The 3rd International Conference on Resources and Technology – RESAT 2025

Agenda and Abstracts

19-20 June 2025,
Ulaanbaatar, Mongolia

Hosted by
German-Mongolian Institute for Resources and Technology (GMIT)

in cooperation with
The Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

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KHAN ALTAI RESOURCE

BOROO GOLD

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Background: The Mongolian national strategy for implementing the Sustainable Development Goals launched in 2016 includes the objective to develop internationally competitive university education. Since 2012, the Mongolian Government has initiated academic and institutional reforms to design more practical teaching, research, and corporate cooperation to close the gap between employers' needs and graduates' skills sets.

The GMIT responds to these reforms and to the demand for highly qualified engineers in the Mongolian natural resources sector and in downstream industries. It transfers international scientific expertise and modern academic standards to Mongolia.

The project enhances the GMIT's institutional and financial capacities focusing on:

- Increasing the attractiveness of the GMIT
- Strengthening the GMIT's cooperation with industry
- Further developing into a quality oriented and efficient
- university
- Expanding the GMIT campus

The project supports the development of practice-oriented courses, provides consultation on institutional development, and advises on quality management, qualification in teaching, and methodology. It supports the GMIT in becoming a leading university in the Mongolian higher education landscape and in expanding the range of its services.

Objective: The institutional and financial capacities of the GMIT, educating qualified specialists and creating scientific know-how for the Mongolian economy, are strengthened.

Commissioned by The German Federal Ministry for Economic Cooperation and Development (BMZ)

Project are: GMIT campus in Nalaikh / Ulaanbaatar

Lead executing agency: Mongolian Ministry of Education and Sciences (MEDS)

Duration: 2024/01 – 2026/12

Attractive GMIT for youth: The project supports increasing the attractiveness of GMIT for young people of all gender. Continuous support and technical advice are offered for the GMIT team to analyze the academic programmes and strengthen the international cooperation and partnerships with German universities. Technical advice on student recruitment, measures to improve the learning environment for female students, and the (re)accreditation of study programs will be provided.

Quality oriented and efficient university: The institutional blended learning concept with regard to teaching quality and IT insfrastructure will be developed and implemented. Furthermore, the project will offer technical advice on areas such as: human resources, partnership management, fundraising, and networking to create a quality oriented and efficient university. The GMIT also serves as a model for the Mongolian higher education sector by applying the principles of modern university management and institutional autonomy. Knowledge transfer from GMIT to the Mongolian university landscape will be supported as well.

Cooperation with industry: The project also supports the GMIT in fostering the cooperation with industry in the areas of applied research and further education. The GMIT's Strategic Research Development Fund will be evaluated and the updated edition will be supported. In line with the business needs and demand, further training for businesses will be analyzed and further developed.

Campus expansion: The expansion of the GMIT campus is supported through the joint efforts of German Financial and Technical Cooperation. The construction of a new multi-functional building is carried out with the support of Financial Cooperation and the equipment will be procured by the GMIT project. It is planned to be operational by fall of 2025. The building features laboratories, which will strengthen the GMIT's ability to conduct industry- driven research.

Khan Altai Resource LLC

Khan Altai Resource LLC is dedicated to the advancement of the mining industry in the remote regions of Mongolia, particularly in the western region. Our primary objective is to unlock the economic potential of significant gold deposits, fostering the creation of sustainable employment opportunities within the local communities.

Location of Khan Altai Gold Mine: Situated in Yesunbulag sum, Gobi Altai province, it is positioned approximately 1,000 kilometers to the west of Ulaanbaatar city and about 95 kilometers southeast of Altai city.

VISION: Our aim is to establish ourselves as the foremost and renowned mining company in the nation.

MISSION: We are committed to constructing a sustainable and socially responsible gold mine, positioning us to compete globally, while contributing to the development of Mongolia's western region.

A CORE VALUE: Respect for both humanity and nature.

Phase I Operation

In this initial phase, the focus lies on establishing a robust infrastructure for processing 3 million tonnes per annum (Mtpa) of oxide gold ore. This primary phase is designed to ensure efficient and sustainable ore extraction and processing.

Phase II Operation

Following the success of Phase I, Phase II is marked by the expansion of the operation's capacity to handle 5 Mtpa of primary gold ore. This ambitious step forward is geared towards further enhancing the project's economic potential.

"Khan Altai Resources LLC" is wholeheartedly committed to advancing and revitalizing the mining industry in Mongolia's remote western regions. Our primary focus lies in the exploration and responsible development of substantial gold deposits, contributing to the sustainable growth and prosperity of the region while adhering to the highest standards of environmental and social responsibility.

Boroogold LLC prioritizes green development, safe operation and responsible mining

In the 27 years of its operations, Boroogold LLC contributed to Mongolia a total of MNT 2.2 trillion including:

- MNT 1.1 trillion as local purchases,
- MNT 26.3 billion as donation and investment,
- MNT 665 billion to the state and local budgets in taxes and fees,
- MNT 176.4 billion as mineral royalty,
- MNT 170.7 billion as employees' payroll,
- MNT 295.5 billion as corporate income tax

Boroogold LLC is one of the leading mining companies of Mongolia and is the recipient of the following awards.

- 2001-2010, 2013-2015 - Best Tax Payer Entity of Mongolia
- 2011 - Best Tax Payer of the Capital City
- 2023, 2024 - Best Tax Payer of Selenge aimag
- 2024 - Best Payer of Social Insurance Premium of Selenge aimag
- 2021-2024 - Best Tax Payer - one of the TOP-100 Entities of Mongolia.

As of 2024, Boroogold LLC has 559 employees. The company was in care and maintenance mode since 2015 and had reinstated its operations in 2018. The number of employees has been increased constantly as follows.

- 2018 - 51
- 2019 - 72
- 2020 - 337
- 2021 - 450
- 2022 - 464
- 2023 - 536
- 2024 - 559

CORPORATE SOCIAL RESPONSIBILITY

An annex of the First Maternity Hospital of Ulaanbaatar City was funded by Boroogold Company at a cost of 10 billion tugriks and was commissioned in 2013. This hospital is a 6-storey building with 150 beds and is fully equipped with state-of-the-art medical equipment.

In addition, the company has provided 16.9 billion tugriks for projects and programs to support local socio-economic development in the first half of 2024.

Total investment in local communities as of the end of 2024 is as follows.

- MNT 6 billion invested in Mandal soum,
- MNT 6.1 billion invested in Bayangol soum,
- MNT 2.8 billion invested in Selenge aimag,
- MNT 2 billion invested in the Bornuur soum of Tuv aimag.

ENVIRONMENTAL RECLAMATION

Boroogold Company has been contributing in development of responsible mining in Mongolia by conducting environmental reclamation concurrently with mining operations. In 2003-2024, the company completed technical reclamation in 607.1 ha and biological reclamation in 699.8 ha in total.

BILLION TREE NATIONAL PROGRAM

Boroo Gold Company joined the Billion Tree national program initiated by the President of Mongolia in 2021, and committed to plant and grow 3 million trees until 2030.

Within the scope of the Billion Tree national program a total of 168203 trees have been planted, grown and protected as of 2024 with the purpose to rehabilitate degraded forests, diminish land degradation and desertification and increase green spaces in urban settlements in Mandal and Bayangol soums of Selenge aimag, Bornuur soum of Tuv aimag, the mine site and its vicinity, by conducting forestation and gardening and planting a wall of trees to protect from wind. With the purpose to establish a reserve of seedlings and saplings required for forestation, the tree nursery at the mine site was expanded and a new Ulaanbulag tree nursery was established on 41.7 ha land. It is planned to plant and grow 215,000 trees in 2025.

Boroogold company, the pioneer in many aspects.

- The first hard-rock gold deposit mining and processing in Mongolia
- Pioneer that established comprehensive occupational health, safety and environmental practices
- The first hard-rock deposit processing plant with CIL/CIP technology to recover gold in Mongolia
- The pioneer that first introduced the heap leach technology, an environmentally friendly technology to recover gold from low grade ores
- Skill-based pay system first introduced in Mongolia in 2007 to provide equal opportunity to every employee
- The pioneer that introduced the best occupational safety practices, standards and norms in the mining industry of Mongolia
- The first and only gold mine of Mongolia that joined the International Cyanide Management Institute
- Environmental management system standard ISO 14001:2004, Occupational health and safety management system standard ISO 18001:2007 and Energy management system ISO 50001:2018 standard introduced.

