

ISSN 2518-1483 (Online),
ISSN 2224-5227 (Print)

**ACADEMIC JOURNAL
OF PHYSICAL AND CHEMICAL SCIENCES**

**№1
2026**

ISSN 2518-1483 (Online),
ISSN 2224-5227 (Print)

2026 • 1



**ACADEMIC JOURNAL
OF PHYSICAL AND
CHEMICAL SCIENCES**

PUBLISHED SINCE JANUARY 1944

ALMATY, NAS RK

EDITOR-IN-CHIEF

ZHURINOV Murat Zhurinovich, Doctor of Chemical Sciences, Professor, Academician of IAAS and NAS RK, General Director Oil refining and Petrochemistry Research Institute (Almaty, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=6602177960>, <https://www.webofscience.com/wos/author/record/2017489>

DEPUTY EDITOR-IN-CHIEF:

KALIMOLDAYEV Maksat Nuradilovich, Doctor of Physical and Mathematical Sciences, Professor, Academician of NAS RK (Almaty, Kazakhstan), <https://www.scopus.com/authid/detailuri?authorId=56153126500>, <https://www.webofscience.com/wos/author/record/2428551>

ABILMAGZHANOV Arlan Zainutallaevich, PhD in Chemistry, General Director of JSC "Institute of Fuel, Catalysis and Electrochemistry named after D.V. Sokolsky", (Almaty, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=57197468109>, <https://www.webofscience.com/wos/author/record/2024265>

EDITORIAL BOARD:

ADEKENOV Sergazy Mynzhasarovich, Doctor of Chemical Sciences, Professor, Academician of NAS RK, Director of the JSC "Phytochemistry Research and Production Center", (Karaganda, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=7006153118>, <https://www.webofscience.com/wos/author/record/48648658>

RAMAZANOV Tlekkabul Sabitovich, Doctor of Physical and Mathematical Sciences, Professor, Academician of NAS RK (Almaty, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=6701328029>, <https://www.webofscience.com/wos/author/record/13503476>

ABIEV Rufat, Doctor of Technical Sciences (Biochemistry), Professor, Head of the Department of Optimization of Chemical and Biotechnological Equipment, St. Petersburg State Technological Institute (St. Petersburg, Russia), <https://www.scopus.com/authid/detail.uri?authorId=6602431781>, <https://www.webofscience.com/wos/author/record/1405661>

OLIVIERO Rossi Cesare, PhD (Chemistry), Professor at the University of Calabria (Calabria, Italy), <https://www.scopus.com/authid/detail.uri?authorId=57221375979>, <https://www.webofscience.com/wos/author/record/399768>

TIGINYANU Ion Mihailovich, Doctor of Physical and Mathematical Sciences, Academician, President of the Academy of Sciences of Moldova, Technical University of Moldova (Chisinau, Moldova), <https://www.scopus.com/authid/detail.uri?authorId=7006315935>, <https://www.webofscience.com/wos/author/record/524462>

SANG SU Kwak, PhD (Biochemistry, Agricultural Chemistry), Professor, Chief Scientist, Research Center for Plant Systems Engineering, Korea Research Institute of Bioscience and Biotechnology (KRIBB), (Daecheon, Korea), <https://www.scopus.com/authid/detail.uri?authorId=59286321700>, <https://www.webofscience.com/wos/author/record/30028581>

BERSIMBAYEV Rakhmetkazhi Iskenderovich, Doctor of Biological Sciences, Professor, Academician of NAS RK, L.N. Gumilyov Eurasian National University (Astana, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=7004012398>, <https://www.webofscience.com/wos/author/record/19854255>

CALANDRA Pietro, PhD (Physics), Professor, Institute for the Study of Nanostructured Materials (Rome, Italy), <https://www.scopus.com/authid/detail.uri?authorId=7004303066>, <https://www.webofscience.com/wos/author/record/616360>

BOSHKAEV Kuantai Avgazyevich, PhD, Associate Professor, Department of Theoretical and Nuclear Physics, Al-Farabi Kazakh National University (Almaty, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=54883880400>, <https://www.webofscience.com/wos/author/record/2080231>

BURKITBAEV Mukhambetkali, Doctor of Chemical Sciences, Professor, Academician of NAS RK, (Almaty, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=8513885600>, <https://www.webofscience.com/wos/author/record/29017135>

QUEVEDO Hernando, Professor, National Autonomous University of Mexico (UNAM), Institute of Nuclear Sciences (Mexico City, Mexico), <https://www.scopus.com/authid/detail.uri?authorId=55989741100>, <https://www.webofscience.com/wos/author/record/30353742>

ZHUSUPOV Marat Abzhanovich, Doctor of Physical and Mathematical Sciences, Professor of the Department of Theoretical and Nuclear Physics, Al-Farabi Kazakh National University (Almaty, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=6602166928>, <https://www.webofscience.com/wos/author/record/566>

KOVALEV Alexander Mikhailovich, Doctor of Physical and Mathematical Sciences, Academician of NAS of Ukraine, Institute of Applied Mathematics and Mechanics (Donetsk, Ukraine), <https://www.scopus.com/authid/detail.uri?authorId=7202799321>, <https://www.webofscience.com/wos/author/record/65533963>

TAKIBAEV Nurgali Zhabagaevich, Doctor of Physical and Mathematical Sciences, Professor, Academician of NAS RK, Al-Farabi Kazakh National University (Almaty, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=24077239000>, <https://www.webofscience.com/wos/author/record/1671760>

KHARIN Stanislav Nikolaevich, Doctor of Physical and Mathematical Sciences, Professor, Academician of NAS RK, Kazakh-British Technical University (Almaty, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=6701353063>, <https://www.webofscience.com/wos/author/record/2023295>

ABISHEV Medeu Erzhanovich, Doctor of Physical and Mathematical Sciences, Professor, Corresponding Member of NAS RK, (Almaty, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=26530759900>, <https://www.webofscience.com/wos/author/record/1556025>

ACADEMIC JOURNAL OF PHYSICAL AND CHEMICAL SCIENCES.

ISSN 2518-1483 (Online), ISSN 2224-5227 (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 № KZ93VPY00121157 issued 05.06.2025

Thematic scope: *physics and chemistry*.

Periodicity: 4 times a year.

<http://reports-science.kz/index.php/en/archive>

БАС РЕДАКТОР

ЖҰРЫНОВ Мұрат Жұрынулы, химия ғылымдарының докторы, профессор, ХҒАҚ және ҚР ҰҒА академигі, Мұнай өңдеу және мұнай-химиясы ғылыми-зерттеу институтының бас директоры (Алматы, Қазақстан), <https://www.scopus.com/author/detail.uri?authorId=6602177960>, <https://www.webofscience.com/wos/author/record/2017489>

БАС РЕДАКТОРДЫҢ ОРЫНБАСАРЛАРЫ:

КАЛИМОЛДАЕВ Мақсат Нұрәділұлы, физика-математика ғылымдарының докторы, профессор, ҚР ҰҒА академигі (Алматы, Қазақстан), <https://www.scopus.com/author/detail.uri?authorId=56153126500>, <https://www.webofscience.com/wos/author/rec-ord/2428551>

ӘБИЛМАҒЖАНОВ Арлан Зайнуталлайұлы, химия ғылымдарының кандидаты, Д.В. Сокольский атындағы «Жанармай, катализ және электрохимия институты» АҚ Бас директоры (Алматы, Қазақстан), <https://www.scopus.com/author/detail.uri?authorId=57197468109>, <https://www.webofscience.com/wos/author/record/2024265>

РЕДАКЦИЯ АЛҚАСЫ:

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

РАМАЗАНОВ Тілеккабыл Сәбитұлы, физика-математика ғылымдарының докторы, профессор, ҚР ҰҒА академигі (Алматы, Қазақстан), <https://www.scopus.com/author/detail.uri?authorId=6701328029>, <https://www.webofscience.com/wos/author/record/13503476>

ӘБИЕВ Руфат, техника ғылымдарының докторы (биохимия), профессор, Санкт-Петербург мемлекеттік технологиялық институты «Химиялық және биотехнологиялық аппаратураны оңтайландыру» кафедрасының меңгерушісі (Санкт-Петербург, Ресей), <https://www.scopus.com/author/detail.uri?authorId=6602431781>, <https://www.webofscience.com/wos/author/record/1405661>

ОЛИВЬЕРО Росси Сесаре, PhD (химия), Калабрия университетінің профессоры (Калабрия, Италия), <https://www.scopus.com/author/detail.uri?authorId=57221375979>, <https://www.webofscience.com/wos/author/record/399768>

ТИГИНЯНУ Ион Михайлович, физика-математика ғылымдарының докторы, академик, Молдова Ғылым академиясының президенті, Молдова техникалық университеті (Кишинев, Молдова), <https://www.scopus.com/author/detail.uri?authorId=7006315935>, <https://www.webofscience.com/wos/author/record/524462>

САНГ-СУ Квак, PhD (биохимия, агрохимия), профессор, Корей Биоғылым және биотехнология ғылыми-зерттеу институты (KRIBB), өсімдіктердің инженерлік жүйелері ғылыми-зерттеу орталығының бас ғылыми қызметкері (Дэчон, Корея), <https://www.scopus.com/author/detail.uri?authorId=59286321700>, <https://www.webofscience.com/wos/author/record/30028581>

БЕРСІМБАЕВ Рахметқажы Есендірұлы, биология ғылымдарының докторы, профессор, ҚР ҰҒА академигі, Л.Н. Гумилев атындағы Еуразия ұлттық университеті (Астана, Қазақстан), <https://www.scopus.com/author/detail.uri?authorId=7004012398>, <https://www.webofscience.com/wos/author/record/19854255>

КАЛАНДРА Пьетро, PhD (физика), нанокүрылымды материалдарды зерттеу институтының профессоры (Рим, Италия), <https://www.scopus.com/author/detail.uri?authorId=7004303066>, <https://www.webofscience.com/wos/author/record/616360>

БӨШКАЕВ Қуантай Авғазыұлы, PhD теориялық және ядролық физика кафедрасының доценті, әл-Фараби атындағы Қазақ ұлттық университеті (Алматы, Қазақстан), <https://www.scopus.com/author/detail.uri?authorId=54883880400>, <https://www.webofscience.com/wos/author/record/2080231>

БҮРКІТБАЕВ Мұхамбетқали, химия ғылымдарының докторы, профессор, ҚР ҰҒА академигі (Алматы, Қазақстан), <https://www.scopus.com/author/detail.uri?authorId=8513885600>, <https://www.webofscience.com/wos/author/record/29017135>

QUEVEDO Hernando, профессор, Мексика ұлттық автономиялық университеті (UNAM), Ядролық ғылымдар институты (Мехико, Мексика), <https://www.scopus.com/author/detail.uri?authorId=55989741100>, <https://www.webofscience.com/wos/author/record/30353742>

ЖҮСІПОВ Марат Абжанұлы, физика-математика ғылымдарының докторы, теориялық және ядролық физика кафедрасының профессоры, әл-Фараби атындағы Қазақ ұлттық университеті (Алматы, Қазақстан), <https://www.scopus.com/author/detail.uri?authorId=6602166928>, <https://www.webofscience.com/wos/author/record/566>

