measurement, survey, monitoring) and statistical analysis of historical data on resource consumption.

Results and discussion

The oil-bearing reservoir fluid extracted from oil fields has a complex composition. It contains: oil itself; associated petroleum gas; reservoir waters; drilling mud; various mechanical (Smit et al., 2000). It is unprofitable to transport such a mixture through main oil pipelines. Therefore, special oil treatment and stabilization units (OTSU) are being built and operated directly at the fields. These installations carry out the processes of degassing, dewatering, desalination and stabilization of extracted raw materials, and these processes, like most processes in the oil refining and petrochemical industries, are among the most energy-intensive processes among all industries. Therefore, the search and synthesis of systemic technological solutions to reduce specific energy consumption in these areas of industry is an urgent task.

Currently, the most effective methods of improving the energy efficiency of oil refining plants are process integration methods, and, in particular, the pinch analysis method (Khusanov et al., 2017).

In this paper, the object of research is the heat exchange system of an oil stabilization unit located in a field with production of 34,200 thousand tons of crude oil per year (Fig. 1).



1 – tank with raw materials; 2, 4, 6, 9, 13, 16, 19 – heat exchangers; 3 – sump; 5 – electric dehydrogenator; 7 – furnace; 8 – stabilization column; 10 – reservoir of prepared oil; 11, 14, 17 – separators; 12, 15, 18 – compressors.

Figure 1- Schematic technological diagram of the existing process at the OTSU

Crude oil with an initial temperature of $\sim 0^{\circ}\text{C}$ from the reservoir 1 of the central collection point is pumped through a heat exchanger 2 and at a temperature of about 44°C enters the sump 3. In the sump, reservoir waters are diverted from the target stream, and the dehydrated oil, after heating in the heat exchanger 4, is fed into an electric dehydrogenator 5, in which, mixing with a stream of prepared fresh water with a flow rate of 13.89 kg/s , it is re-dehydrated and desalinated. Further, the prepared oil, passing through the heat exchanger 6, is fed under the upper plate of the stabilization column 8. The temperature of the bottom of the column is maintained between $110\text{--}130^{\circ}\text{C}$ due to the heat of stable oil circulating through the coils of the tubular furnace 7. The overpressure in the column is maintained at values from 0.1 to 0.2 MPa , which creates the best conditions for fractionation of gasoline vapors – a wide fraction of hydrocarbons – in the cascade of separators 11, 14, 17 and in refrigerating condensers (the diagram shows separately 12, 15, 18 – condensers and 13, 16, 19 – cooling heat exchangers). Stable oil leaving the bottom of the column is cooled in the heat exchanger 9 and enters the reservoir of the prepared products. Hot steam circulates in the heating heat exchangers, and cooling water circulates in the cold ones.

The study of the technological regulations of the process, the technological scheme and the synthesis of the engineering model (Fig. 2) of the installation using the mathematical software of Honeywell UniSim® Design allowed us to form a flow table for the process under consideration (Tovar-Facio et al., 2020) (Table 1).

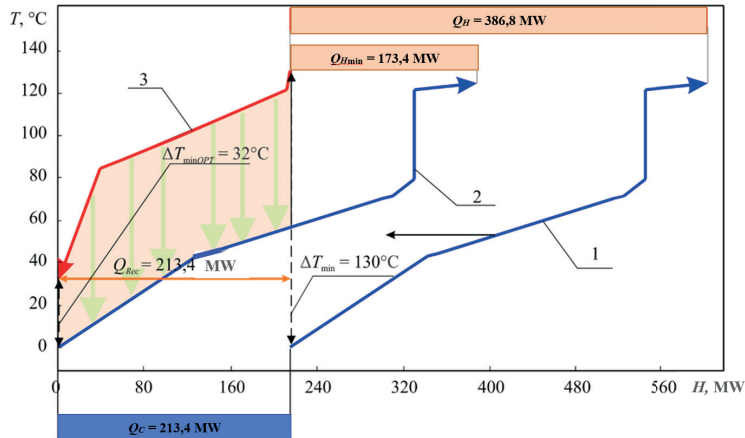
Table 1 -Table of streaming data of the oil treatment and stabilization unit