Boroogold LLC, the first hard-rock gold deposit miner in Mongolia, pioneer in hard-rock gold processing and production

CONFERENCE AGENDA

Thursday, 19 June 2025

Ballroom, 4th floor, Novotel hotel, Ulaanbaatar, Mongolia

Time	Activity / Presentation	Speaker / Chair
08:00 – 09:00	Registration (4th floor)	
09:00 – 09:20	Opening Remarks	**Prof. Battsengel Baatar** *Chair of the Conference, Rector of GMIT* **Dr. Undraa Agvaanluvsan** *Member of the Parliament of Mongolia* **Battumur Batsuuri** *Advisor to the Minister of Economy and Development, Mongolia* **Hana Becker** *Deputy Head of Mission, Embassy of the Federal Republic of Germany to Mongolia*
09:20 – 09:40	Global Perspectives on STI Ecosystem Development	**Dr. Battogtokh Dorjgotov** *Director General, Department of Science, Technology Integrated Policy, Ministry of Economy and Development, Mongolia*
09:40 – 10:00	Transformation of Mining Regions and the Use of Underground Space in Germany	**Prof. Axel Preusse** *Head of the Institute for Mine Surveying, Mining Subsidence Engineering and Geophysics in Mining, RWTH Aachen, Germany*
10:00 – 10:20	Photo session & Coffee break	

Session 1a: **Raw material processing & environmental and economic challenges**		**Chairs:** **Battsengel Baatar** (GMIT) **Sebastian Burghoff** (GIZ)
10:20 – 10:35	Processing of a polymetallic REE ore (REE -Zr - Nb), ground by a vertical roller mill and sorted by magnetic separation and flotation	Nomintuya Choijilsuren* Tobias Vraetz
10:35 – 10:50	Improving efficiency of flotation for Tavantolgoi coal after interplay combination ultrasonic and electrolysis	Ariyasuren Purevdorj Erdenechimeg Dolgor Tugsuu Tserendorj*
10:50 – 11:05	Multimodal characterization of minerals from Erdenet mining corporation: implications for enhanced flotation and processing efficiency	Bulganchimeg Unentogtokh Narangerel Adiyasuren Khaliun Amartuvshin Sondor Ganbat Davaadulam Batbileg Ganzorig Chimed*

11:05 – 11:20	Studies on fabrication of 2D MoS2 nanomaterial from molybdenite-bearing rock at the Erdenetiin Ovoo deposit	Narangerel Adiyasuren Batmunkh Tumen-Ayush Delgerjargal Altantsetseg Enkhtur Erdenebileg Ganzorig Chimed*
11:20 – 11:35	Metallurgical test work of lithium and rubidium ore	Purev-Ochir Togtokhbaatar* Baasandorj Myagmarsuren Battsengel Baatar
11:35 – 11:50	An experimental study of new depressants to upgrade fluorite ore for hydrofluoric acid production	Narangarav Terbish Purev-Ochir Togtokhbaatar Bayardulam Jamiyansuren Baasandorj Myagmarsuren*
11:50 – 12:15	Q&A session	
12:15 - 13:30	Lunch	

Session 2: Renewable and storage materials		**Chairs: Ik Jin Kim (GMIT) Ganzorig Chimed (NUM)**
13:30 – 13:45	Energy efficiency benchmark industry	Tino Schuette*
13:45 – 14:00	Innovative silicon anode design: the rule of MXene and copolymeric binders in lithium-ion batteries	Bolormaa Gendensuren Yuri Seo Eun-Suok Oh*
14:00 – 14:15	Innovative business model for sustainability: the inclusion of green technology and green marketing in Peru's Quinoa agriculture	Diego Naoki Kawanishi Ramos Helmut Yabar* Takeshi Mizunoya
14:15 – 14:30	A study on the impact of solar panels' tilt angle on operation and maintenance	Munkhsaran Nairamdaltgerel Mungunshagai Gansukh*
14:30 – 14:45	Advanced uncertainty modeling to enhance resource efficiency in high voltage material engineering	Daniel Fiss* Stefan Kühnel Alexander Kratzsch Stefan Kornhuber
14:45 – 15:00	Study on the diagnosis of rotor faults in motors using inrush current	Ariunbolor Purvee* Bold Enkhbold Nikita Abramov
15:00 – 15:15	Recent advances in carbon capture, utilization, and storage and its applications	John Wang B.*
15:15 – 15:30	Study on Iron (Fe) Alloying of Nickel (Ni) Extracted from Spent NiMH Batteries	Uriankhai Chinzorig Sarantuya Lkhagvajav* Sevjidsuren Galsan
15:30 - 16:00	Coffee break	

Time	Activity / Presentation	Speaker / Chair
Session 3: Resource-oriented engineering development and circular economy		**Chairs:** **Gantuya Ganbat** (GMIT) **Tino Schuette** (University of Applied Science Zittau/Goerlitz, Germany)
16:00 – 16:15	Pilot-testing electrostatic dust Precipitators in Ulaanbaatar/ Mongolia: insights into particulate matter composition and potential for air pollution reduction	Gunther Claus Stehr* Daniel Karthe Byambasuren Battulga Lodoysamba Sereeter
16:15 – 16:30	Battery-electric vehicles: the pathway to pollution-free road transport in the Global South?	Daniel Karthe* Luisa Prates Gantuya Ganbat Minjeong Choi Serena Caucci Seoyoung Lim Lulu Zhang Lili Wang Jack O'Connor Christina Dornack Alexey Alekseenko
16:30 – 16:45	Evaluating sustainable municipal solid waste management scenarios for Ulaanbaatar, Mongolia: an integrated life cycle assessment and geospatial analysis	Buyanbilig Namnansuren Helmut Yabar* Takeshi Mizunoya
16:45 – 17:00	Safety assessment of road railing on UB-Nalaikh road	Dashdavaa Tuvshintur Sungchil Lee* Odbileg Norovrinchen
17:00 – 18:00	Poster session	
18:00	Welcome reception	

Friday, 20 June 2025

Ballroom, 4th floor, Novotel hotel, Ulaanbaatar, Mongolia

Time	Activity / Presentation	Speaker / Chair
Session 4a: Green development technology (interdisciplinary session)		**Chairs: Sungchil Lee** (GMIT) **Daniel Karthe** (UNU-Flores)
09:00 – 09:15	Lesson learnt from Mongolia's first adoption of the toward sustainable mining (TSM) framework	Enkhzaya Chuluunbaatar* Oyungerel Ganbaatar
09:15 – 09:30	Effect of characteristics of circulating water on the flotation process of Erdenetiin Ovoo porphyry copper-molybdenum deposit	Ganbat Munkhtuya* Erdenebileg Tsedevsuren Batmend Tseveenjav Myagmarsuren Bayanmunkh
09:30 – 09:45	Detection of enteric bacteria in Selbe River, Mongolia with dissolved oxygen and BOD assimilative capacity of the river	Bodigerel Lkhagvasuren Enkhzul Enkhsaikhan Usukhbayar Puntsagsuren Ariunaa Saraadan Ariuntuya Tserendorj*
09:45 – 10:00	Assessing land governance frameworks to support environmental and land use planning in resource-oriented development	Unenbuyan Gantig*
10:00 – 10:15	Enhancing control engineering education through simulation-based lab work using open-source multibody dynamics software	Young Suk Kim* Odbileg Norovryenchin
10:15 – 10:30	Mapping wildfire dynamics in eastern Mongolia: integrating remote sensing for sustainable resource management	Enkhjin Enkhbold Gantuya Ganbat*
10:30-10:45	Coffee break	

Session 4b: Green development technology (interdisciplinary session)		**Chairs: Enkhzaya Chuluunbaatar** (GMIT) **Orgodol Togoo** (Boroo Gold LLC)
10:45 – 11:00	Mongolia's rare earth elements: market potential and strategic insights for German industry engagement	Thomas Hollenberg Oyungerel Balgansuren*
11:00 – 11:15	Review of sustainable water technologies for heavy metal removal	Bolormaa Purevjav* Bern Klein Enkhzaya Chuluunbaatar Gantuya Ganbat

11:15 – 11:30	CFD-based optimization of stove designs for sustainable heating in Mongolian gers	Battulga Nasanjargal* Gantuya Ganbat
11:30 – 11:45	Biodegradation of polyhydroxyalkanoates (PHAs) in various environment and isolation of PHA-degrading bacteria	Odbat Erdenechimeg Sivashankari Ramamoorthi Chimed Ganzorig* Takeharu Tsuge
11:45 – 12:00	Bestger - Mongolian national green building rating system	Batgerel Tseren*
12:00 - 12:15	Porous ceramics by direct foaming and its applications	Kamrun Nahar Fatema Liew Yun Ming Heah Cheng Yong Sungchil Lee Ik Jin Kim*
12:15-13:00	Lunch	