КОВАЛЕВ Александр Михайлович, физика-математика ғылымдарының докторы, Украина ҰҒА академигі, Қолданбалы математика және механика институты (Донецк, Украина), <https://www.scopus.com/author/detail.uri?authorId=7202799321>, <https://www.webofscience.com/wos/author/record/65533963>

ТАКИБАЕВ Нұрғали Жабағаұлы, физика-математика ғылымдарының докторы, профессор, ҚР ҰҒА академигі, әл-Фараби атындағы Қазақ ұлттық университеті (Алматы, Қазақстан), <https://www.scopus.com/author/detail.uri?authorId=24077239000>, <https://www.webofscience.com/wos/author/record/1671760>

ХАРИН Станислав Николаевич, физика-математика ғылымдарының докторы, профессор, ҚР ҰҒА академигі (Алматы, Қазақстан), <https://www.scopus.com/author/detail.uri?authorId=6701353063>, <https://www.webofscience.com/wos/author/record/2023295>

ӘБИШЕВ Медеу Ержанұлы, физика-математика ғылымдарының докторы, профессор, ҚР ҰҒА академигі (Алматы, Қазақстан), <https://www.scopus.com/author/detail.uri?authorId=26530759900>, <https://www.webofscience.com/wos/author/record/1556025>

ACADEMIC JOURNAL OF PHYSICAL AND CHEMICAL SCIENCES

ISSN 2518-1483 (Online), ISSN 2224-5227 (Print)

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

Ақпарат агенттігінің мерзімді баспасөз басылымын, ақпарат агенттігінің және желілік басылымды қайта есепке қою туралы ҚР Мәдениет және Ақпарат министрлігі «Ақпарат комитеті» Республикалық мемлекеттік мекемесі 05.06.2025 ж. берген № KZ93VPY00121157 Куәлік.

Тақырыптық бағыты: *физика, химия.*

Мерзімділігі: жылына 4 рет.

<http://reports-science.kz/index.php/en/archive>

ГЛАВНЫЙ РЕДАКТОР

ЖУРИНОВ Мурат Журинович, доктор химических наук, профессор, академик МААН и НАН РК, Генеральный директор Научно-исследовательского института нефтепереработки и нефтехимии (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=6602177960>, <https://www.webofscience.com/wos/author/record/2017489>

ЗАМЕСТИТЕЛИ ГЛАВНОГО РЕДАКТОРА:

КАЛИМОЛДАЕВ Максат Нурадилович, доктор физико-математических наук, профессор, академик НАН РК (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=56153126500>, <https://www.webofscience.com/wos/author/record/2428551>

АБИЛЬМАГЖАНОВ Арлан Зайнуталлаевич, кандидат химических наук, Генеральный директор АО «Институт топлива, катализа и электрохимии им. Д.В. Сокольского», (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=57197468109>, <https://www.webofscience.com/wos/author/record/2024265>

РЕДАКЦИОННАЯ КОЛЛЕГИЯ:

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

РАМАЗАНОВ Тлеккабул Сабитович, (заместитель главного редактора), доктор физико-математических наук, профессор, академик НАН РК (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=6701328029>, <https://www.webofscience.com/wos/author/record/13503476>

АБИЕВ Руфат, доктор технических наук (биохимия), профессор, заведующий кафедрой «Оптимизация химической и биотехнологической аппаратуры», Санкт-Петербургский государственный технологический институт (Санкт-Петербург, Россия), <https://www.scopus.com/authid/detail.uri?authorId=6602431781>, <https://www.webofscience.com/wos/author/record/1405661>

ОЛИБЬЕРО Россин Чезаре, доктор философии (PhD, химия), профессор Университета Калабрии (Калабрия, Италия), <https://www.scopus.com/authid/detail.uri?authorId=57221375979>, <https://www.webofscience.com/wos/author/record/399768>

ТИГИНЯНУ Ион Михайлович, доктор физико-математических наук, академик, президент Академии наук Молдовы, Технический университет Молдовы (Кишинев, Молдова), <https://www.scopus.com/authid/detail.uri?authorId=7006315935>, <https://www.webofscience.com/wos/author/record/524462>

САНГ-СУ Квак, доктор философии (PhD, биохимия, агрохимия), профессор, главный научный сотрудник, Научно-исследовательский центр инженерных систем растений, Корейский научно-исследовательский институт бионауки и биотехнологии (KRIBB) (Дэчон, Корея), <https://www.scopus.com/authid/detail.uri?authorId=59286321700>, <https://www.webofscience.com/wos/author/record/30028581>

БЕРСИМБАЕВ Рахметкажи Искендерович, доктор биологических наук, профессор, академик НАН РК, Евразийский национальный университет им. Л.Н. Гумилева (Астана, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=7004012398>, <https://www.webofscience.com/wos/author/record/19854255>

КАЛАНДРА Пьетро, доктор философии (PhD, физика), профессор Института по изучению наноструктурированных материалов (Рим, Италия), <https://www.scopus.com/authid/detail.uri?authorId=7004303066>, <https://www.webofscience.com/wos/author/record/616360>

БОШКАЕВ Куантай Авгазиевич, PhD, преподаватель, доцент кафедры теоретической и ядерной физики, Казахский национальный университет им. Аль-Фараби (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=54883880400>, <https://www.webofscience.com/wos/author/record/2080231>

БУРКИТБАЕВ Мухамбетали, 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/29017135>

QUEVEDO Hernando, профессор, Национальный автономный университет Мексики (UNAM), Институт ядерных наук (Мехико, Мексика), <https://www.scopus.com/authid/detail.uri?authorId=55989741100>, <https://www.webofscience.com/wos/author/record/30353742>

ЖУСУПОВ Марат Абжанович, доктор физико-математических наук, профессор кафедры теоретической и ядерной физики, Казахский национальный университет имени аль-Фараби (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=6602166928>, <https://www.webofscience.com/wos/author/record/566>

КОВАЛЕВ Александр Михайлович, доктор физико-математических наук, академик НАН Украины, Институт прикладной математики и механики (Донецк, Украина), <https://www.scopus.com/authid/detail.uri?authorId=7202799321>, <https://www.webofscience.com/wos/author/record/65533963>

ТАКИББАЕВ Нурғали Жабағаевич, доктор физико-математических наук, профессор, академик НАН РК, Казахский национальный университет им. Аль-Фараби (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=24077239000>, <https://www.webofscience.com/wos/author/record/1671760>

ХАРИН Станислав Николаевич, доктор физико-математических наук, профессор, академик НАН РК (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=6701353063>, <https://www.webofscience.com/wos/author/record/2023295>

АБИШЕВ Мелеу Ержанович, доктор физико-математических наук, профессор, академик НАН РК, (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=26530759900>, <https://www.webofscience.com/wos/author/record/1556025>

ACADEMIC JOURNAL OF PHYSICAL AND CHEMICAL SCIENCES

ISSN 2518-1483 (Online), ISSN 2224-5227 (Print)

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

Свидетельство № KZ93VPY00121157 о повторной регистрации периодического печатного издания информационного агентства, информационного агентства и сетевого издания, выданное Республиканским государственным учреждением «Комитет информации» Министерства культуры и информации Республики Казахстан **05.06.2025**Тематическая направленность: *физика, химия*.

Периодичность: 4 раза в год.

<http://reports-science.kz/index.php/en/archive>

CONTENTS

PHYSICS

Aimaganbetova Z.K., Kulshymbayev Y.A., Zhanturina N.N., Beketova G.K.
 First-principles calculation of the electronic properties of the Double Halide
 Perovskite $\text{Cs}_2\text{Ag}_{0.2}\text{Na}_{0.4}\text{In}_{0.6}\text{Ti}_{0.4}\text{Cl}_6$ based on the quantum ESPRESSO software.....14

Amangeldinova S., Zhuniskhan S., Kalzhigitov N., Kurmangaliyeva V.
 Study of the cluster structure of ^5He and ^5Li mirror nuclei in two-cluster
 approximation.....35

Chokin K., Otunchi Ye., Kozhahmetova A., Kasenova A., Shongalova A.
 Development and testing of a laboratory pyrometallurgical installation for recycling
 lithium-ion batteries.....46

Issayeva A., Beisebayeva A., Madybekova G., Shynazbekova Sh., Issa A.
 Comparative analysis of physico-chemical characteristics of drinking, spring
 and natural water in the South Kazakhstan.....65

Kim V.Yu., Aimuratov Y.K.
 Search for transient cosmic events by scanning the sky with wide-field telescopes.....78

Koshtybayev T.B., Tatenov A.M., Aliyeva M.E., Tugelbaeva G.T., Zhanaliyeva G.Zh.
 Study of the electromagnetic field based on thermodynamics principles.....89

Mukamedenkyzy V., Akberdiyev B.
 Numerical investigation of the effect of inclination angle on the stability
 of mechanical equilibrium in Ar–N₂ binary gas mixtures.....105

Myasnikova L.N., Uzakbaeva S.S., Shanina Z.K., Bekeshev A.Z.
 Kinetic properties of high-density polyethylene filled with chromium spinel powder.....119

Nurbayev B.M., Dmitriyeva E.A., Kemelbekova A.E.
 The role of low-dimensional layered structures in enhancing the stability of tin-based
 perovskite materials.....136

Sattinova Z., Ermakhanova F., Assilbekov B., Taimuratova L.
 Influence of various cooling conditions and heat transfer coefficients on solidification
 during the formation of beryllium ceramic products.....149

Shestakova L.I., Serebryanskiy A.V., Spassyuk R.R., Omarov Ch.T.
 Search for gas of comet-meteor origin in the inner Solar System: caii ion emission.....165

Ualikhanova U., Tursynkazy F., Syzdykova A.M., Altayeva G.S., Altaibayeva A.B.
 Studying the amplitude of $f(T)$ gravitational waves using Bessel functions.....179

Zhexenbayeva G.A., Nasirova D.M., Aimanova G.K., Shomshekova S.A. Photometric study of the symbiotic object V725 Tau.....	194
Zhusupova N.K., Zhadyranova A.A. Bounce cosmology in $f(T, \mathcal{T})$ gravity based on energy condition analysis.....	205
Ziyatbekova G., Abdimanapova P., Sagyntay O., Nurym A., Ilinov R. Using artificial intelligence to predict diseases based on medical data.....	225