№	Stream name	Type of stream	$T_s, ^{\circ}$	$T_p, ^{\circ}$	$C, \text{ kW}/(\text{kg } ^{\circ}\text{C})$	$G, \text{ kg/s}$	$CP, \text{ kW}/^{\circ}$	$\alpha, \text{ kW}/(\text{m}^2)^{\circ}$
1	Power	cold	0	44	2.35	1257.5	2957.7	0.3
2	Power supply for the electric dehydrator	cold	43	71	5.0	1257.5	6304.8	0.25
3	Power supply of the stabilization column	cold	70	79	1.9	1257.5	2333.1	0.25
4	Heating of the column cube	cold	121	124	20.2	958	19380.7	0.25
5	Flow from the separator of the 3rd stage	hot	99	32	4.62	916.9	4235.9	0.02
6	Flow from the separator of the 2nd stage	hot	88	32	0.93	340.6	316.1	0.02
7	Flow from the separator of the 1st stage	hot	130	32	0.97	163.44	158.3	0.03
8	Bottom of the stabilization column	hot	121	84	3.37	77.65	261.8	0.25

Stream numbers in the table. 1 coincide with the numbers of technological flows on the basic technological scheme (Fig. 1.). The following designations are used in the flow table: T_s – initial flow temperature, $^{\circ}\text{C}$; C , – specific heat capacity, $\text{kW}/(\text{kg} \cdot ^{\circ}\text{C})$; G is the mass flow rate, kg/s ; CP is the flow heat capacity, $\text{kW}/^{\circ}\text{C}$; α is the heat transfer coefficient characteristic of the flow, $\text{kW}/(\text{m}^2 \cdot ^{\circ}\text{C})$

It follows from the regulations and technological scheme of the OTSU (Fig. 1) that

only utility heat exchangers are used in the technology, and the heat energy recovery capacity is zero. Using the Pinch 2.02 software package, we will construct composite curves of technological flows of USPS so that they do not overlap along the axis of flow enthalpy (Fig. 2).



1 – cold composite curve of the initial process; 2 – cold composite curve of the initial process after thermal energy integration; 3 – hot composite curve; Q_H – useful capacity of the hot utility before thermal energy integration; Q_C – useful capacity of the cold utility before thermal energy integration; Q_{rec} – heat energy recovery capacity; ΔT_{minOPT} – economically optimal the value of the minimum driving force in the heat exchange system

Figure 2- Composite curves of technological flows of OTSU

In this case, the cold process streams are heated in utility heat exchangers and the useful power used for this heating is equal to $Q_H = 386.8$ MW. Hot process streams are cooled in utility heat exchangers and heat output from them is equal to $Q_C = 213.4$ MW. In this case, the value $\Delta T_{min} = 130^\circ\text{C}$ is not the driving force of heat transfer, but simply shows the distance between the curves along the temperature axis.

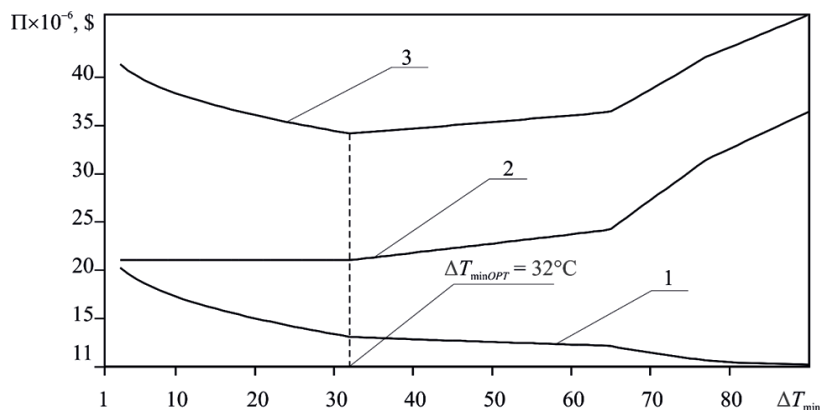
With a known power consumption and output and the specific cost of energy resources, it is easy to calculate the total cost of energy resources consumed by a thermal power system. However, to determine the optimal value of ΔT_{min} it is necessary to know the cost of reconstructing the heat exchange system. The cost of reconstructing the heat exchange system is calculated using the dependence of the cost of installed heat exchange equipment, which is obtained using a regression analysis of the cost of heat exchangers at oil refineries [A.A. Carmona-Martínez, et al. 2023]:

$$\Pi_{HE} = A + B(S)^c, \quad (1)$$

where $A = 40000$ USD is the cost of installing the heat exchanger together with fittings and delivery; $B = 1000$ USD is the cost of 1 m^2 of the heat exchange surface, S ; $c = 0.87$ is an indicator of the nonlinear dependence of the cost of the heat exchanger on its heat exchange surface. The typical cost of hot utilities at oil refineries is ~ 120

USD per 1 kW per year, cold ~ 10 USD per 1 kW per year, and the loan rate is 20% for a period of 10 years.

Using the Pinch-2.02 software package, taking into account the cost data, we construct cost curves for the reconstruction project of the OTSU heat exchange system (Fig. 3).



1 – The dependence of the present value of the installed heat exchange surface on the minimum driving force of heat exchange; 2 – The dependence of the annual cost of surface utilities on the minimum driving force of heat exchange; 3 – The total dependence of the present value of the reconstruction project on the minimum driving force of heat exchange.

Figure 3- Cost curves of the OTSU reconstruction project

And the optimal value of the minimum temperature difference, i.e. the difference, at which the discounted cost of the reconstruction project will be the lowest, is $\Delta T_{\min OPT} = 32^{\circ}\text{C}$.

The construction of composite curves for $\Delta T_{\min OPT} = 32^{\circ}\text{C}$ (Fig. 2) shows the payload of hot utilities $Q_{Hmin} = 175390$ MW, cold utilities $-Q_{Cmin} = 0$ MW and thermal energy recovery capacity $-Q_{Rec} = 213.4$ MW. Thus, by completing the reconstruction project, it is possible to reduce the consumption of hot utilities by 55%, and to abandon cold ones altogether and put all refrigerators in reserve. The energy values obtained during the construction of composite curves for the optimal value of the driving force of heat transfer are the target energy values that must be achieved during the implementation of the pinch reconstruction project of the OTSU heat exchange system. In our case, we need to create a regenerative heat exchange system at the installation in question.

Next, using the laws and rules of pinch analysis to build optimal heat exchange systems, we synthesize a grid diagram of the OTSU reconstruction project (Fig. 4.)

In the grid diagram, the net capacity of the hot utilities is 173.4 MW, which is 45% of the currently existing hot utilities. All hot streams are brought to their target temperatures by cooling them in a regenerative heat exchange system with cold process streams. Summing up the thermal loads of the regenerative heat exchangers shown in the grid diagram, we obtain the value of the hot utility, which we obtained when constructing composite curves for $\Delta T_{\min OPT} = 32^{\circ}\text{C}$. Thus, by placing regenerative heat exchangers

on the grid diagram, we have shown the possibility of achieving target energy values in the project of creating a new OTSU regenerative heat exchange system.

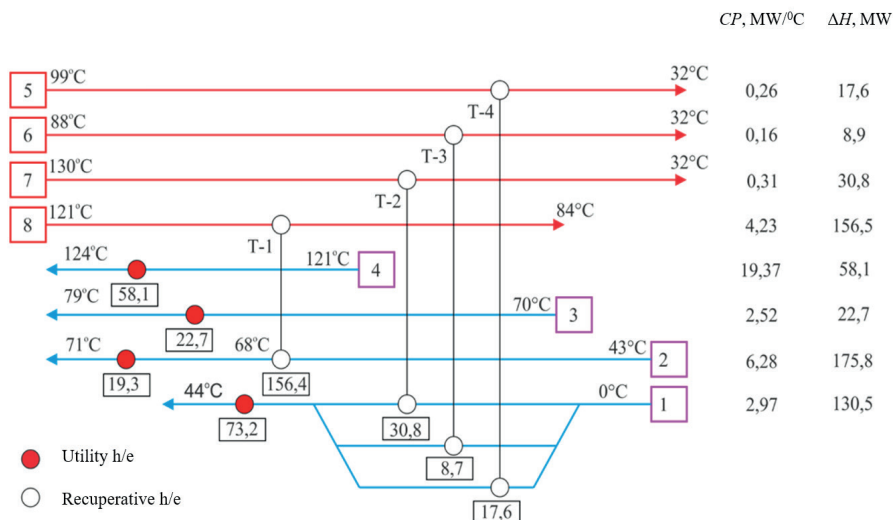


Figure 4- Grid diagram of the OTSU heat exchange system reconstruction project. The flow numbers correspond to the numbers in the Flow Table 1. The circled values below the image of the heat exchangers show their thermal load