Session 1b: **Raw material processing & environmental and economic challenges**		**Chairs:** **Altantuya Ochirkhuyag** (MAS) **Gunther Claus Stehr** (HTWD)
13:00– 13:15	Chemical reduction based synthesis copper nanopowder from copper concentrate at the Erdenetiin Ovoo deposit	Munkhjin Byambachuluun Narangerel Adiyasuren Ganzorig Chimed*
13:15 – 13:30	Ionometallurgical test work on gold and copper concentrate	Purev-Ochir Togtokhbaatar* Charlotte Ashworth Güth Gero Frisch
13:30 – 13:45	Purification and structural optimization of natural MoS2 extracted from Mongolian molybdenite concentrate	Bayardulam Jamiyansuren Bolormaa Gendensuren Battsengel Baatar* Narangarav Terbish
13:45 – 14:00	Rare Earth recycling from NdFeB magnets via pyrometallurgy & molten salt electrolysis	Ulziikhuu Otgonbayar Chinedu Francis Anochie Daniel Vogt* Alexandros Charitos
14:00 – 14:15	Thermal dissolution of coal: a pathway to high-value carbon materials	Vladimir Safin* Budeebazar Avid Peter Kuznetsov Nergui Navchtsetseg Ludmila Kuznetsova Anastasia Obukhova
14:15 – 15:00	Coffee break & Poster session	

Hybrid session		Chair: Altangerel Lkhamsuren (GMIT)
15:00 – 15:15	Mining for the energy transition: Exploring questions of justice and equity for Mongolia	Vigya Sharma* (Australia)
15:15 – 15:30	Overview of current research topics in advanced mineral processing technologies	Tobias Vraetz* (Germany)
15:30 – 15:45	Theoretical strategies for enhancing catalytic performance in advanced hydrogen storage systems	Sung Gu Kang* (Korea)
15:45 – 16:00	Collaborative GIS for sustainable waste management: the case of Ulaanbaatar in 3R4UB	Francesco S. Sammarco* (Italy) Gaia Daldanise Fabio Maria Esposito Gabriella Esposito De Vita Gantuya Ganbat Marina Rigillo
16:00 – 16:15	Stochastic optimal control of heating systems with a geothermal energy storage	Ralf Wunderlich* (Germany)
16:15	Closing remarks	

Poster Session		
№	**Presentation**	**Speakers**
1	Correlation between different adhesion measurement methods according to binder content	In-Seo Kim Gendensuren Bolormaa Ji-Young Nam Eun-Suok Oh*
2	Research on synthesis and process for performance optimization of mid-nickel single-crystal cathode materials for lithium-ion battery	Ye-Jin Sung So-Yeon An Seo-Yoon Oh Ye-Eun Hwang Eun-Suok Oh*
3	Computational exploration of Pt_n clusters on Ti-based MXenes for methylcyclohexane dehydrogenation catalysis	Thi Bich Tram Bui Prasad Reddy Sung Gu Kang*
4	Surface-displayed cobalt-affinity recombinant Escherichia coli for the potential applications of cobalt recovery from wastewater and photocatalytic dye degradation	Jonguk Lee Saranya Shanmugasundaram Soon Ho Hong*
5	Impact of the Ni-Oxygen vacancy interface created after the reduction of the NiAl2O4 phase on resistance to coke formation during Dry Reforming of Methane	Nhiem Pham-Ngoc Azam Jamsaz Phuong Anh Nguyen Song Chao Youngil Lee Eun Woo Shin*

6	Examining the influence of cations on modulating the electrochemical properties of nickel-copper oxy(hydroxide) for enhanced ammonia oxidation reaction	Pragyan Sharma Jin Suk Chung*
7	Multi-objective optimization of lignin-to-vanillin process for minimizing cost and CO2 emissions using machine learning-based surrogate modeling	Yun Gyu Lee Dong Hwi Jeong*
8	Process simulation, techno-economic and environmental evaluation of hydrogen-based reduction ironmaking process	Yoo Ri Kim Jeong Cheol Lee Shi Kyung Yoon Dong Hwi Jeong*
9	Fabrication of metallic membranes and the impact of catalytic layer thickness on permeation behavior	Hyeon Uk Kim Ik Seong Ahn Chan Hyun Lee*
10	Development of thermal swing adsorption (TSA) process for moisture removal from pome-derived biomethane	Jae Hyeon Park Chan Hyun Lee*
11	Facile preparation of phosphorous-doped graphene quantum dots/bismuth iron vanadate composite as bifunctional electrocatalysts for water splitting	Beena Mol Babu Min Jae Kim Tata Sanjay Kanna Sharma* Won Mook Choi*
12	Steam gasification of Tavantolgoi bituminous coals with a combined drop-tube and fixed-bed reactor	Zorigtbaatar Erdenemunkh* Baigalmaa Ganbold Enkhsaruul Byambajav
13	Spectroscopic and thermal analysis of CuO-ZnO composite particles synthesized by sol-gel method	Davaadulam Batbileg* Narangerel Adiyasuren Ganzorig Chimed
14	Kinetic investigation of sphalerite leaching in ethaline deep eutectic solvent	Maral Bat-Erdene*
15	Preparation and characterization of ZnO: Al thin films using low temperature aqueous solution method	Maral Bolor-Erdene Oyunjargal Tumurbaatar Ganzorig Chimed*
16	Integrating flood mitigation and groundwater recharge in water scarce mining area of southern Mongolia	Tuguldur Bat-Itgelt* Ariuntuya Tserendorj Alireza Arab
17	Elemental and mineralogical analysis of rare earth elements in iron ore concentrate waste	Battsengel Baatar* Bayardulam Jamiyansuren Baasandorj Myagmarsuren
18	Estimating the impact of cloud cover on solar energy utilization in Mongolia	Ganbold Boldbaatar Jambajamts Lkhamjav*
19	Investigation of slurry rheology fundamentals, measurements and applications in the mining industry	Batchimeg Batbayar*

20	Processing technological solutions for acid mine drainage of copper ore stockpiles (on the example of Erdenet Ovoo mine)	Nergui Nosron* Ulziisaikhan Naidandorj
21	Simulation of copper recovery from acid mine drainage using 3 stage membrane filtration and SX-EW process in Aspen Plus	Nergui Nosron Khuslen Ankhbayar Bolor-Erdene Byambabasan Ulziisaikhan Naidan Enkhbayar Dondog Zoljargal Naranbaatar Ganzorig Chimed*
22	Water hammering in slurry of lime distribution pipeline at Oyu Tolgoi, LLC	Odbileg Norovryenchin* Turtsetseg Nanjid Sungchil Lee
23	Vegetation-climate responses in mining areas in the Mongolian Plateau	Urangoo Baasandorj Nandin-Erdene Geserbaatar Gantuya Ganbat*
24	Research on zero-waste technology for iron ore beneficiation and processing	Khuzaabayar Lkhagvabaatar* Danzandorj Sunjidmaa Bavuu Chinzorig
25	Strategic study of technology for the development of mining-metallurgy complex	Bolor-Erdene Otgonkhuu*
26	A study on the technology for producing thermal insulation material from iron ore beneficiation plant waste	Khuzaabayar Lkhagvabaatar Danzandorj Sunjidmaa* Bavuu Chinzorig
27	Nighttime light as a proxy for socioeconomic and environmental change in urban and mining contexts	Munkh-Erdene Tuvshinkhuu Enkhjargal Sodnomdarjaa Gantuya Ganbat*
28	Study on the production of triple superphosphate (tsp) fertilizer from phosphate concentrate by acid leaching method	Davaabal Batmunkh Javzandulam Chuluuntumur Bayarzul Uyat Oyun-Erdene Gendenjamts Altantuya Ochirkhuyag*
29	Baseline study and design solutions for the tailings storage facility project of the mineral processing plant	Otgon Maruush* Bavuu Chinzorig*
30	Unseen threats: soil pollution from household ash in Nalaikh's ger districts	Enkhjargal Sodnomdarjaa* Martin Knippertz

ORAL ABSTRACTS

GLOBAL PERSPECTIVES ON STI ECOSYSTEM DEVELOPMENT

Battogtokh DORJGOTOV[1, 2*]
[1]*Department of Science and Technology Integrated Policy, Ministry of Economy and Development, Mongolia*
[2]*National Committee for Future Earth Mongolia*
*E-mail: battogtokh.d@med.gov.mn, dbattogtokh@mas.ac.mn