CHEMISTRY

Almassov N.Zh., Zhumagaliyeva A.N., Duisenbekov S.E., Zhakiyev N.K. Design and optimization of hybrid renewable energy systems for hydrogen production in Kazakhstan.....	236
Amangeldi B., Zhanikulov N., Taimasov B., Aitureev M.M., Dauletiyarov M. Calculation of the Raw material composition for obtaining white Portland cement clinker.....	251
Baeshov A., Tashenov E.A., Atykhanova S.B., Koshkarbayeva Sh.T. Preparation of cadmium sulfide by electrochemical method using a composite sulfur-graphite electrode.....	267
Baisalova G.Zh., Azhikhanova Zh., Taltenov A.A., Kuzhatova P. Determination of the total phenolic content in perennial herbaceous plants of the flora of Kazakhstan.....	277
Darmenbayeva A.S., Rajasekharan R., Zhussipnazarova G.M., Mukazhanova Zh.B., Begenova B.E. Composites based on chitosan and cellulose: synthesis, properties, and application prospects.....	287
Erkasov R.Sh., Zhamkenova A.S., Sergazina S.M., Nurmukhanbetova N.N., Kassenova N.B. Halide-dependent modulation of hydrogen bonding in Mn(II) complexes with protonated acetamide: a QAIM, NCI, and energy decomposition study.....	304
Kalimoldina L.M., Shaikhova Zh.E., Kaliyeva B.K., Bubish Sh., Askarova Sh.K. The effect of silver nanoparticles on the germination of bean, lemon, tangerine and avocado seeds.....	320
Kurtebayeva A.A., Alvarez-Torrellas S., Gomes H.T., Orynbayev S.A., Kalmakhanova M.S. Activated-carbon-enhanced polymeric membranes for efficient elimination of emerging contaminants.....	334

Massenova A.T., Zhumakanova A.S., Torlopov I.I., Rakhmetova K.S., Abilmagzhanov A.Z. Optimization of the hierarchical zeolite ZSM-5 synthesis process by steam-assisted alkaline modification.....	350
Mutushev A.Zh., Nuraly A.M., Sanat A.S., Shaukharova M.A., Yessimsiitova Z.B. The effect of light-converting films on the accumulation of bioactive compounds and the quality of fruits.....	366
Nefedov A.N., Taikenova A.T. Current state of organic corrosion inhibitor application in oil refining.....	379
Omarov B.T., Altybayev Zh.M., Serikbayeva B.S. Production of biohumus by vermicomposting of organic wastes and study of its agroecological effectiveness.....	399
Rakhman D.M., Kappasuly A., Makhayeva D.N., Kazybayeva D.S., Irmukhametova G.S. Development and investigation of mucoadhesive hydrogels based on gellan–cysteine complexes.....	414
Sabyrzhanova A.E., Bolatkyzy N., Berganaeva G.E., Dyusebaeva M.A. Study of amino acids and fatty acids in the aerial part of <i>Plantago major</i>	428
Satayeva S., Akhmetova F., Urazova A., Aituganova S., Yerniyazova K. The influence of PEPA concentration on the physical, mechanical, and operational properties of ED-20 epoxy adhesives.....	439
Zamanbek A.Zh., Koshkarbayeva Sh.T., Satayev M.S. Methods of Obtaining Silver Nanoparticles and Antibacterial Properties.....	450
Zhortarova A.A., Salkeyeva L.K., Minayeva Ye.V., Ibrayev M.K., Fazylov S.D. New possibilities for the synthesis and phosphorylation of phosphonoacetic acid ester.....	462

МАЗМҰНЫ

ФИЗИКА

Аймағанбетова З.К., Құлшымбаев Е.А., Жантурина Н.Н., Бекетова Г.К. Quantum Espresso бағдарламасы негізінде Cs ₂ Ag _{0.2} Na _{0.4} In _{0.6} Ti _{0.4} Cl ₆ кос галогенді перовскиттің электрондық қасиеттерін бірінші принциптік есептеу.....	14
Амангелдинова С., Жүнісхан С., Калжигитов Н., Курманғалиева В. Екі кластерлік жуықтауда 5He және 5Li айналық ядроларының кластерлік құрылымын зерттеу.....	35
Чокин К., Отунчи Е., Кожаметова А., Касенова А., Шонғалова А. Литий-ионды аккумуляторларды қайта өндеуге арналған зертханалық пирометаллургиялық қондырғыны әзірлеу және сынау.....	46
Исаева А.Б., Бейсебаева А.С., Мадыбекова Г.М., Шиназбекова Ш.С., Иса А.Б. Сравнительный анализ физико-химических характеристик питьевой, родниковой и природной воды юга Казахстана.....	65
Ким В.Ю., Аймуратов Е.К. Кең бұрышты телескоптармен аспанды сканерлеу арқылы өтпелі ғарыштық оқиғаларды іздеу.....	78
Коштыбаев Т.Б., Татенов А.М., Алиева М.Е., Тугелбаева Г.Т., Жаналиева Г.Ж. Электромагниттік өрісті термодинамикалық бастамалар тұрғысында зерттеу.....	89
Мукамеденқызы В., Ақбердиев Б. Ar–N ₂ бинарлы газ қоспаларындағы механикалық тепе-теңдік тұрақтылығына қиғаш бұрыштың әсерін сандық зерттеу.....	105
Мясникова Л.Н., Узакбаева С.С., Шанина З.К., Бекешев А.З. Хром-шпинельді ұнтақ қосылған жоғары тығыздықты полиэтиленнің кинетикалық қасиеттері.....	119
Нұрбаев Б.М., Дмитриева Е.А., Кемелбекова А.Е. Қалайы негізіндегі перовскитті материалдардың тұрақтылығын арттырудағы төменөлшемді қабатты құрылымдардың рөлі.....	136
Саттинова З., Ермаханова Ф., Асылбеков Б., Таймуратова Л. Бериллий керамикалық бұйымдарын қалыптастыру кезінде әр түрлі салқындату жағдайлары мен жылу беру коэффициенттерінің қатаюға әсері.....	149
Шестакова Л.И., Серебрянский А.В., Спасюк Р.Р., Омаров Ш.Т. Күн жүйесінің ішкі аймағындағы комета-метеорлық тектегі газды іздеу: CaII иондарының жарқырауы.....	165

Уалиханова У.А., Тұрсынқазы Ф., Сыздықова А.М., Алтаева Г.С., Алтайбаева А.Б.
Бессель функцияларын пайдаланып $f(T)$ гравитациялық толқындардың
амплитудасын зерттеу.....179

Жексенбаева Г.А., Насирова Д.М., Айманова Г.К., Шомшекова С.А
V725 Тау симбиотикалық объектiсiн фотометрлiк зерттеу.....194

Жусупова Н.К., Жадыранова А.А.
Энергия шарттарын талдауға негiзделген $f(T, T)$ серпiлiс космологиясы.....205

Зиятбекова Г.З., Абдиманапова П.Б., Сағынтай О.А., Нұрым А.А., Ильинов Р.А.
Жасанды интеллект көмегiмен медициналық деректер бойынша
ауруларды болжау.....225

ХИМИЯ

Алмасов Н.Ж., Жумагалиева А.Н., Дүйсенбеков С.Е., Жакиев Н.К.
Қазақстанда сутегi өндiруге арналған гибрирдiк жаңартылатын энергия жүйелерiн
жобалау және оңтайландыру.....236

Амангелдi Б., Жаникулов Н., Таймасов Б., Айтуреев М., Даулетияров М.
Ақ портландцемент клинкерiн алу үшiн шикiзат шихта құрамын есептеу.....251

Баешов А., Ташенов Е.А., Атыханова С.Б., Кошкарбаева Ш.Т.
Композициялы күкiрт-графит электродын қолдану арқылы кадмий
сульфидiн электрохимиялық әдiспен алу.....267

Байсалова Г.Ж., Ажиханова Ж., Талтенов А.А., Құжатова П.
Қазақстан флорасындағы көпжылдық шөптесiн өсiмдiктердiң фенолдық
қосылыстарының жиынтық мөлшерiн анықтау.....277

**Дарменбаева А.С., Rajasekharan R., Жусипназарова Г.М., Мукажанова Ж.Б.,
Бегенова Б.Е.**
Хитозан және целлюлоза негiзiндегi композиттер: синтез, қасиеттерi және қолдану
перспективалары.....287

**Еркасов Р.Ш., Жамкенова А.С., Сергазина С.М., Нурмуханбетова Н.Н.,
Касенова Н.Б.**
Mn (II) кешендерiндегi сутектiк байланыстардың энергиясы мен табиғатына
галогеннiң әсерi: QТАІМ, NCI және энергия декомпозициясы.....304

Калимолдина Л.М., Шаихова Ж.Е., Калиева Б.К., Бубиш Ш., Аскарова Ш.К.
Күмiс нанобөлшектерiнiң бұршақ, лимон, мандарин, авокадо тұқымдарының
өнуiне әсерi.....320

Қуртебаева А.А., Álvarez-Torrellas S., Gomes Н.Т., Орынбаев С.Ә., Калмаханова М.С. Алаңдаушылық тудыратын ластаушы заттарды тиімді жою үшін белсендірілген көмір полимерлі мембраналар.....	334
Масенова А.Т., Жұмақанова А.С., Торлопов И.И., Рахметова К.С., Абильмагжанов А.З. ZSM-5 иерархиялық цеолитін бумен сілтілі модификациялау арқылы алу процесін онтайландыру.....	350
Мутушев А.Ж., Нұралы Ә.М., Санат А.С., Шаукарова М.А., Есимситова З.Б. Жарық түрлендіретін пленкалардың биоактивті қосылыстардың жинақталуына және жеміс сапасына әсері.....	366
Нефедов А.Н., Тайекенова А.Т. Мұнай өңдеу өнеркәсібінде органикалық коррозия ингибиторларын қолданудың қазіргі жағдайы.....	379
Омаров Б.Т., Алтыбаев Ж.М., Серикбаева Б.С. Органикалық қалдықтарды вермикомпостинг арқылы биогумус өндіру және оның агроэкологиялық тиімділігін зерттеу.....	399
Рахман Д.М., Қаппасұлы Ә., Махаева Д.Н., Қазыбаева Д.С., Ирмухаметова Ғ.С. Геллан–цистеин кешендері негізінде мукоадгезиялық гидрогельдерді әзірлеу және зерттеу.....	414
Сабыржанова А.Е., Болатқызы Н., Берганаева Г.Е., Дюсебаева М.А. Plantago Major жер үсті бөлігінің құрамындағы амин қышқылдары мен май қышқылдарын зерттеу.....	428
Сатаева С., Ахметова Ф., Уразова А., Айтуганова С., Ерниязова К. ЭД-20 эпоксидті желімдерінің физика-механикалық және эксплуатациялық қасиеттеріне ПЭПА концентрациясының ықпалы.....	439
Заманбек А.Ж., Кошкарбаева Ш.Т., Сатаев М.С. Күміс нанобөлшектерінің алыну әдістері мен антибактериалдық қасиеттері.....	450
Жоргарова А.А., Салькева Л.К., Минаева Е.В., Ибраев М.К., Фазылов С.Д. Фосфоносірке қышқылының эфирін синтездеу мен фосфорландырудың жаңа мүмкіндіктері.....	462