It should be noted that the synthesized grid diagram of the OTSU heat exchange system project should serve as a technical specification for designing a regenerative heat exchange system and preparing working documentation for the reconstruction project.

Conclusions.

The paper performs thermal energy integration and presents a grid diagram of a regenerative heat exchange system for an oil stabilization and treatment plant. As a result of the project's implementation, the energy consumption of external hot energy sources will decrease by 213.4 MW, or 55%. You can completely abandon cold utilities. Greenhouse gas emissions will decrease by about 71%. The discounted payback period is about 11 months from the moment the reconstruction project reaches its target capacity.

References

- Smit R., Klemesh J., Tovazhnjanskij L.L., Kapustenko P.A., Ul'ev L.M. (2000) Osnovy integracii teplovyh processov [Fundamentals of thermal process integration]. Har'kov. NTU "HPI". — 458 p. (in Eng.).
- Khusanov A.E., Ul'ev L.M., Kaldybaeva B.M., Sabyrhanov D.S., Boldyrev S.A. (2017) Modelirovanie i optimizacija jenergotreblenija, snizhenie urovnja zagriznenija promyshlennyh predpriyatij na osnove integracij processov s primeneniem metodov pinch-analiza [Modeling and optimization of energy consumption, reducing pollution levels in industrial enterprises based on process integrations using pinch analysis methods.]. — Shymkent: SKSU named M. Auezov. — 266 p. (in Eng.).
- J. Tovar-Facio, M. Martín, J. María Ponce-Ortega (2020) Sustainable energy transition: modeling, optimization. Sensor Actuator B Chem, Article 129129, 10.1016/j.snb.2020.129129. (in Eng.).
- A.A. Carmona-Martínez, A. Fresneda-Cruz, A. Rueda, O. Birgi, C. Khawaja, R. Janssen, B. Davidis, P. Reumerman, M. Vis, E. Karampinis, P. Grammelis, C. Jarauta-Córdoba (2023) Renewable power and

heat for the decarbonisation of energy-intensive industries. *Processes*, 11. — 18 p. 10.3390/pr11010018. (in Eng.).

J. Klemeš, V.R. Dhole, K. Raissi, S.J. Perry, L. Puigjaner (1997) Targeting and design methodology for reduction of fuel, power and CO₂ on total sites. *Appl Therm Eng*, 17. — P. 993-1003p., 10.1016/S1359-4311(96)00087-7 (in Eng.).

M. Kuznetsov, S. Boldyryev, D. Kenzhebekov, B. Kaldybaeva (2022). Improving inter-plant integration of syngas production technologies by the recycling of CO₂ and by-product of the fischer-tropsch process. *Int J Hydrogen Energy*, 47. — P. 31755-31772, 10.1016/j.ijhydene.2021.12.184 (in Eng.).

V.R. Dhole, B. Linnhoff (1993) Total site targets for fuel, Co-generation, emissions, and cooling. *Comput Chem Eng*, 17. — P. S101, 10.1016/0098-1354(93)80214-8-S109 (in Eng.).

H. Amiri, A.F. Sotoodeh, M. Amidpour (2021) A new combined heating and power system driven by biomass for total-site utility applications. *Renew Energy*, 163. — P. 1138-1152, 10.1016/j.renene.2020.09.039 (in Eng.).

P.Y. Liew, S.R.W. Alwi, Z.A. Manan, J.J. Klemeš, P.S. Varbanov (2015). Incorporating District Cooling System in Total Site Heat Integration. — P. 19-24, 10.3303/CET1545004 (in Eng.).

K.H. Chew, J.J. Klemeš, S.R. Wan Alwi, Z.A. Manan (2015). Process modifications to maximise energy savings in total site heat integration. *Appl Therm Eng*, 78. — P. 731-739, 10.1016/j.applthermaleng.2014.04.044 (in Eng.).