Abstract

Science, Technology, and Innovation (STI) are fundamental drivers of economic growth, social well-being, and environmental sustainability in the 21 st century. As countries shift from resource-based economies to knowledge-driven systems, developing an effective STI ecosystem has become a strategic imperative. This presentation offers global perspectives on STI ecosystem development, focusing on best practices, key policy mechanisms, and Mongolia's efforts to strengthen its STI platform. The STI ecosystem is conceptualized as comprising five interdependent subsystems: (1) Knowledge Generation (research institutes, universities, inventors), (2) Customer and Market Interaction (domestic and international markets, citizens), (3) Production and Industrial Sector (SMEs, industries), (4) Management Infrastructure (technology parks, incubators), and (5) Policy, Legal, and Regulatory Frameworks (government roles and regulations). The synergy of these subsystems is essential to fostering innovation and technology-based development. Global R&D investment trends reveal that countries with high R&D intensity and strong public-private linkages outperform others in technological advancement, industrial competitiveness, and startup growth. Leading economies apply a mix of financial tools such as tax deductions, R&D tax credits, and refundable incentives to stimulate private sector innovation. Comparative analysis shows Mongolia ranks 100th in industrial competitiveness, with relatively low R&D intensity, highlighting the need for strategic reform. In Mongolia, recent legislative updates, including the Science and Technology Law (2024) and the Innovation Law (2019), provide a legal foundation for STI sector. Priority research areas include green technologies, artificial intelligence, renewable energy, agricultural, biotechnology, and cultural industries. Meanwhile, the number of publications and citations indexed in international databases such as Scopus and Web of Science has grown substantially, indicating improved research output. To support early-stage innovation, Mongolia has introduced startup incentives, such as corporate income tax exemptions, customs and VAT waivers for innovation-related equipment and materials, and targeted grant programs such as Mon-X. However, the "valley of death" between research and commercialization remains a challenge. Bridging this gap requires stronger coordination between research institutions, technology transfer centers, industry partners, and venture capital. The presentation also emphasizes the importance of transdisciplinary and problem-based research. Addressing complex challenges such as climate change, food security, and digital transformation requires collaboration across natural and social sciences, engineering, policy, and local stakeholders. Mongolia's STI strategy thus promotes both international cooperation and local engagement to enhance innovation impact. Drawing on international experience and Mongolia's evolving STI framework, the presentation outlines a roadmap for building a resilient, inclusive, and high-performing STI ecosystem. Recommendations include expanding R&D investment, improving human capital development, strengthening innovation infrastructure, and ensuring consistent policy implementation across sectors.

Keywords: STI ecosystem, R&D management, valley of death.

TRANSFORMATION OF MINING REGIONS AND THE USE OF UNDERGROUND SPACE IN GERMANY

Axel PREUSSE*
Institute for Mine Surveying, Mining Subsidence Engineering and Geophysics in Mining, RWTH Aachen University, Germany
*E-mail: preusse@ifm.rwth-aachen.de

Abstract

With the phasing out of nuclear and coal energy, Germany is undertaking its energy transition. The expansion of renewable energies is an essential aspect of this transition and crucial for achieving national and international climate goals. As renewable energy primarily relies on alternative sources (e.g., wind and photovoltaic), there is an increased need for developments in energy storage, as these technologies are vital for addressing the intermittency associated with renewable energy generation. Additionally, advancements in the expansion of geothermal energy as well as approaches to the subsequent use of former mine workings and infrastructure result in new challenges and approaches to the utilization of underground space. In light of the challenges posed by the energy transition, this opens up a wide range of applications for the core competencies of mine surveying, particularly in terms of interfaces between different disciplines and the development of problem-solving solutions. Regarding renewable energies and the energy transition, the focus of mine surveying includes assessing issues related to new challenges in underground spatial planning as well as developing concepts for the subsequent use of former mine workings. A central aspect of mine surveying in this context is gathering and processing of data, throughout all stages of a project, as well as data management, provision and visualization. Old exploration and mining data have the potential to provide a valuable basis for future projects through reprocessing and interpretation. Examples include exploration for geothermal projects and the installation of underground pumped storage power plants reusing former mine workings. Since exploration is a cost-intensive task, especially regarding to larger areas, costs for new exploration can be reduced, allowing further exploration work to be strategically guided. Data from previous geothermal research and projects also offer valuable information for future endeavors in the surrounding area. Detailed knowledge of the structure and geometry of underground cavities and their spatial conditions is a crucial aspect. 3D documentation in the form of photogrammetry and laser scanning (LiDAR) is considered an effective approach to gather, process and visualize spatial data for planning and operational stages. This is illustrated through the project work of KarboEx (Carbonate exploration NRW - Development of a heat source for the carbon-free heat market), DFG project “Cyclical Processes related to Underground Pumped Storage Power Plants using abandoned mines” as well as the opening and repurposing of the former geothermal well RWTH-1 as a monitoring location.

Keywords: Mine Surveying, Utilization of Underground Space, Energy Transition, Subsequent Use

PROCESSING OF A POLYMETALLIC REE ORE (REE - ZR - NB), GROUND BY A VERTICAL ROLLER MILL AND SORTED BY MAGNETIC SEPARATION AND FLOTATION

Nomintuya CHOIJILSUREN[1*], Tobias VRAETZ[1]
[1]*Advanced Mineral Processing Technologies (AMR), RWTH Aachen University, Germany*
*E-mail: nc@amr.rwth-aachen.de

Abstract

Rare earth elements (REE) make a decisive contribution to nowadays high-tech developments. Although only a relatively small percentage of complex technical applications consist of REEs, the characteristic chemical properties of REEs are essential for the functionality of these applications. REEs are key in the production of permanent magnets, they contribute to high-tech applications, and they are part of components for sustainable energy generation. The use of REEs has the potential to make technologies more durable, smaller and more energy efficient. The presentation documents the results of the processing of a polymetallic REE - Zr - Nb ore from Mongolia. The REE - Zr - Nb ore has been mined in the peralkaline granitoid deposit Khalzan Buregtei in western Mongolia. In previous investigations with this REE - Zr - Nb ore, various processing test series were conceived with different grain sizes. The grain size range of 63 - 250 µm showed potential for enrichment by magnetic separation. The QEMSCAN analysis has shown a liberation of 41 % in the grain size range of 45 - 63 µm [1]. To reduce the energy consumption for grinding, this presentation documents focuses on the grain sizes of 45 - 63 µm and 63 - 90 µm. In addition to characterizing the REE - Zr - Nb ore, the ore sample has been crushed using a vertical roller mill (VRM) in preparation for the various separation/sorting steps. One advantage of crushing with VRM is the pressure on all sides of the particles, which promotes cracks at the mineral boundaries and thus enables better crushing with reduced overgrinding compared to conventional mills [2 - 5]. During the series of different experiments, it has been determined whether it is possible to enrich REE and zircon by means of magnetic separation and subsequent flotation. Different parameters for magnetic separation, like e.g. field strengths and matrix gaps have been investigated during the test series. Furthermore, parameters during flotation have been varied to explore different options for concentration of the valuable components. The experiments have shown that it is possible to concentrate the valuable materials REE and zircon by means of magnetic separation at grain size < 90 µm. The experiments have also shown potential in the selective extraction of iron and zirconium. The subsequent flotation experiments have investigated whether further enrichment of valuable materials and the purification of iron from the products of magnetic separation is possible and proofed that there is potential to enrich various concentrates.

Keywords: REE - Zr - Nb, Vertical roller mill, Magnetic separation, Khalzan Buregtei.

IMPROVING EFFICIENCY OF FLOTATION FOR TAVANTOLGOI COAL AFTER INTERPLAY COMBINATION ULTRASONIC AND ELECTROLYSIS

Ariyasuren PUREVDORJ[1], Erdenechimeg DOLGOR[1], Tugsuu TSERENDORJ[1*]
[1]*Department of Chemical and Biological Engineering, National University of Mongolia, Mongolia*
*E-mail: tugsuu@num.edu.mn

Abstract

The Tavantolgoi coal deposit used in this study is one of the largest in Mongolia and contains coking coal of Permian age. Technical properties of coal seams from the Ukhaa Khudag section of the deposit were determined and compared. This research focused on seam 4C, which has the lowest calorific value among economically important layers. Following sieve analysis, the ultra-fine fraction (<0.25 mm) was selected, and three flotation enrichment techniques were examined: conventional flotation, flotation after ultrasonic vibration, and flotation with combined ultrasonic vibration and electrolysis. Among these, the combination of ultrasonic vibration and electrolysis achieved the best result, producing a coal concentrate with a calorific value of 6078 kcal/kg and ash content of 25.65%. Optimization experiments further identified the most effective conditions

for flotation: ultrasonic vibration for 20 minutes, 30 mL of ethanol, and 1.5 A electrolysis power. These conditions yielded a coal concentrate with the lowest ash content (24.1%) and the highest calorific value (6264 kcal/kg). The study demonstrates that the interplay of ultrasonic vibration and electrolysis significantly improves the flotation efficiency of ultra-fine coking coal and offers promising conditions for further industrial application.