СОДЕРЖАНИЕ

ФИЗИКА

Аймаганбетова З.К., Кулшымбаев Е.А., Жантурина Н.Н., Бекетова Г.К. Расчет по первому принципу электронных свойств двойного галогенидного перовскита Cs ₂ Ag _{0.2} Na _{0.4} In _{0.6} Ti _{0.4} Cl ₆ на основе программы Quantum Espresso.....	14
Амангелдинова С., Жүнісхан С., Калжигитов Н., Курмангалиева В. Исследование кластерной структуры зеркальных ядер ⁵ He и ⁵ Li в двухкластерном приближении.....	35
Чокин К., Отунчи Е., Кожаметова А., Касенова А., Шонгалова А. Разработка и испытания лабораторной пирометаллургической установки для переработки литий-ионных аккумуляторов.....	46
Исаева А.Б., Бейсебаева А.С., Мадыбекова Г.М., Шиназбекова Ш.С., Иса А.Б. Сравнительный анализ физико-химических характеристик питьевой, родниковой и природной воды юга Казахстана.....	65
Ким В.Ю., Аймуратов Е.К. Поиск транзиентных космических событий методом сканирования неба широкоугольными телескопами.....	78
Коштыбаев Т.Б., Татенов А.М., Алиева М.Е., Тугелбаева Г.Т., Жаналиева Г.Ж. Исследование электромагнитного поля на основе термодинамических принципов.....	89
Мукамеденкызы В., Акбердиев Б. Численное исследование влияния угла наклона на устойчивость механического равновесия в бинарной газовой смеси Ar–N ₂	105
Мясникова Л.Н., Узакбаева С.С., Шанина З.К., Бекешев А.З. Кинетические свойства высокоплотного полиэтилена с добавлением хром-шпинельного порошка.....	119
Нурбаев Б.М., Дмитриева Е.А., Кемелбекова А.Е. Роль низкоразмерных слоистых структур в повышении стабильности перовскитных материалов на основе олова.....	136
Саттинова З., Ермаханова Ф., Асылбеков Б., Таймуратова Л. Влияние различных условий охлаждения и коэффициентов теплопередачи на затвердевание при формировании бериллиевых керамических изделий.....	149

Шестакова Л.И., Серебрянский А.В., Спасюк Р.Р., Омаров Ш.Т. Поиск газа кометно-метеорного происхождения во внутренней области Солнечной Системы: Свечение ионов СаII.....	165
Уалиханова У.А., Турсынказы Ф., Сыздыкова А.М., Алтаева Г.С., Алтайбаева А.Б. Изучение амплитуды $f(T)$ гравитационных волн с использованием функций Бесселя.....	179
Жексенбаева Г.А., Насирова Д.М., Айманова Г.К., Шомшекеева С.А. Фотометрическое исследование симбиотического объекта V725 Tau.....	194
Жусупова Н.К., Жадыранова А.А. Космология отскока в $f(T, \mathcal{J})$ гравитации на основе анализа энергетических условий.....	205
Зиятбекова Г.З., Абдимананова П.Б., Сағынтай О.А., Нұрым А.А., Ильинов Р.А. Использование искусственного интеллекта для прогнозирования заболеваний на основе медицинских данных.....	225

ХИМИЯ

Алмассов Н.Ж., Жумагалиева А.Н., Дуйсенбеков С.Е., Жакиев Н.К. Проектирование и оптимизация гибридных возобновляемых источников энергии для производства водорода в Казахстане.....	236
Амангелді Б., Жаникулов Н., Таймасов Б., Айтуреев М., Даулетияров М. Расчёт состава сырьевой шихты для получения белого порландцементного клинкера.....	251
Башов А., Ташенов Е.А., Атыханова С.Б., Кошкарбаева Ш.Т. Получение сульфида кадмия электрохимическим методом с использованием композитного сера-графитового электрода.....	267
Байсалова Г.Ж., Ажиханова Ж., Талтенов А.А., Кужатова П. Определение суммы фенольных соединений в многолетних травянистых растениях флоры Казахстана.....	277
Дарменбаева А.С., Rajasekharan R., Жусиппазарова Г.М., Мукажанова Ж.Б., Бегенова Б.Е. Композиты на основе хитозана и целлюлозы: синтез, свойства и перспективы применения.....	287
Еркасов Р.Ш., Жамкенова А.С., Сергазина С.М., Нурмуханбетова Н.Н., Касенова Н.Б. Влияние галогена на энергетику и природу водородных связей в Mn(II): QTAIM, NCI и энергодекомпозиция.....	304

Калимолдина Л.М., Шаихова Ж.Е., Калиева Б.К., Бубиш Ш., Аскарова Ш.К. Влияние наночастиц серебра на прорастание семян фасоли, лимона, мандарина, авокадо.....	320
Куртебаева А.А., Álvarez-Torrellas S., Gomes Н.Т., Орынбаев С.А., Калмаханова М.С. Полимерные мембраны с активированным углем для эффективного удаления загрязняющих веществ вызывающих обеспокоенность.....	334
Масенова А.Т., Жұмақанова А.С., Торлопов И.И., Рахметова К.С., Абильмагжанов А.З. Оптимизация процесса получения иерархического цеолита ZSM-5 паровой щелочной модификацией.....	350
Мутушев А.Ж., Нуралы А.М., Санат А.С., Шаукарова М.А., Есимсиитова З.Б. Влияние светопреобразующих плёнок на накопление биоактивных соединений и качество плодов.....	366
Нефедов А.Н., Тайекенова А.Т. Современное состояние применения органических ингибиторов коррозии в нефтепереработке.....	379
Омаров Б.Т., Алтыбаев Ж.М., Серикбаева Б.С. Получение биогумуса путем вермикомпостирования органических отходов и исследование его агроэкологической эффективности.....	399
Рахман Д.М., Қаппасұлы Ә., Махаева Д.Н., Казыбаева Д.С., Ирмухаметова Г.С. Разработка и исследование мукоадгезивных гидрогелей на основе комплексов геллан–цистеин.....	414
Сабыржанова А.Е., Болаткызы Н., Берганаева Г.Е., Дюсебаева М.А. Исследование аминокислот и жирных кислот в составе надземной части <i>Plantago Major</i>	428
Сатаева С., Ахметова Ф., Уразова А., Айтуганова С., Ерниязова К. Влияние концентрации ПЭПА на физические, механические и эксплуатационные свойства эпоксидных клеев ЭД-20.....	439
Заманбек А.Ж., Кошкарбаева Ш.Т., Сатаев М.С. Методы получения наночастиц серебра и антибактериальные свойства.....	450
Жоргарова А.А., Салькева Л.К., Минаева Е.В., Ибраев М.К., Фазылов С.Д. Новые возможности синтеза и фосфорилирования фосфонуксусного эфира.....	462

ACADEMIC JOURNAL
OF PHYSICAL AND CHEMICAL SCIENCES
ISSN 2224-5227
Volume 1.
Number 357 (2026), 149–164

<https://doi.org/10.32014/2026.2518-1483.411>

UDC: 666.56
IRSTI: 29.19.09

©Sattinova Z.*¹, Ermakhanova F.¹, Assilbekov B.², Taimuratova L.³, 2026.

¹L.N. Gumilyov Eurasian National University, Astana, Kazakhstan;

²Auezov South Kazakhstan University, Shymkent, Kazakhstan;

³Yessenov University, Aktau, Kazakhstan.

E-mail: lidiya.taimuratova@yu.edu.kz

INFLUENCE OF VARIOUS COOLING CONDITIONS AND HEAT TRANSFER COEFFICIENTS ON SOLIDIFICATION DURING THE FORMATION OF BERYLLIUM CERAMIC PRODUCTS

Sattinova Zamira — Candidate of Physical and Mathematical Sciences, Associated Professor, Gumilev Eurasian National University, Astana, Kazakhstan,

E-mail: sattinova.kz@gmail.com, <https://orcid.org/0000-0002-2990-6581>;

Yermakhanova Fatima — Candidate of Technical Sciences, Associated Professor, Gumilev Eurasian National University, Astana, Kazakhstan,

E-mail: yermakhanova_fr@enu.kz, <https://orcid.org/0000-0001-7002-1606>;

Assilbekov Bakytzhan — PhD, Acting Vice-Rector for Science and Innovations Employment, Mukhtar Auezov South Kazakhstan University, Shymkent, Kazakhstan,

E-mail: assilbekov.b@gmail.com, <https://orcid.org/0000-0002-0368-0131>;

Taimuratova, Lidiya — Candidate of Physical and Mathematical Sciences, Associated Professor, Yessenov University, Aktau, Kazakhstan,

E-mail: lidiya.taimuratova@yu.edu.kz, <https://orcid.org/0000-0002-1692-4350>.

Abstract. The article presents the results of a parametric study of the solidification process of a thermoplastic beryllium oxide (BeO) suspension in the cavity of a ring mold. The primary aim of the study is to ensure uniform structure formation in cast products and to address the issue of preventing technological defects. To this end, the spatial-phase characteristics of beryllium oxide suspensions were comprehensively analyzed, and their dependence on casting properties, phase composition, rheological characteristics, and technological parameters was scientifically assessed. It was shown that the solidification process of cast products is determined by a complex set of hydrodynamic, thermal, and crystallization phenomena that develop during solidification. It was established that these phenomena directly depend on the suspension flow rate, temperature regime, ratio of liquid to solid phases, particle distribution, and the intensity of heat removal from the mold. The mathematical models presented in this work provide a practical and experimental scientific tool to predict the non-

uniform distribution of suspension structure and physico-mechanical properties across the cross-section of castings. It was determined that during solidification, the heat removal rate from the normal state depends on the suspension flow rate, the thermal conductivity of the mold material, and the temperature field characterized by the width of the transition zone. The solidification process of the suspension mass was evaluated through the analysis of heat flux distribution, viscosity changes, and density variations along the concentric channel. Hydrodynamic and heat transfer modeling results, carried out considering the crystallization of the thermoplastic beryllium oxide suspension, showed good agreement with experimental data. The obtained results enable efficient control of the casting process, reduce energy consumption, and consequently produce homogeneous, high-quality castings in terms of texture.

Keywords. Beryllium oxide, continuous casting, Bingham liquid, rheological parameters, heat transfer, solidification

For citations: Sattinova Z., Ermakhanova F., Assilbekov B., Taimuratova L. Influence of Various Cooling Conditions and Heat Transfer Coefficients on Solidification during the Formation of Beryllium Ceramic Products. Academic Journal of Physical and Chemical Sciences. 2026. No.1. Pp. 149–164. DOI: <https://doi.org/10.32014/2026.2518-1483.411>

©Саттинова З.¹, Ермаханова Ф.¹, Асылбеков Б.², Таймуратова Л.³, 2026.

¹Гумилев атындағы Еуразия ұлттық университеті, Астана, Қазақстан;

²Әуезов атындағы Оңтүстік Қазақстан университеті, Шымкент, Қазақстан;

³Есенов университеті, Ақтау, Қазақстан.