L. Čuček, V. Mantelli, J.Y. Yong, P.S. Varbanov, J.J. Klemeš, Z. Kravanja (2015). A Procedure for the Retrofitting of Large-Scale Heat Exchanger Networks for Fixed and Flexible Designs Applied to Existing Refinery Total Site, 45. — P. 109-114, 10.3303/CET1545019 (in Eng.).

F. Mehdizadeh, N. Tahouni, M.H. Panjeshahi (2022). Total site exergy analysis, using a new conceptual method. *Energy*, 250, Article 123790, 10.1016/j.energy.2022.123790 (in Eng.).

A. Pirmohamadi, M. Ghazi, M. Nikian (2019). Optimal design of cogeneration systems in total site using exergy approach. *Energy*, 166. — P. 1291-1302, 10.1016/j.energy.2018.10.167 (in Eng.).

X.-Y. Ren, X.-X. Jia, P.S. Varbanov, J.J. Klemeš, Z.-Y. Liu (2018). Targeting the cogeneration potential for total site utility systems. *J Clean Prod*, 170. — P. 625-635, 10.1016/j.jclepro.2017.09.170 (in Eng.).

K.A. Pyrgakis, A.C. Kokossis (2020). Total site synthesis: selection of processes to save energy and boost cogeneration. S. Pierucci, F. Manenti, G.L. Bozzano, D. Manca (Eds.), *Computer aided chemical engineering*, 30 European symposium on computer aided process engineering. — vol. 48. — P. 1345-1350, 10.1016/B978-0-12-823377-1.50225-1 (in Eng.).

P.Y. Liew, S.R. Wan Alwi, W.S. Ho, Z. Abdul Manan, P.S. Varbanov, J.J. Klemeš (2018). Multi-Period energy targeting for total site and locally integrated energy sectors with cascade Pinch analysis. — *Energy*, 155. — P. 370-380, 10.1016/j.energy.2018.04.184 (in Eng.).

L. Sun, L. Gai, R. Smith (2017). Site utility system optimization with operation adjustment under uncertainty. *Appl Energy*, 186. — P. 450-456, 10.1016/j.apenergy.2016.05.036 (in Eng.).

Boldyryev S., Gil T., Krajačić G., Khussanov, A. (2023) Total site targeting with the simultaneous use of intermediate utilities and power cogeneration at the polymer plant. — *Energy*, 279. — 128034 p. <https://doi.org/10.1016/j.energy.2023.128034>. (in Eng.).

Boldyryev S., Kuznetsov M., Ryabova I., Krajačić G., Kaldybaeva B. (2023) Assessment of renewable energy use in natural gas liquid processing by improved process integration with heat pumps. *e-Prime - Advances in Electrical Engineering, Electronics and Energy*. — Vol. 5. — № 100246. doi: 0.1016/j.prime.2023.100246 (in Eng.).

B. Linnhoff, S. Ahmad (1986). SUPERTARGETING: optimum synthesis of energy management systems. *J Energy Resour Technol*, 2 (1). — P. 1-13, 10.1115/1.3231413 (in Eng.).

Publication Ethics and Publication Malpractice in the journals of the Central Asian Academic Research Center LLP

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 journals of the Central Asian Academic Research Center LLP 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 Central Asian Academic Research Center LLP 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 Central Asian Academic Research Center LLP.

The Editorial Board of the Central Asian Academic Research Center LLP will monitor and safeguard publishing ethics.

Правила оформления статьи для публикации в журнале смотреть на сайтах:

www.nauka-nanrk.kz

<http://chemistry-technology.kz/index.php/en/arhiv>

ISSN 2518-1491 (Online), ISSN 2224-5286 (Print)

Ответственный редактор *А. Ботанқызы*

Редакторы: *Д.С. Аленов, Т. Апендиев*

Верстка на компьютере *Г.Д. Жадырановой*

Подписано в печать 23.12.2025.

Формат 60х88¹/₈. Бумага офсетная. Печать – ризограф.

13,5 п.л. Заказ 4.

«Central Asian Academic Research Center» LLP

Алматы, Қонаев к-сі, 142