Keywords: Coal, Flotation, Ultrasonic vibration, Electrolysis

MULTIMODAL CHARACTERIZATION OF MINERALS FROM ERDENET MINING CORPORATION: IMPLICATIONS FOR ENHANCED FLOTATION AND PROCESSING EFFICIENCY

Bulganchimeg UNENTOGTOKH[1], Narangerel ADIYASUREN[1], Khaliun AMARTUVSHIN[1], Sondor GANBAT[1], Davaadulam BATBILEG[1], Ganzorig CHIMED[1*]

[1]Center for Nanoscience and Nanotechnology, Department of Chemical and Biochemical Engineering, School of Applied Sciences and Engineering, National University of Mongolia, Ulaanbaatar, Mongolia

*E-mail: ch_ganzorig@num.edu.mn

Abstract

This study presents an analysis of four important ore minerals—chalcopyrite, cuprite, malachite, and molybdenite sourced from the Erdenet Mining Corporation in Mongolia. The first three are copper contained and molybdenite is the main mineral of molybdenum in the deposit. The purpose of this work is to better understand the minerals' properties using kinds of analytical techniques and provide results that could enhance the efficiency of the process. To break down the notable insights of the various of analysis, starting with petrographic and TIMA (Tescan Integrated Mineral Analyzer) analyses revealed the mineral textures and intergrowths, purposed to separate monocrystals. Surface area and pore analysis with nitrogen adsorption showed that chalcopyrite and cuprite have extremely low surface areas, with cuprite showing nearly 0 m^2/g, indicating a non-porous structure due to long-term oxidation. Malachite, on the other hand, showed a significantly higher surface area (50 m^2/g) affected by its carbonate structure, suggesting better surfactant interaction potential in further processing. TG-DTA analysis of one of copper-bearing mineral chalcopyrite showed major mass loss of 12.11% loss near 400°C and a total of 24.99% up to 700°C, indicating thermal decomposition. Also the exothermic peak at 530°C and an endothermic peak at 560°C. Another mineral with copper, malachite showed a total mass loss of 21.02%, related to water and CO_2 release during decomposition. Molybdenite on the other hand showed a 39.58% mass loss at 950°C with endothermic transitions at 412°C and at 580°C, mostly due to phase changes and MoO_3 formation. XRD was used to confirm the crystalline purity of separated samples from raw ore. Each method resulted a unique piece of information. With all these in hand, we achieved complete oversight of these ore minerals. The results showed significant differences among the minerals in terms of surface area, crystallinity, bonding environments, and thermal response, which could all influence their behavior during flotation and processing. The study helps build a stronger foundation for improving mineral separation and recovery strategies, especially in complex ores containing both copper and molybdenum.

Keywords: Mineral characterization, Flotation process

STUDIES ON FABRICATION OF 2D MoS2 NANOMATERIAL FROM MOLYBDENITE-BEARING ROCK AT THE ERDENETIIN OVOO DEPOSIT

Narangerel ADIYASUREN[1], Batmunkh TUMEN-AYUSH[2], Delgerjargal ALTANTSETSEG[1], Enkhtur ERDENEBILEG[1], Ganzorig CHIMED[1*]

[1]*Center for Nanoscience and Nanotechnology, Department of Chemical and Biological Engineering, School of Engineering and Technology, National University of Mongolia, Mongolia*

[2]*Erdenet Mining Corporation SOE, Orkhon Province, Erdenet, Mongolia*

*E-mail: ch_ganzorig@num.edu.mn

Abstract

The Erdenetiin Ovoo deposit, a significant source of molybdenite resources, provided the foundational material for this research. Our objective was to extract high-quality, few-layer MoS2 nanomaterials from this geological source and characterize their fundamental physicochemical properties. The application landscape of 2D MoS2 is significantly more extensive and rapidly expanding compared to its bulk form. This surge in interest is primarily driven by the unique properties that emerge when MoS2 is thinned down to a few atomic layers. Initially, a highly pure mono-mineral molybdenite fraction was obtained from the deposit's ore through meticulous petrographic separation. X-ray diffraction (XRD) analysis confirmed the phase purity, identifying the predominant 2H polytype. Subsequently, this purified molybdenite was subjected to mechanical milling to achieve a controlled average particle size of 2.89 μm, optimizing it for subsequent exfoliation. Two distinct methodologies, probe ultrasonication and a salt-assisted exfoliation process within a green solvent medium, were employed to synthesize 2D MoS2 nanomaterials. The resulting materials exhibited thicknesses ranging from approximately 5 layers down to predominantly 4 layers, as evidenced by characteristic Raman spectral shifts. UV-Vis spectroscopy revealed a significant increase in the bandgap energies of the exfoliated MoS2 to 1.86 eV and 1.92 eV, a notable deviation from the ~1.3 eV bandgap of bulk MoS2, indicative of quantum confinement effects. Future research will focus on refining exfoliation techniques to preferentially yield monolayer MoS2, establishing scalable production protocols, and exploring diverse applications through targeted surface modification and stabilization strategies to enhance material performance and durability.

Keywords: 2D molybdenite, Erdenetiin ovoo, Bandgap, Tauc equation

METALLURGICAL TESTWORK OF LITHIUM AND RUBIDIUM ORE

Purev-Ochir TOGTOKHBAATAR[1*], Baasandorj MYAGMARSUREN[1], Battsengel BAATAR[1]

[1]*Faculty of Raw Materials and Environmental Engineering, German Mongolian Institute for Resources and Technology (GMIT), Nalaikh, Mongolia*

*E-mail: purevochir@gmit.edu.mn

Abstract

This study investigates the characterization and processing of lithium (Li) and rubidium (Rb) ores using multiple analytical techniques. For mineral characterization Mineral Liberation Analysis-Scanning Electron Microscopy (MLA-SEM), X-ray Powder Diffraction (XRPD), and X-ray Fluorescence (XRF) are used. Metal quantification was done by Inductively Coupled Plasma-Atomic Emission Spectroscopy (ICP-AES) determined Li and Rb concentrations of 0.6% and 0.39%, respectively. The presence of fluorine in the ore detected, hence calcination process was used to enhance metal extraction and remove fluorine gas. The research focused on evaluating calcination with and without additives to optimize the liberation of Li and Rb. Then, leaching experiments were conducted using various ligands, including sulfuric acid, hydrochloric acid, nitric acid, and water, to compare their metal recovery. The pregnant leach solution was evaporated at 100°C for 24 hours, resulting in a dried salt with elevated concentrations of Li and Rb. The study shows that calcination, particularly with additives, significantly improves minerals alteration, while the choice of leaching ligand influences extraction efficiency. The resulting high-concentration Li and Rb salts indicate potential for further refinement. To enhance the processing

method, future work will explore electrodialysis to purify and concentrate the leaching solution, aiming to improve recovery rates and reduce environmental impact. This integrated approach, combining advanced characterization, calcination, and leaching, provides the efficient extraction of Li and Rb from natural ores, with implications for sustainable resource recovery in the context of increasing global demand for critical metals.

Keywords: Lithium, Rubidium, Calcination, Leaching

AN EXPERIMENTAL STUDY OF NEW DEPRESSANTS TO UPGRADE FLUORITE ORE FOR HYDROFLUORIC ACID PRODUCTION

Narangarav TERBISH[1], Purev-Ochir TOGTOKHBAATAR[1], Bayardulam JAMIYANSUREN[1], Baasandorj MYAGMARSUREN[1*]
[1]*Faculty of Raw Materials and Environmental Engineering, German-Mongolian Institute for Resources and Technology (GMIT), Nalaikh, Mongolia*
*E-mail: baasandorj@gmit.edu.mn

Abstract

Mongolia possesses substantial fluorspar (CaF_2) resources, with over 224 licensed deposits covering more than 61,000 hectares. The country holds strong potential to expand its export capacity by producing value-added products such as hydrofluoric acid (HF) and its downstream derivatives. This study explores the potential to process fluorite ore from one of Mongolia's major mining regions into a high-purity concentrate suitable for HF production. Laboratory-scale flotation tests were conducted to establish effective processing conditions. The ore was composed primarily of quartz, fluorite, and calcite, minerals with similar surface properties that pose challenges for selective separation. To improve flotation performance, the study introduced newly tested depressants, used on this ore type for the first time, to increase selectivity and enhance concentrate purity. The flotation process was optimized for grinding fineness, pH, and reagent combinations. The best results were obtained at 60% passing 74 μm, with flotation at pH 10 using fatty acid-based collectors and depressants dosed at 100–250 g/t. Open-circuit flotation produced a concentrate with 96.1% CaF2 and 58% recovery. A closed-circuit configuration with multiple cleaning stages improved the final product to 96.03% CaF2 and 68.8% recovery. XRD analysis confirmed a final CaF2 purity of 97.2%, meeting the specifications for HF production. These results demonstrate that high-grade fluorite concentrate can be produced from Mongolian ore using optimized flotation conditions and new reagent strategies, supporting the country's ambitions to grow its chemical manufacturing capabilities through resource-based industrial development.