E-mail: lidiya.taimuratova@yu.edu.kz

БЕРИЛЛИЙ КЕРАМИКАЛЫҚ БҰЙЫМДАРЫН ҚАЛЫПТАСТЫРУ КЕЗІНДЕ ӘР ТҮРЛІ САЛҚЫНДАТУ ЖАҒДАЙЛАРЫ МЕН ЖЫЛУ БЕРУ КОЭФИЦИЕНТТЕРІНІҢ ҚАТАЮҒА ӘСЕРІ

Саттинова Замира — физика және математика ғылымдарының кандидаты, қауымдастырылған профессор, Гумилев атындағы Еуразия ұлттық университеті, Астана, Қазақстан,
E-mail: sattinova.kz@gmail.com, <https://orcid.org/0000-0002-2990-6581>;

Ермаханова Фатима — техника ғылымдарының кандидаты, қауымдастырылған профессор, Гумилев атындағы Еуразия ұлттық университеті, Астана, Қазақстан,
E-mail: yermakhanova_fr@enu.kz, <https://orcid.org/0000-0001-7002-1606>;

Асылбеков Бақытжан — PhD, ғылым жұмыс және инновациялар жөніндегі проректоры м.а., Әуезов атындағы Оңтүстік Қазақстан университеті, Шымкент, Қазақстан,
E-mail: assilbekov.b@gmail.com, <https://orcid.org/0000-0002-0368-0131>;

Таймуратова Лидия — физика және математика ғылымдарының кандидаты, қауымдастырылған профессор, Есенов университеті, Ақтау, Қазақстан,
E-mail: lidiya.taimuratova@yu.edu.kz, <https://orcid.org/0000-0002-1692-4350>.

Аннотация. Мақалада сақиналы қалыптау қуысында бериллий оксидінің (BeO) термопластикалық суспензиясының қатаю процесін параметрлік зерттеу



нәтижелері баяндалған. Зерттеудің негізгі мақсаты – құйма бұйымдарда құрылымның біркелкі қалыптасуын қамтамасыз ету және технологиялық ақаулардың алдын алу мәселесін шешу болып табылады. Осы мақсатта бериллий оксиді суспензиясының кеңістіктік-фазалық сипаттамалары жан-жақты қарастырылып, олардың құю қасиеттеріне, фазалық құрамына, реологиялық сипаттамасына және технологиялық параметрлерге тәуелділігі ғылыми тұрғыдан бағаланды. Құйма өнімдердің қатаю процесі қатаю кезінде дамитын гидродинамикалық, термиялық және кристалдану құбылыстарының күрделі жиынтығымен анықталатыны көрсетілді. Бұл құбылыстар суспензияның қозғалу жылдамдығына, температуралық режимге, сұйық және қатты фазалардың арақатынасына, бөлшектердің таралуына, сондай-ақ қалыптан жылуды әкету интенсивтілігіне тікелей байланысты екені айқындалды. Жұмыста ұсынылған математикалық модельдер құймалардың көлденең қимасы бойынша суспензия құрылымы мен физика-механикалық қасиеттерінің біркелкі емес таралуын болжауға нақты тәжірибелік және қолданбалы ғылыми мүмкіндік береді. Қатаю кезеңінде қалыпты жағдайдан жылуды кетіру жылдамдығы суспензия қозғалысының жылдамдығына, қалып материалының жылу өткізгіштігіне және өтпелі аймақтың енімен сипатталатын температуралық өріске тәуелді екені анықталды. Суспензия массасының қатаю процесі жылу ағынының таралуын, тұтқырлық өзгерісін және концентрлік арна бойындағы тығыздықтың өзгеруін талдау арқылы бағаланды. Бериллий оксиді термопластикалық суспензиясының кристалдануын ескере отырып, жүргізілген гидродинамика мен жылу алмасуды модельдеу нәтижелері эксперименттік деректермен жақсы сәйкестік көрсетті. Алынған нәтижелер құю процесін тиімді басқаруға, энергия шығынын азайтуға және нәтижесінде біркелкі құрылымды, жоғары сапалы құймалар алуға мүмкіндік береді.

Түйін сөздер: Бериллий оксиді, үздіксіз құю, Бингем сұйықтығы, реологиялық параметрлер, жылу беру, қатаю

©Саттинова З.¹, Ермаханова Ф.¹, Асылбеков Б.², Таймуратова Л.³, 2026.

¹Евразийский национальный университет имени Гумилева, Астана, Казахстан;

²Университет Сатпаева, Алматы, Казахстан;

³Южно-Казахстанский университет имени Ауезова, Шымкент, Казахстан;

⁴ Университет Есенова, Актау, Казахстан.

ВЛИЯНИЕ РАЗЛИЧНЫХ УСЛОВИЙ ОХЛАЖДЕНИЯ И КОЭФФИЦИЕНТОВ ТЕПЛОПЕРЕДАЧИ НА ЗАТВЕРДЕВАНИЕ ПРИ ФОРМИРОВАНИИ БЕРИЛЛИЕВЫХ КЕРАМИЧЕСКИХ ИЗДЕЛИЙ

Саттинова Замира — кандидат физико-математических наук, ассоциированный профессор, Евразийский национальный университет имени Гумилева, Астана, Казахстан,
E-mail: sattinova.kz@gmail.com, <https://orcid.org/0000-0002-2990-6581>;

Ермаханова Фатима — Кандидат технических наук, ассоциированный профессор, Евразийский национальный университет имени Гумилева, Астана, Казахстан,

E-mail: yermakhanova_fr@enu.kz, <https://orcid.org/0000-0001-7002-1606>;

Асылбеков Бақытжан — Ph.D, и.о. проректора по науке и инновациям, Южно-Казахстанский университет имени Аuezова, Шымкент, Казахстан,

E-mail: assilbekov.b@gmail.com, <https://orcid.org/0000-0002-0368-0131>;

Таймуратова Лидия — кандидат физико-математических наук, ассоциированный профессор, Университет Есенова, Актау, Казахстан,

E-mail: lidiya.taimuratova@yu.edu.kz, <https://orcid.org/0000-0002-1692-4350>.

Аннотация. В статье представлены результаты параметрического исследования процесса затвердевания термопластичной суспензии оксида бериллия (BeO) в полости кольцевой формы. Основной целью исследования является обеспечение равномерного формирования структуры в литых изделиях и предотвращение технологических дефектов. Для достижения этой цели были всесторонне рассмотрены пространственно-фазовые характеристики суспензий оксида бериллия, а также дана научная оценка их зависимости от литейных свойств, фазового состава, реологических характеристик и технологических параметров. Показано, что процесс затвердевания литых изделий определяется сложным комплексом гидродинамических, тепловых и кристаллизационных явлений, развивающихся в ходе затвердевания. Установлено, что эти явления напрямую зависят от скорости движения суспензии, температурного режима, соотношения жидкой и твердой фаз, распределения частиц, а также интенсивности отвода тепла из формы. Представленные в работе математические модели обеспечивают возможность прогнозирования неравномерности распределения структуры суспензии и физико-механических свойств по поперечному сечению отливок, что имеет как экспериментальное, так и прикладное значение. Установлено, что в период затвердевания скорость отвода тепла из расплава зависит от скорости движения суспензии, теплопроводности материала пресс-формы и температурного поля, характеризуемого шириной переходной зоны. Процесс затвердевания суспензионной массы оценивали путем анализа распределения теплового потока, изменения вязкости и плотности вдоль концентрического канала. Результаты гидродинамического моделирования и моделирования теплообмена, выполненные с учетом кристаллизации термопластичной суспензии оксида бериллия, показали хорошее согласование с экспериментальными данными. Полученные результаты позволяют эффективно управлять процессом литья, снижать энергозатраты и, как следствие, получать высококачественные отливки с однородной структурой.

Ключевые слова: Оксид бериллия, непрерывная разливка, жидкость Бингема, реологические параметры, теплопередача, затвердевание

Introduction. Products made of thermoplastic beryllium oxide slip have become widely used in various industries over the past decades, primarily as a thermal insulation material for equipment operating at high temperatures (Walsh, 2020). Using the hot casting method in an industrial injection molding plant with preset dimensions, ceramic products of a predetermined shape with an adjustable density can be obtained

(Wei, et al., 2019), the high thermal conductivity of beryllium oxide during casting in the temperature range of 40-55°C causes difficulty in controlling structure formation (Shakhov, 2008). The mechanism of solidification, as well as the mechanical behavior of the casting mass during the casting process, the rheological and thermophysical properties of a thermoplastic beryllium oxide slip due to exposure to ultrasound are poorly understood. The experimental study of physical-chemical properties and phase transformation, while taking into account all factors affecting the quality of products in the continuous casting process, is laborious. Therefore, an effective way to control the physical processes occurring during the formation of products with specified properties and shapes is to model the process and determine its main characteristics. The main purpose of the article is to determine the influence of cooling and heat transfer conditions on the solidification of the slip, while the rheological properties of the thermoplastic slip during its flow are an important factor. According to experimental data (Zhapbasbayev, et al., 2016), the Bingham-Papanastasiou model with a control parameter is used to validate experimental curves and describe the behavior of a viscoplastic slip before and after yield strength and viscosity during ultrasonic treatment (Papanastasiou, et al., 1997), (Jabbari, et al., 2016), (Mehmood, et al., 2020). The high thermal conductivity of beryllium oxide has a significant effect on the increase in the volume of the liquid phase and the rheology of the viscoplastic slip during preparation and molding (Shakhov, et al., 2008). The thermal conductivity of beryllium oxide with a relative density of 99% is 220-230 (W/m*S) at a temperature of 100□ (Walsh, 2020). However, with an increase in shrinkage friability to 5-10% and zonal liquation, the thermal conductivity of ceramics at low temperatures decreases by 10-13%. As the temperature increases, the thermal conductivity decreases and reaches a value of 15.4 W/m×From (Shakhov, et al., 2008). Therefore, when considering the object under study, factors such as the dependence of thermophysical properties on temperature, phase transformations of liquid suspensions into a solid state, heat of crystallization, and a sharp change in temperature boundary conditions on cooling circuits should be taken into account. As mentioned in other articles on MIM technology, increasing the volume of the liquid phase to impart the necessary casting properties to the slip does not allow achieving the desired effect, since during firing an «additional» amount of binder leads to the appearance of structural defects and deformations of products. (Sattinova, et al., 2022). When forming products in the forming cavity, it is of great importance to control the cooling of the slip mass, since the solidification process inside the mass depends on the temperature distribution (Zhao-Hui, al., 2021). Also, the change in the temperature field during the cooling process depends on the heat release in the phase transition region and the determination of boundary conditions. Experimentally determined temperatures of the liquidus and solidus of the slip make it possible to identify the nature of the phase distribution at different stages of crystallization, calculate the rate of solid phase separation necessary for studying thermal processes and analyzing the formation of shrinkage defects (Zhapbasbayev, et al., 2016), (Weiß, et al., 2019).

The comparative analysis of the rheological and thermal characteristics of the slip in the range of phase transformations, combined with experimental data, allows us to

identify a detailed method of physico-chemical analysis of the solidification of the slip depending on the cooling rate and the change in the position of the crystallization interval of the slip in the forming cavity of the casting installation.

Materials and methods. Rheological characteristics of the thermoplastic slip. Thermoplastic slips based on beryllium oxide (BeO) with a binder content of 9.5, 10.7 and 11.7% were used to produce ceramic products. The molding compound, a thermoplastic slip, is a highly viscous suspension in which one of the phases is a solid – beryllium oxide powder, and the second is a liquid - organic binder. The organic binder includes three components: paraffin, beeswax, and oleic acid in a ratio of (82; 15 and 3%) (Sattinova, et al., 2022).