Keywords: Fluorite flotation, High-purity CaF2, Hydrofluoric acid, Depressant optimization.

ENERGY EFFICIENCY BENCHMARK INDUSTRY

Tino SCHUETTE[1*]
[1]*Department of Engineering and Management, University of Applied Science Zittau/Goerlitz, Germany*
*E-mail: t.schuette@hszg.de

Abstract

The rational use of energy is crucial to industrial companies especially when energy prices are rising and the necessity for green energy is increasing. In order to improve energy efficiency, companies need to compare their energy efficiency with others to see whether their own performance is better or worse than that of competitors, to show whether rational use increased or decreased and to control their own improvement goals. To give reliable measures, suitable energy performance indicators need to be calculated which base on robust data. Founded on available data since 2015 from of the Federal Statistical Office in Germany for over 45,000

companies with 20 or more employees summarized in over 300 economic sectors (NACE 4-digits) the Energy Efficiency Benchmark (EEB) was developed by the Hochschule Zittau/Goerlitz. The benchmark is calculated using on the annual survey of energy use in manufacturing, mining and quarrying, the cost structure survey in the manufacturing industry, mining and the annual report for companies in the manufacturing sector. Besides a wide inter- and cross-sectional view, the developed EEB gives a solid set of longitudinal data. The calculated indicators allow for fact-bases comparisons of companies of different sizes by reference values, esp. turnover, gross value added and employees with regard to fuel intensity, electricity intensity, total energy consumption and CO2-emission intensity. The available database of indicators in the EEB gives industrial companies from mining and manufacturing the possibility to generate an own benchmark report which shows how the firm performers in relation to the direct competitors in the same sector (with the same NACE-Code). Remark: NACE is a four-digit classification providing the framework for collecting and presenting statistical data according to economic activity.

Keywords: Energy efficiency benchmark, Energy performance indicators, Industry and technology.

INNOVATIVE SILICON ANODE DESIGN: THE RULE OF MXENE AND COPOLYMERIC BINDERS IN LITHIUM-ION BATTERIES

Bolormaa GENDENSUREN[1], Yuri SEO, Eun-Suok OH[1*]
[1]*School of Chemical Engineering, University of Ulsan, Ulsan, Republic of Korea*
*E-mail: esoh1@ulsan.ac.kr

Abstract

Development of high-performance silicon anodes is crucial for the advancing lithium-ion batteries, given silicon's impressive theoretical capacity. However, the significant volume exchange during cycling present a major challenge. This study explores the synergistic effect of MXene and copolymer binders in enhancing the performance of silicon anodes. MXene, known for its excellent electrical conductivity, large surface area, and mechanical properties, combined with copolymeric binder, provides a robust matrix that is crucial that accommodates volume changes and maintains structural integrity. Our result demonstrated that integration MXene and copolymeric was systematically examined at various levels: the slurry level for rheology and dispersion stability, at the electrode sheet level for adhesive properties and sheet resistance, and at the coin cell level for various electrochemical performance metrics. The finding shows significant durable improvements compared with pristine Mxene in the copolymeric binder. This innovative approach offers a promising pathway for developing next-generation lithium-ion batteries with higher energy densities and longer life spans.

Keywords: Surface functionalized MXene, Well dispersion, Copolymeric binder, High-capacity anode.

INNOVATIVE BUSINESS MODEL FOR SUSTAINABILITY: THE INCLUSION OF GREEN TECHNOLOGY AND GREEN MARKETING IN PERU'S QUINOA AGRICULTURE

Diego Naoki KAWANISHI RAMOS[1], Helmut YABAR[2*], Takeshi MIZUNOYA[2]
[1]*Graduate School of Science and Technology, University of Tsukuba, Japan.*
[2]*Faculty of Life and Environmental Sciences, University of Tsukuba, Japan.*
*E-mail: yabar.mostacero.h.ke@u.tsukuba.ac.jp

Abstract

This research aims to develop a sustainable agribusiness model for Quinoa (Chenopodium quinoa L.), Andean seed known for its nutritious properties, but also for its role towards food security and sustainability, due to the resilience and adaptability to different ecosystems. This study work explores the interconnection between Business Model Innovation (BMI), Green Technology (agroecology and organic farming) and Green Marketing (channel development) on

quinoa farming in Puno, number one producer region in Peru, that represents endemic conditions for the cultivation of this crop, facilitating the organic cultivation but face several sustainability challenges, including severe poverty, geographic isolation, low yield and climate change. The proposed agribusiness model has 2 major layers; first, to consolidate organic farming under the context of agroecology, to achieve a social transformation that enhance the sustainability of the cropping stage under local conditions; evaluated through life cycle assessment (SimaPRO) and compared with intensive, organic and traditional farming systems. Second, to leverage from agroecology, for channel development, to link producers and consumers, building awareness for a conscious consumption, through a market study for consumers knowledge and preferences on agroecological labels and willingness to pay for agroecological quinoa, statistically assessed (SPSS). It was found that the agroecological system provides a local custom-made solution based on a biodiversity regenerative scheme that can shorten structural gaps trough the generation of visibility and opportunities for farmers and peasants' communities, promoting an inclusive economy, proving the best sustainable features for quinoa cultivation with a global warming potential for 1kg of quinoa of 0.289 kg CO_2 eq., equal to 0.06 CO_2 eq. per PEN generated. In the market study it was identified a low level of awareness and knowledge about agroecological labels among consumers; however, a positive attitude towards purchasing them, with a willingness to pay of 22.9% extra for agroecological certified quinoa.

Keywords: Agroecological labels, Agroecology, Channel development, Organic farming.

A STUDY ON THE IMPACT OF SOLAR PANELS' TILT ANGLE ON OPERATION AND MAINTENANCE

Munkhsaran NAIRAMDALTGEREL[1], Mungunshagai GANSUKH[1]*
[1]*Department of New and Renewable Energy, School of Energy Engineering, Mongolian University of Science and Technology, Mongolia*
*E-mail: mungunshagai@must.edu.mn

Abstract

Snow and dust accumulation on the surface of solar panels reduces energy output and negatively affects production efficiency. An experiment was conducted to determine how snow and dust accumulation on solar panels impacts solar energy generation efficiency. In this study, the relationship between the tilt angle of panels and the thickness of accumulated snow and dust, as well as the efficiency of energy production, was analyzed. The results showed that on a solar panel with a 60° tilt, 1 cm of snow melted and slid off within 2-3 hours at a rate of 2.11 m²/hour. In contrast, a 45°-tilted panel accumulated 1.5 cm of snow, which melted completely in 5-6 hours at a rate of 1.27 m²/hour, while a 0°-tilted panel accumulated 2 cm of snow and required 3-4 days to melt at a rate of 0.17 m²/hour fully. Thus, it was determined that the steeper the tilt angle, the faster the snow melts and slides off, which positively affects energy production. Regarding dust accumulation, a comparative study revealed that a panel tilted at 90° accumulated only 2.6 mg of dust on a 0.0162 m² area, whereas the same area on a 45°-tilted panel had 8.5 mg, and on a 0°-tilted panel had 18.4 mg of dust. Additionally, as snow melts and slides off, it carries dust along, resulting in uneven distribution. For instance, after 5 months without cleaning, a 45°-tilted panel accumulated 22 mg of dust at the top, 11 mg in the middle, and 61 mg at the bottom of the 0.0162 m² area. This indicates that the steeper the tilt angle, the less dust accumulates, though dust tends to concentrate more at the upper and lower parts of the panel. It was also found that a steeper tilt angle generally results in lower dust accumulation. In 2019, Ulaanbaatar experienced seven snowfalls, leading to an estimated annual energy loss of 326,400 kWh at the Monnaran Solar Power Plant. This highlights the significant impact of weather conditions on solar energy production. Snow accumulation reduced the panels' ability to absorb sunlight, leading to decreased energy output. The loss of 326,400 kWh due to snow corresponds to a financial loss of 195,219,840 MNT, calculated at a rate of 598.1 MNT/kWh. Such high losses could increase further if similar weather conditions persist over extended periods.

Keywords: Solar panel, Tilt angle, Solar energy, Energy production

ADVANCED UNCERTAINTY MODELING TO ENHANCE RESOURCE EFFICIENCY IN HIGH-VOLTAGE MATERIAL ENGINEERING

Daniel FISS[1*], Stefan KÜHNEL[2], Alexander KRATZSCH[1], Stefan KORNHUBER[2]
[1]*Institute of Process Technology, Process Automation and Measurement Technology (IPM), Hochschule Zittau/Görlitz, University of Applied Science, Germany*
[2]*Faculty of Electrical Engineering and Informatics - Department for High-voltage Engineering / Materials / Electromagnetic Theory, Hochschule Zittau/Görlitz, University of Applied Science, Germany*
*E-mail: d.fiss@hszg.de

Abstract

This study offers a comprehensive overview of a range of mathematical methods designed to address uncertainties in engineering calculations and assesses their suitability. The focus is on fuzzy set theory, which has proven to be particularly effective and offers a robust solution package for modelling and analysing uncertainties. Additionally, a detailed model for analysing the dynamic behaviour of the surface temperature of insulating materials under high-voltage arcs is presented, systematically incorporating uncertainties and imprecision. The model is divided into three sub-models: a current-voltage model, a three-cylinder model, and a temperature-heat model. Through Monte Carlo simulations and correlation analyses, the key influencing parameters on surface temperature were identified, with material and heat transfer properties being recognized as particularly significant. The model was validated through cooling experiments by observing the cooldown process after heating, which showed a high degree of agreement with the simulation results. The application of fuzzy set theory for modelling uncertain parameters enabled precise consideration of uncertainties, making the model a reliable basis for predicting surface temperature under various test conditions and for better understanding the behaviour of insulating materials under low current high-voltage arcs (DC).

Keywords: Uncertainty analysis, Fuzzy set theory, Low current high-voltage arc (DC), Dynamic process modelling.

STUDY ON THE DIAGNOSIS OF ROTOR FAULTS IN MOTORS USING INRUSH CURRENT

Ariunbolor PURVEE[1*], Bold ENKHBOLD[1], Nikita ABRAMOV[1]
[1]*Faculty of Mechanical and Electrical Engineering, German-Mongolian Institute for Resources and Technology (GMIT), Nalaikh, Mongolia*
*E-mail: ariunbolor@gmit.edu.mn

Abstract

Squirrel-cage induction motors are widely used in industrial applications due to their robustness and simplicity. However, these motors are prone to mechanical and electrical faults caused by frequent start-stop cycles, overload conditions, and aging components. Such faults can lead to reduced operational efficiency, unexpected downtimes, and increased maintenance costs. Early fault detection is therefore essential to ensure system reliability, optimize maintenance schedules, and prevent catastrophic failures. This study focuses on developing a diagnostic method for the early detection of rotor faults by analysing the stator inrush current during the transient start-up phase of squirrel-cage induction motors. Unlike conventional methods that rely primarily on steady-state analysis, this approach captures critical fault signatures at the moment of energization, offering a more proactive means of fault identification. The proposed methodology is validated through a combination of laboratory experiments and dynamic simulations, confirming its effectiveness in identifying rotor asymmetries and other abnormalities. Additionally, fault analysis is extended to the motor's steady-state operation using simulation models to further validate the fault indicators and support predictive maintenance strategies. The approach allows for a more comprehensive understanding of motor health under both transient and steady-state conditions. This research is particularly significant in the context of Mongolia, where systematic studies on induction motor fault diagnosis are limited. By addressing this gap, the findings contribute to enhancing the reliability and efficiency of industrial operations across

the country. The proposed techniques can be applied in routine maintenance programs, helping to extend motor lifespan, reduce downtime, and improve overall equipment performance.

Keywords: Predictive maintenance, Transient analysis, Fault signature extraction, Dynamic simulation.

RECENT ADVANCES IN CARBON CAPTURE, UTILIZATION, AND STORAGE AND ITS APPLICATIONS

John WANG B.[1*]
[1]*Department of Energy and Mineral Engineering, The Pennsylvania State University, USA*
*E-mail: jb8474@psu.edu

Abstract

Carbon capture, utilization, and storage is one of the technologies to help decarbonize and to create value for power generation and industrial processes, which contribute to ½ of carbon emission in the U.S. in 2024. This presentation will (a) review recent advances in carbon capture technologies and numerical analysis of factors affecting MEA-based solvent capture process, (b) discuss utilization options, and (c) cover a comprehensive and updated assessment of geological storage resources in the Appalachia basin. Our preliminary study demonstrates that emissions could be reduced by more than 50% in natural gas production operations.

Keywords: Carbon capture, Utilization, Storage resources, Air emissions, Energy production

STUDY ON IRON (Fe) ALLOYING OF NICKEL (Ni) EXTRACTED FROM SPENT NiMH BATTERIES

Uriankhai CHINZORIG[1], Sarantuya LKHAGVAJAV[1*], Sevjidsuren GALSAN[1]
[1]*Institute of Physics and Technology, Mongolian Academy of Science, Mongolia*
*E-mail: sarantuyal@mas.ac.mn

Abstract

In this study, we aimed to enhance the electrochemical properties of high-purity nickel (Ni) powder extracted via chemical reduction and precipitation from the cathode material of spent NiMH batteries. To achieve this, pure Ni was alloyed with Fe (iron) in weight ratios of 1:3, 3:1, and 1:1, producing $NiFe_3$, Ni_3Fe, and NiFe alloys, respectively. The electrochemical redox potentials and catalytic activities of the synthesized alloys were investigated and comparatively analyzed. Additionally, the electronic structures of the NiFe alloys were modeled using Density Functional Theory (DFT) through the VASP software, and the theoretical results were compared with experimental data. The results demonstrated that Fe alloying significantly influenced the redox behavior and catalytic efficiency of the nickel-based materials, with each composition exhibiting distinct electrochemical characteristics. These findings suggest that NiFe alloys derived from recycled NiMH batteries hold strong potential for application in energy conversion and storage technologies, contributing to sustainable material recovery and utilization.

Keywords: Recovering nickel, Spent NiMH battery, Electrochemistry, NiFe alloy

PILOT-TESTING ELECTROSTATIC DUST PRECIPITATORS IN ULAANBAATAR/MONGOLIA: INSIGHTS INTO PARTICULATE MATTER COMPOSITION AND POTENTIAL FOR AIR POLLUTION REDUCTION

Gunther Claus STEHR[1*], Daniel KARTHE[2], Byambasuren BATTULGA[3], Lodoysamba SEREETER[4]
[1]*Faculty of Mechanical Engineering, Hochschule für Technik und Wirtschaft Dresden - University of Applied Sciences (HTWD), Dresden, Germany*
[2]*Institute for Integrated Management of Material Fluxes and of Resources, United Nations University (UNU), Germany*
[3]*Department of Electrical Engineering, Korea University, Seoul 02841, South Korea*
[4]*Faculty of Raw Materials and Environmental Engineering, German-Mongolian Institute for Resources and Technology (GMIT), Nalaikh, Mongolia*
*E-mail: stehr@htw-dresden.de

Abstract

Ulaanbaatar, the Mongolian capital, experiences severe air pollution during winter months, primarily caused by small coal- and wood-fired stoves. A research and development project that developed an electrostatic dust precipitator (ESP) for these stoves provided insights not only into particulate matter (PM) reduction potential, but interestingly also into its composition. The ESP effectively collected fly ash, thus allowing for the chemical analysis of aerosol precipitates. On the one hand, the collected fly ash differed significantly from the bottom ash. On the other hand, fly ash precipitation with the ESP system significantly facilitated the collection of dust particles originating from coal combustion than alternative collection approaches like atmospheric deposition, which have the additional disadvantage of producing less specific results. Precipitates contained significant concentrations of trace elements, including As, B, Cd, Cr, Cu, Ni, Pb, and Zn. These elements are known to be major soil and water pollutants locally. Because of multiple possible ingestion routes (e.g. by breathing polluted air and by accumulation in water and food), these pollutants constitute significant human health risks. This risks also mean that safe disposal strategies must be developed for the fly ash precipitated during ESP operation. Besides revealing insights into PM composition, the study also quantified the air pollution reduction potential of a large-scale implementation of ESPs: this could reduce PM emissions by several thousand tons per heating season for the whole city. Besides reducing ambient aerosol concentrations, such measures would simultaneously reduce toxic metal and metalloid emissions into the atmosphere and the wider environment. The study highlights the need for effective enforcement of regulations and the development of safe disposal strategies to protect public health and the environment. In the last few years, air quality measurements in Ulaanbaatar have shown notable improvements, but pollution levels remain at a high level. In ger areas in particular, air quality is critical during winter heating seasons, and the Mongolian public expects the government to implement measures for further improvements of air quality. There have been important advances; The use of improved coal briquettes instead of raw coal since 2019 has led to a reduction in PM emissions, but also to an increase in registered deaths due to coal briquette burning. As high PM concentrations and associated pollutants continue to be a major source of disease and mortality, the importance of measures such as implementing ESP systems in small stoves in Ulaanbaatar are an important element for improving quality of life and public health in Ulaanbaatar. In addition to the implementation of ESP systems, it is also necessary to develop and implement new technologies that can remove gas-phase pollutants such as CO and NOx from the exhaust gases. Recent studies have shown that the use of catalytic converters in combination with ESP systems can be an effective way to reduce emissions of these pollutants. Therefore, it is essential to conduct further research on the development and implementation of these technologies in Ulaanbaatar.