The slip mass is characterized by a certain ratio of the concentration of solid C_v , liquid C_w phases, the critical concentration of the solid phase in the c_{v_crit} system, the proportion of kinetically free C_V and kinetically bound C_W liquids. The critical concentration of $[Cv]_{crit}$ is considered an important criterion for objectively characterizing the state of a slip when determining its properties and structure (Shakhov and Bitsoev, 1999). (Shakhov, et al., 2002), (Pivinskii, et al., 1983). Its proportion in the slurry is equal to the relative density of the solid phase in the sediment obtained after 60 minutes of centrifugation at a temperature of $90^\circ C$.

For the BeO slip, the technologically permissible concentration of the solid phase is 75-78% (Shakhov, Bitsoev, 1999). (Sattinova, et al., 2024). High-quality molding of ceramic products with homogeneous properties is achieved by increasing the fluidity of the slip due to intensive ultrasonic treatment with a frequency of 16-18 kHz. As a result, the technological properties increase and at the same time the slip changes its structure under the influence of the forces of molecular attraction, forming conglomerates of particles (Fig.1). An increase in the fluidity of the suspension is accompanied by a decrease in the thickness of the solvated shell and an increase for ligament (Kiiko V.S., et al., 2015). The amount of kinetically bound ligament in a slip with different volume concentrations is $C_{w_f2}=0.252$. Improving the fluidity of the slip leads to a decrease in viscosity, which is one of the main indicators of the relationship between the concentration of the slip and its rheological properties (Shakhov and Bitsoev, 1999).

The rheological parameters of the slip, such as yield strength, plastic viscosity and shear rate, were determined experimentally in the studied temperature range of 80-40°C in the production conditions of ceramic products of Keramika LLP (Shakhov, Bitsoev, 1999). Along with rheological properties, thermal conductivity, heat capacity and heat of melting are the main elements for calculating technical parameters and play an important role in the manufacture of products by injection molding (Dvinskikh, et al., 1976). Based on experimental data, empirical dependences of the rheological and thermophysical properties of a thermoplastic slip on temperature have been established, which make it possible to describe the movement and heat exchange during the molding of beryllium ceramics, taking into account changes in its state of aggregation (Sattinova, et al., 2022). In scientific literature, data on the thermophysical properties of a dispersed system are limited, and they theoretically confirm that mechanical

damage to the structure of a dispersed system does not affect the thermophysical properties, i.e., the value of heat capacity c_p and thermal conductivity λ (Makurin, et al., 2006). To confirm which, graphs of changes in thermal conductivity are given before (1) and after (2) ultrasonic treatment with the action of a slip (BeO batch No. 3) in the temperature range of 20-80 °C (Fig.1).

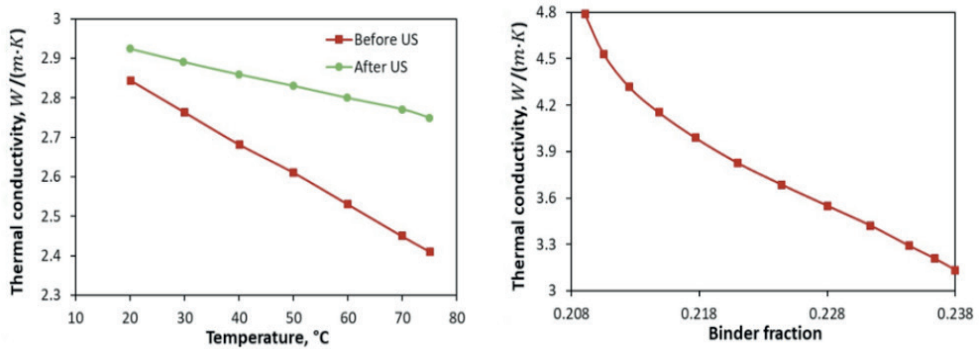


Figure 1- Thermal conductivity of the slurry versus liquid phase concentration (a) and thermoplastic slurry before/after ultrasonic treatment (b)

The effect of ultrasonic vibrations on the thermophysical properties of a dispersed system is related to the anisotropy of thermal conductivity, i.e., the direction of heat flow. This means that heat transfer is mainly due to a molecular mechanism, unlike momentum transfer, where deformations of the structural framework are of decisive importance (Makurin, et al., 2006).

A comparison of the high thermal conductivity of pure beryllium oxide with the low thermal conductivity of the binder indicates that when considering a thermoplastic slip as a structured dispersed system, its thermal conductivity depends primarily on the thermal conductivity of the binder, especially free, undissolved, since the particles of the dispersed phase practically do not interact with each other. They are in contact with each other and cannot significantly affect the thermal conductivity of the system. This phenomenon is noticeable when considering the dependence of thermal conductivity on the volume fraction of the bundle content in the slips (Fig.1).

The specific heat capacity of beryllium oxide has been widely studied experimentally and theoretically (Dong Hou, et al., 2022); Yamamoto, et al., 2021). The heat capacity of the beryllium oxide slip increases naturally with increasing temperature and binder content. The graphs show that the heat capacity of the slip depends only on the density and does not depend on the viscosity and shear stress (Fig.2).

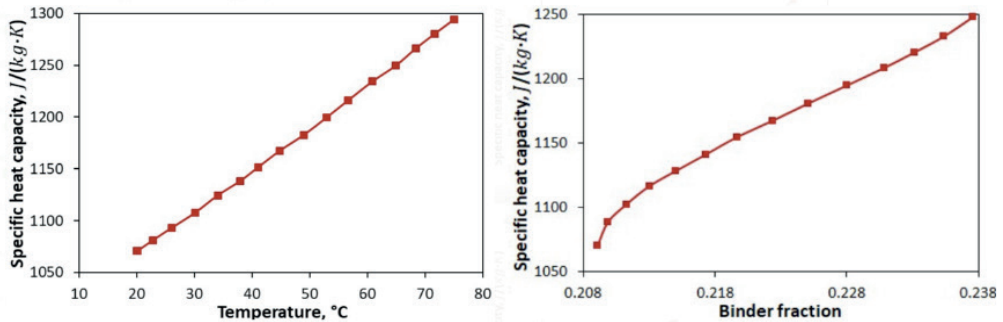


Figure 2- Heat capacity versus liquid phase concentration (a) и temperature slurry (b)

The melting heat of the slip strongly depends on the structure of the dispersed system (Theodore, et al., 2011). In the structure of the slip on the surface of solid particles, some physical properties of adsorbed liquid molecules change significantly, in particular, the melting point and density increase

During the melting process, the solvated bond in the slip will not significantly change its structure. This is equivalent to the absence of the latent heat of melting of the solvated bond, i.e. the heat spent on the destruction of the structure to change the state of aggregation at the melting temperatures of the free bond.

Flow of beryllium oxide (BeO) slurry considered between two concentric cylinders with the length of 108 mm as shown in Fig. 3(a). This approach considers damping source in the Navier-Stokes equation to force calculated velocity to equal zero when BeO slurry becomes fully solid. Damping coefficient is introduced similar with the permeability of porous medium, which depends on BeO slurry liquid fraction. As BeO slurry enters the cavity between concentric cylinders, it begins to be cooled by external circulating water in three cooling zones with the lengths of $L_1=22$, $L_2=45$ and $L_3=41$ mm, respectively, and cooling temperature of $T_1=73^{\circ}C$, $T_2=59^{\circ}C$ and $T_3=45^{\circ}C$ mm, respectively (see Fig. 3(b)). Outer radius of inner cylinder, inner radius of outer cylinder and outer radius of outer cylinder is $r_1=20$, $r_2=25$ and $r_3=26$, and $r_3=26$ mm, respectively. The thickness of outer cylinders (crystallizer) wall is mm. the material of inner and outer cylinders is made from steel of grade 12X18H10T. Inner radius of water circulation zones is $r_w=36$ mm. The model equations are derived under the following assumptions that BeO slurry:

- Flow is laminar due to the low casting velocity.
- Flow is steady-state
- Behaves as Bingham liquid
- Flow is axisymmetric
- Thermophysical and rheology properties are functions of temperature.

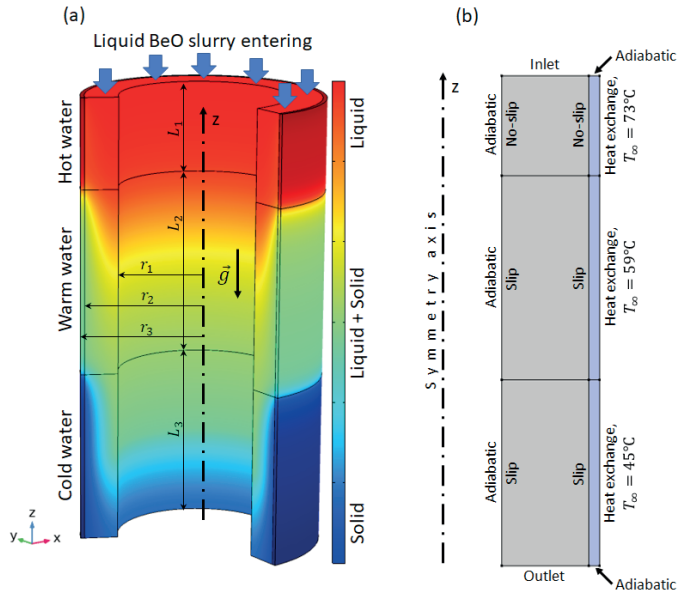


Figure 3- (a) 3D schematic of BeO slurry flow and solidification and (b) 2D domain with an imposed boundary conditions

Under the above assumptions flow equation for BeO slurry, energy equation for BeO slurry and crystallizer are described as following.

Fluid flow equations

$$\rho(\vec{u} \cdot \nabla)u = \nabla \cdot (-pI + K) + \rho\vec{g} - A(\vec{u} - \vec{u}_{cast}) \quad (1)$$

$$\nabla \cdot (\rho\vec{u}) = 0 \quad (2)$$

where \vec{u} is the BeO slurry velocity (m/s), ρ is the BeO slurry density (kg/m³), $K = \mu_{app}(\nabla\vec{u} + (\nabla\vec{u})^T) - \frac{2}{3}\mu_{app}(\nabla \cdot \vec{u})I$ and I denote the viscous stress and identity tensor, respectively, p is the pressure (Pa), μ_{app} is the apparent dynamic viscosity (Pa·s), $\vec{u}_{cast} = (0, u_{cast})$ is the casting velocity.

Energy equation for BeO slurry

$$\rho C_{p,app}\vec{u} \cdot \nabla T = \nabla \cdot (\lambda \nabla T) \quad (3)$$

where $C_{p,app} = C_p + L_H D(T)$ is the apparent specific heat capacity (J/(kg · K)), C_p , and $L_H = 7800$ J/kg are specific heat capacity (J/(kg · K)) and latent heat of solidification, respectively, T is temperature (K), λ , is thermal conductivity (W/(m · K)) and

$$D(T) = \frac{2}{\Delta T \sqrt{\pi}} e^{-\left(\frac{2(T-T_m)}{\Delta T}\right)^2}$$

where $\Delta T = T_l - T_s = 2$ (K) denotes transition zone temperature range (K), $T_m = 59^\circ\text{C}$ is the crystallization temperature (K), $T_l = T_m + \Delta T$ and $T_s = T_m - \Delta T$ are liquidus and solidus temperatures (K), respectively.

Energy equation for the crystallizer

$$\rho_s C_{p,s} \frac{\partial T_s}{\partial t} = \nabla \cdot (\lambda_s \nabla T_s) \quad (14)$$

where $\rho_s = 7900 \text{ kg/m}^3$, $C_{p,s} = 500 \text{ J/(kg} \cdot \text{K)}$ and $k_s = 15 \text{ W/(m} \cdot \text{K)}$ and [14].

Boundary conditions. Hot BeO slurry enters the cavity between two concentric cylinders (gray domain in Fig. 3(b)) at a constant casting velocity $u_{cast} = 20 \text{ mm/min}$ and temperature $T_{cast} = 75^\circ\text{C}$. The surface of the mandrel is assumed to be adiabatic and partly no-slip (Fig. 3(a)). BeO slurry leaves the cavity with uniform outlet pressure and zero gradient of temperature. On the inner surface of the crystallizer there is conjugate condition between energy equations for the BeO slurry and crystallizer. On this surface, no-slip and slip conditions are applied to the momentum conservation equation. Slip condition allows the movement of the thermoplastic slurry near the wall when it starts to be cooled. COMSOL Multiphysics software automatically calculates slip velocity based on the yield stress value and velocity profile at the wall. Convective heat transfer occurs between the outer surface of the crystallizer and the cooling water. Adiabatic boundary condition is imposed to the energy equation for the crystallizer at the top and bottom surfaces of the crystallizer.

Convective heat transfer coefficient h_i on each part of outer boundary with height L_i is calculated from the Nusselt number using Churchill and Bernstein correlation for the external forced convection which is valid for $RePr \gtrsim 0.2$.

$$Nu = \frac{2r_3 h}{\lambda_w} = 0.3 + \frac{0.62 Re^{1/2} Pr^{1/3}}{\left[1 + \left(\frac{0.4}{Pr}\right)^{2/3}\right]^{1/4}} \left[1 + \left(\frac{Re}{282000}\right)^{5/8}\right]^{4/5}$$

where $Re = \frac{2r_3 Q_w}{\nu_w (r_w - r_3) L}$ and $Pr = \frac{\mu_w c_{p,w}}{\lambda_w}$ are Reynolds and Prandtl numbers, respectively, r_w is the inner radius of cooling zone, Q_w is the flow rate of circulating water in the cooling zone, μ_w , $c_{p,w}$ and λ_w are dynamic viscosity ($\text{Pa} \cdot \text{s}$), specific heat capacity ($\text{J/(kg} \cdot \text{K)}$) and thermal conductivity ($\text{W/(m} \cdot \text{K)}$) of circulating water.

Results and discussion. Isothermal temperature distribution lines at different casting speeds are shown in Fig.5. The correspondences of the above-shown phase transition intervals (liquidus isotherm AB-54°C, solidus isotherm CD-45°C) established experimentally are confirmed by temperature profiles that coincide with the intervals along the length of the annular cavity. For example, at $u=20$ mm/min and $u=100$ mm/min, the phase transition temperatures correspond to the following channel length ranges $H=0.008-0.010$ and $H=0.011-0.015$, respectively (Fig.4).

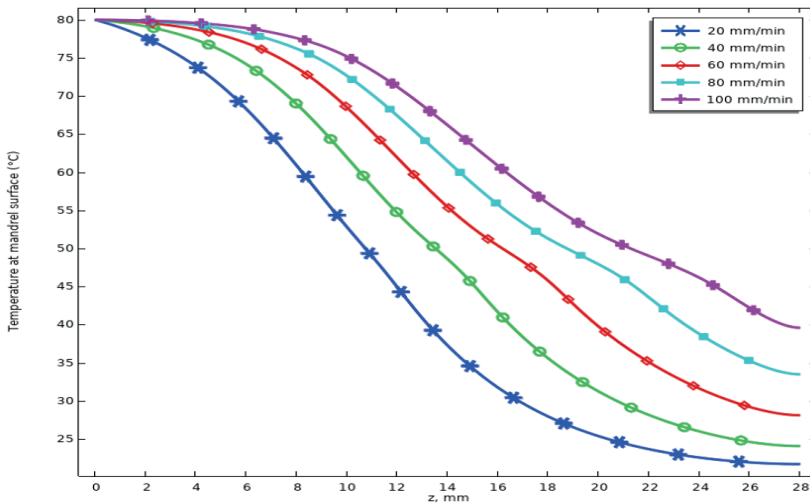


Figure 4- Casting velocity effect.

Estimates of the effect of cooling conditions on the hardening process of beryllium ceramics are achieved by a detailed study of the profiles of casting speed, shear rate and temperature along the annular cavity. The evolutions of the transient temperature contours at different casting speeds are presented (Fig.5, 6). From the graphs shown, it can be seen that with increasing casting speed, the solidification front becomes steeper starting at $u=70$ mm/min. The zones of liquid, viscoplastic, and solid-plastic slips are represented by red, green, and blue colors, and it can be seen that the red area increases in proportion to the increase in casting speed. The reason for this phenomenon is that as the casting speed increases, more slip mass enters the annular cavity, which in turn increases the flow of thermal convection. Another reason for such phenomena is that as the casting speed increases, the residence time of the liquid slip decreases, and the heat generated also decreases. In all the figures below, the isotherm of the parabolic liquidus changes to an almost horizontal front in the central zone of the cavity. In this part, the conductive mode of heat transfer mainly operates, which, in turn, leads to an increase in the horizontal length of the solidus isotherm. In the phase transition interval, the process proceeds at negligible speeds. According to the phase rule and experimental data, the casting system, i.e. the solid and liquid phases are in an equilibrium state at a temperature of $T = 59^\circ\text{C}$, the zone of which is represented by a bright blue area.

At the end of the thermal circuit, it is observed that the sliding effect has a strong

effect on the velocity profiles of the cold circuit. The change in the direction of velocity in the transition interval from the warm contour (green) to the cold contour (blue) occurs due to the force of viscous friction associated with an increase in the casting speed from $u=40$ mm/min to $u=100$ mm/min, which leads to uneven cooling and zonal liquation. The dynamics of solidification of a thermoplastic slip depending on the casting speed shows when, at a casting speed below $u=30$ mm/min, the temperature pressure gradient effectively affects the heat transfer coefficient, similar to the effect of the flow velocity gradient on the sliding coefficient. The intensity of free convection, which occurs in the presence of a temperature gradient in the flow, leads to a significant increase in heat transfer from the non-isothermal surface, i.e. from the slip to the coolant.

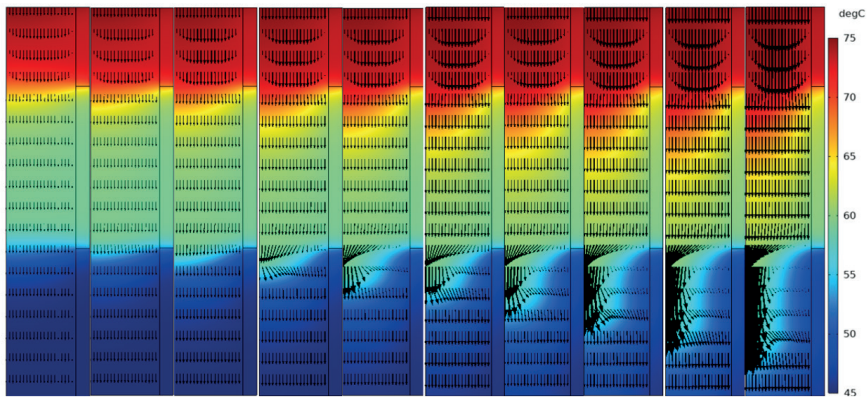


Figure 5- Temperature distribution in *BeO&* crystallizer domain for $\frac{D_2}{D_1} = 1.25$ and casting velocity of 10-100 mm/min

Graphical dependences show that with increasing velocity, the depth of the viscoplastic core zone stretches, forming a curved contour upon contact with the cooling wall.

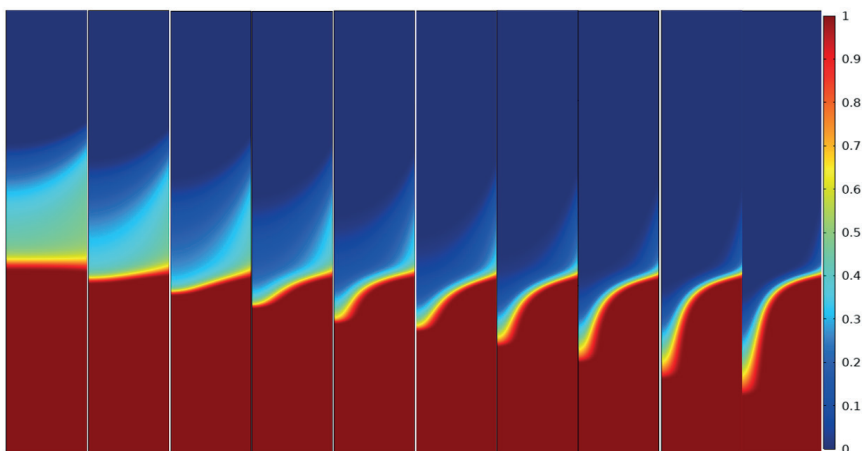


Figure 6- Solid phase fraction for and casting velocity of 10-100 mm/min

In Fig.7 shows the change in heat flow on the inner (discontinuous lines) and outer (solid lines) walls of the mold along the length of the annular cavity at $D_2/D_1=1.25$ and different casting speeds. Obviously, the heat flux density does not change significantly along the length of the hot circuit. This is because the temperature of the coolant $T_0=73^\circ\text{C}$ is almost equal to the initial temperature $T_0=75^\circ\text{C}$ of the slip. At a distance of $z=22$ mm, a warm circuit begins, the coolant temperature will become $T_0=59^\circ\text{C}$ and the heat exchange on the inner wall will increase sharply to $q_-(u=10) = 5089$; $q_-(u=30) = 8832$; $q_-(u=50) = 11458$; $q_-(u=70) = 13368$; $[q_-](u=100) = 15525$ W/m^2 .

The temperature gradient, having reached its maximum, begins to decrease sharply due to the alignment of the temperature plot near the wall. At a distance of $z = 67$ mm, a cold contour is marked, where the temperature of the coolant is $T_0 = 45^\circ\text{C}$. A decrease in the temperature of the slip to the crystallization temperature causes the solidification of the slip mass.

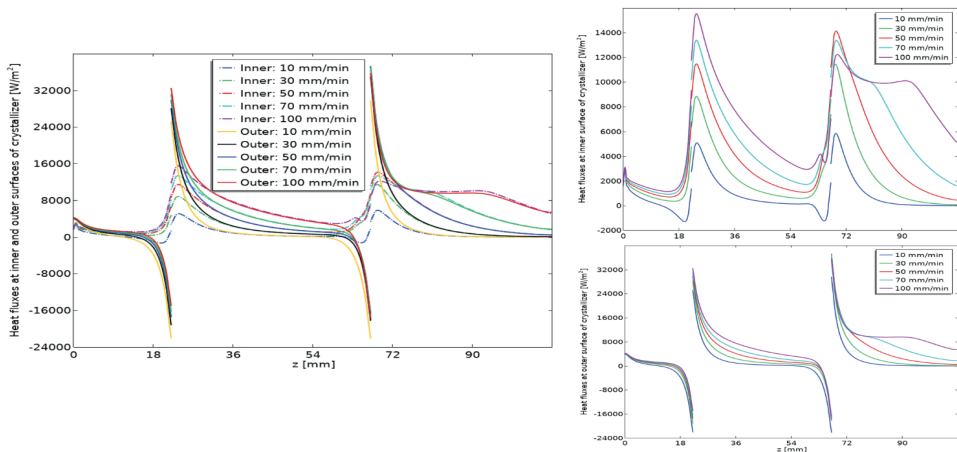


Figure 7- The change in heat flow on the inner (discontinuous lines) and outer (solid lines) walls of the mold along the length of the annular cavity at $D_2/D_1 = 1.25$

The effect of the circulating water layer on the gradual cooling of the slip during product molding is very important, since to calculate the total heat transfer coefficient, it is necessary to determine the coefficients of convective heat transfer. In this case, the hot slide transfers its heat to the inner wall of the die due to internal convection, then it is transferred to the outer wall of the die, only then it enters the cooling water. It is considered that there is no thermal contact layer with a certain thermal resistance between the slip, the inner wall, the outer wall and the water. The influence of the Bi criterion, which characterizes the boundary conditions on the inner wall along the three contours of the annular forming cavity, is shown (Fig.8). Changes in the velocity and temperature profiles determine the patterns of changes in the Bi criterion.

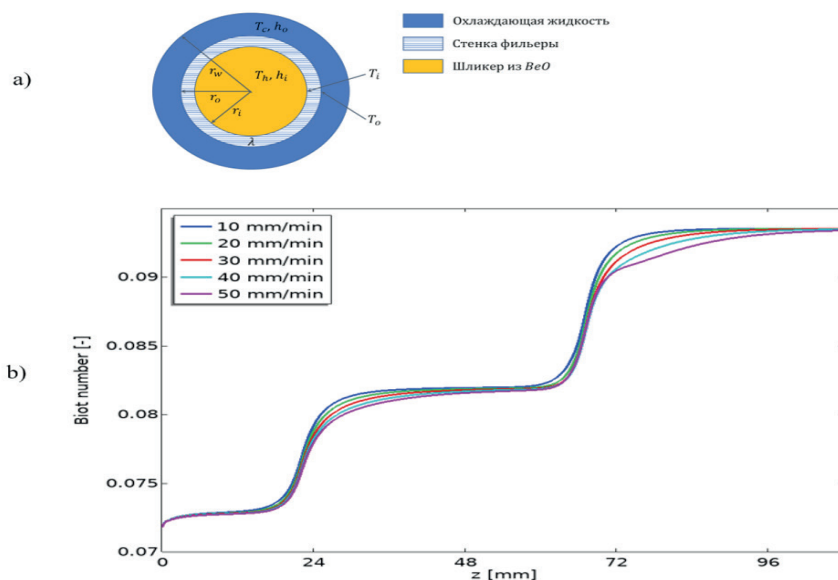


Figure 8- a) the scheme of heat transfer from the slip to the cooling water; b) the effect of the Bi criterion on the inner surface of the annular cavity along three contours.

When the slip moves along the annular channel, an increase in the Bi criterion leads to a decrease in the intensity of heat exchange, and a decrease leads to an increase in the intensity of heat exchange (Fig.8).

The coefficient of external convective heat transfer is calculated from the condition of the cooling water flow through the outer casing of the die, which is the external flow for the die. To explain this, we will use the well-known empirical Nusselt formulas for cooling a cylinder with an external stream of water.

Conclusions. Simulation of the solidification process of beryllium oxide ceramic articles with regard to phase transitions and optimization of casting technology have been performed using COMSOL Multiphysics software. The goal was to improve the quality of products by determining the optimal geometric and technological parameters of the casting process. To obtain articles with uniform properties, the space-phase characteristics of the thermoplastic beryllium oxide slurry are studied in detail, which make it possible to reasonably assess their effects on the property and composition of the casting. Prior to performing numerical calculations of the beryllium ceramic solidification process model in a concentric cylinder with three cooling circuits, the results of the rheological and hydrodynamic model with experimental data have been validated.

Based on the results of the study of the influence of the optimal control parameters of the solidification process on the homogeneity of the product, the following conclusions can be drawn:

- mathematical models of non-isothermal flow and heat exchange taking into account

the phase transformation, as well as the results of calculations of the solidification of the slurry depending on the cooling rate and the change in the position of the crystallization interval of the slurry in the concentric cylinder;

- distribution of heat flows on the inner, outer walls and changes in the density of the slurry along the length of the concentric cylinder at different casting speeds are installed;

The numerical results carried out show adequate agreement with the available experimental data. The results obtained in the work and the quantitative values given for the different casting parameters can be useful in the production process in evaluating possible solidification conditions to obtain castings of higher quality.

References

Bergman T.L., Lavine A.S., Incropera F.P., De Witt D.P. Fundamentals of Heat and Mass Transfer, 7th ed., John Wiley & Sons, Inc. (2011) (in Eng.).

Dong Hou M., Wen Zhou X., Liu B. Beryllium oxide utilized in nuclear reactors: Part I: Application history, thermal properties, mechanical properties, corrosion behavior and fabrication methods, Nucl. Eng. Technol. 54 (2022) 4393–4411. DOI:10.1016/j.net.2022.07.017 (in Eng.).

Dvinskikh Y.V., Popil'skii R.Y., Kostin L.I. The thermophysical properties of thermoplastic cast slips of some highly refractory oxides, Refractories (1979) 37–40 (in Eng.).

Jabbari M., Bulatova R., Tok A.I.Y., Bahl C.R.H., Mitsoulis E., Hattel J.H. Ceramic tape casting: A review of current methods and trends with emphasis on rheological behaviour and flow analysis, Mater. Sci. Eng. B 212 (2016) 39–61. DOI: 10.1016/j.mseb.2016.07.011 (in Eng.).

Kiiko V.S., Vaispapur V.Y. Thermal Conductivity and Prospects for Application of BeO Ceramic in Electronics, Glas. Ceram. 71 (2015) 387–391. DOI:10.1007/s10717-015-9694-6 (in Eng.).

Makurin Y.N., Shein I.R., Gorbunova M.A., Kiiko V.S., Ivanovskii A.L. First-principle quantum-chemical calculations of several thermomechanical parameters of beryllium ceramics, Refract. Ind. Ceram. 47 (2006) 310–313. DOI:10.1007/s11148-006-0115-9 (in Eng.).

Mehmood A., Khan W.A., Mahmood R., Rehman K.U. Finite element analysis on bingham-papanastasiou viscoplastic flow in a channel with circular/square obstacles: A comparative benchmarking, Processes 8 (2020). DOI:10.3390/pr8070779 (in Eng.).

Papanastasiou T.C., Boudouvis A.G. Flows of viscoplastic materials: Models and computations, Comput. Struct. 64 (1997) 677–694. DOI:10.1016/S0045-7949(96)00167-8 (in Eng.).

Pivinskii Y.E. Volume phase characteristics and their effect on the properties of suspensions and ceramic casting systems, Chem. Lerr. 12 (1983) 321–324 (in Eng.).

Sattinova Z., Assilbekov B., Bekenov T., Ramazanova G. Computational investigation of the parameters on the solidification of thermoplastic beryllium oxide slurry in a cylindrical shell, Ceramics 7(3) (2024) 906–925 (in Eng.).

Sattinova Z.K., Bekenov T.N., Assilbekov B.K., Ramazanova G.I., Zhapbasbayev U.K., Nussupbek Z.T. Mathematical modeling of the rheological behavior of thermoplastic slurry in the molding process of beryllium ceramics, Ceram. Int. 48 (2022) 31102–31110. DOI: 10.1016/j.ceramint.2022.07.178 (in Eng.).

Shakhov S. Use of ultrasound in order to intensify molding of high-temperature thermocouple sheaths, Refract. Ind. Ceram. 49 (2008) 261–263. DOI:10.1007/s11148-008-9074-7 (in Eng.).

Shakhov S.A. Rheological characteristics of thermoplastic disperse systems treated with ultrasound, Glas. Ceram. 59 (2002) 194–198 (in Eng.).

Shakhov S.A., Gagarin A.E. Rheological characteristics of thermoplastic disperse systems treated with ultrasound, Glas. Ceram. 65 (2008) 122–124. DOI:10.1007/s10717-008-9030-5 (in Eng.).

Walsh K.A. Beryllium Chemistry and Processing (2020). DOI: 10.31399/asm.tb.bcp.9781627082983 (in Eng.).

Wei J., Zhou W., Zhou W., Shen P., Ren S., Hu A. Modified Embedded Atom Method Potential for

Modeling the Thermodynamic Properties of High Thermal Conductivity Beryllium Oxide, ACS Omega 4 (2019) 6339–6346. DOI:10.1021/acsomega.9b00174 (in Eng.).

Weiß M., Maurath J., Willenbacher N., Koos E. Shrinkage and dimensional accuracy of porous ceramics derived from capillary suspensions, *J. Eur. Ceram. Soc.* 39 (2019) 1887–1892. DOI: 10.1016/j.jeurceramsoc.2019.01.011 (in Eng.).

Yamamoto T., Komarov S.V. Influence of ultrasound irradiation on transient solidification characteristics in DC casting process: Numerical simulation and experimental verification, *J. Mater. Process. Technol.* 294 (2021) 117116. DOI: 10.1016/j.jmatprotec.2021.117116 (in Eng.).

Zhapbasbayev U., Ramazanova G., Kenzhaliev B., Sattinova Z., Shakhov S. Experimental and calculated data of the beryllium oxide slurry solidification, *Appl. Therm. Eng.* 96 (2016) 593–599. DOI: 10.1016/j.applthermaleng.2015.11.114 (in Eng.).

Zhao-Hui R., Xiu-Yan G., Yuan Y., He-Ping T. Determining the heat transfer coefficient during the continuous casting process using stochastic particle swarm optimization, *Case Stud. Therm. Eng.* 28 (2021) 101439. DOI: 10.1016/j.csite.2021.101439 (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 сайте:

**[www:nauka-nanrk.kz](http://www.nauka-nanrk.kz)
ISSN 2518-1483 (Online), ISSN 2224-5227 (Print)
<http://reports-science.kz/index.php/en/archive>**

Ответственный редактор *А. Ботанқызы*
Редакторы: *Д.С. Аленов, Т. Апендиев*
Верстка на компьютере *Г.Д. Жадырановой*

Подписано в печать 16.03.2026.

Формат 60x88¹/₈.
18,0 п.л. Заказ 1.