Keywords: Air pollution, Particulate matter, Heavy metals, Electrostatic precipitator

BATTERY-ELECTRIC VEHICLES: THE PATHWAY TO POLLUTION-FREE ROAD TRANSPORT IN THE GLOBAL SOUTH?

Daniel KARTHE[1, 2, 3*], Luisa PRATES [1, 2], Gantuya GANBAT[3], Minjeong CHOI[1], Serena CAUCCI[1, 2], Seoyoung LIM[4], Lulu ZHANG[5, 1], Lili WANG [6, 7], Jack O'CONNOR[8], Christina DORNACK[2], Alexey ALEKSEENKO[1]

[1]*United Nations University – Institute for Integrated Management of Material Fluxes and of Resources (UNU-FLORES), Dresden, Germany*

[2]*Faculty of Environmental Sciences, Dresden University of Technology, Germany*

[3]*Faculty of Raw Materials and Environmental Engineering, German-Mongolian Institute for Resources and Technology (GMIT), Nalaikh, Mongolia*

[4]*Korea Environment Corporation, Incheon, South Korea*

[5]*Leibniz Supercomputing Centre (LRZ), Garching, Germany*

[6]*United Nations University – Maastricht Economic and Social Research Institute on Innovation and Technology (UNU-MERIT), Maastricht, The Netherlands*

[7]*School of Business & Economics, Maastricht University, The Netherlands*

[8]*United Nations University – Institute for Environment and Human Security (UNU-EHS), Bonn, Germany*

*E-mail: karthe@unu.edu

Abstract

The transport sector currently accounts for more than 21% of global greenhouse gas emissions, the largest share of which is caused by road traffic. Given its large contribution, the Paris Agreement goal of limiting global warming to no more than 2°C is in jeopardy without decarbonizing transport, particularly on roads. Currently, the transition to battery electric vehicles (BEVs) is the only technology that is fully market-ready. BEVs also contribute significantly to the reduction of traffic-related air pollution in densely populated areas. However, it is important to understand that "zero tailpipe emissions" are not equivalent to emission-free transport. While BEVs eliminate tailpipe emissions, their environmental footprint extends far beyond energy consumption. BEVs rely on very large batteries (ranging from about 250 kg in a small passenger car to several tons of battery mass in heavy-duty vehicles), requiring substantial amounts of lithium, cobalt, nickel, manganese and graphite. This has adverse effects on the environment during raw material extraction and processing, including land degradation, water, air and soil pollution, and biodiversity loss. During usage, the increased weight of BEVs can lead to higher particulate matter emissions from tire abrasion. When batteries reach end-of-life (EOL), they constitute hazardous waste unless they are treated in a safe, circular approach that may include repurposing ("second life") and recycling with high levels of material recovery. Both the benefits and the challenges related to BEVs tend to be greater in countries in the Global South. On the positive side, in regions where vehicles with combustion engines tend to be old, poorly maintained and polluting, the contribution of BEVs to urban air quality improvements can be significant. Moreover, some countries of the Global South have significant shares of renewables in their energy mix, thus maximizing the emission benefit of BEVs. On the negative side, raw material producing countries in the Global South bear significant shares of the environmental footprint of battery material production. Moreover, the growing waste stream of end-of-life vehicle batteries constitutes a major challenge for countries with poorly developed waste management and recycling sectors, leading to significant environmental pollution and human health risks. These complexities underscore the need to further explore sustainable pathways toward pollution-free road transport in the Global South.

Keywords: Battery electric vehicle (BEV), Energy transition, Lithium-ion battery (LIB), Pollution

EVALUATING SUSTAINABLE MUNICIPAL SOLID WASTE MANAGEMENT SCENARIOS FOR ULAANBAATAR, MONGOLIA: AN INTEGRATED LIFE CYCLE ASSESSMENT AND GEOSPATIAL ANALYSIS

Buyanbilig NAMNANSUREN[1], Helmut YABAR[2*], Takeshi MIZUNOYA[2]
[1]*Graduate School of Science and Technology, University of Tsukuba, Japan*
[2]*Faculty of Life and Environmental Sciences, University of Tsukuba, Tsukuba, Japan*
*E-mail: yabar.mostacero.h.ke@u.tsukuba.ac.jp

Abstract

Mongolia is experiencing environmental issues related to waste management, including insufficient waste collection, limited treatment, and improper disposal. Mongolia's existing waste management systems are inadequate for handling and disposing the waste due to a growing urban population, poor infrastructure and planning, and a lack of on-site technical equipment. Over the years, the country has seen a dramatic rise in waste generation which causes environmental threat. Most solid waste are not separated at any level of the waste management and collected wastes are mostly disposed into landfill, while smaller portions are burned or thrown directly into the environment, highlighting the need for improved waste management systems. Ulaanbaatar, the nation's capital and home to nearly half of the population, generates a substantial portion of Mongolia's waste. However, the recycling rate remains small, and landfills are primarily used for municipal waste disposal. This study aims to develop a strategic framework to support decision-making in Ulaanbaatar, focusing on sustainable waste management through enhanced material recovery and recycling processes. By using Life Cycle Assessment (LCA) and Geographic Information Systems (GIS) tools, this research seeks to propose innovative solutions for achieving long-term environmental sustainability. The study is focused on six centralised districts of Ulaanbaatar, Mongolia. The methodology employed in this study integrates LCA with geospatial analysis in ArcGIS to construct and evaluate sustainable municipal solid waste management scenarios. LCA evaluates different scenarios and compares them in specific environmental contexts, including final solid waste, air, and water emissions. On the other hand, geospatial analysis will be used to find the most suitable areas for different treatment facilities based on LCA results. To make the research more accurate and realistic, four types of sub-scenarios such as unsanitary landfill, sanitary landfill for waste treatment and Kerbside collection and combination of Kerbside and Material Bank collections for waste collection were included in proposed scenarios. According to the result of LCA, total solid waste remains high in most scenarios; however, combining both Kerbside and Material Bank collection decreases the final waste, bringing the total to 1 million tons. Moreover, the base scenario shows a huge Global Warming Potential (GWP), while every other scenario provides each reduction, especially scenarios with sanitary landfills with combined waste collection. Scenario 1 (S1) is the most effective in reducing Biological Oxygen Demand (BOD) up to 14.1 tons, while Scenario 2 (S2), Scenario 3 (S3), and Scenario 4 (S4) focus more on reducing solid waste and GWP. Among all the other scenarios, S4, especially Material Recovery Facility (MRF)+ composting+ Refused Derived Fuel (RDF)+ sanitary landfill with combined collection, offers the best balance, achieving relatively low final waste (1,079,131 tons), low GWP (85,780 tons), and moderate improvements in BOD (43.7 tons). The GIS analysis found suitable areas for three facilities, including MRF, RDF, and composting facilities, using the Analytical Hierarchy Process (AHP) and restriction modelling in Ulaanbaatar city. Overall, this study presents a sustainable, low-environmental-impact waste management framework, identifies the facilities mentioned in the LCA scenarios, and recommends strategies for decision-makers based on the current conditions in Ulaanbaatar city.

Keywords: Life cycle assessment, Geographic information system, Municipal solid waste

SAFETY ASSESSMENT OF ROAD RAILING ON UB-NALAIKH ROAD

Dashdavaa TUVSHINTUR[1], Sungchil LEE[2*], Odbileg NOROVRINCHEN[2]
[1]*Oyu Tolgoi LLC, Mongolia*
[2]*Faculty of Mechanical and Electrical Engineering, German-Mongolian Institute for Resources and Technology (GMIT), Nalaikh, Mongolia*
*E-mail: sungchillee@gmit.edu.mn

Abstract

Road traffic accidents along the Nalaikh–Ulaanbaatar road have raised serious concerns regarding the adequacy of existing safety measures, particularly the effectiveness of safety railings. This research investigates the structural integrity and performance of these railings with the aim of enhancing road safety and reducing accident severity. The study employs a mixed-methods approach, including on-site assessments, consultations with local authorities and road safety experts, and an in-depth review of international safety railing standards. The evaluation reveals that while the current railings comply with certain Mongolian national standards, they fall short in effectively mitigating accident impacts due to shortcomings in design, material durability, and maintenance practices. Based on these findings, the study proposes a series of improvements, drawing on advanced international design standards and advocating for stricter maintenance protocols. These recommendations aim to improve the railings' ability to prevent vehicles from veering off the roadway, thereby contributing to a safer commuting environment along this critical transportation corridor.

Keywords: Road safety railing, Railing design, Railing standard.

LESSON LEARNT FROM MONGOLIA'S FIRST ADOPTION OF THE TOWARD SUSTAINABLE MINING (TSM) FRAMEWORK

Enkhzaya CHULUUNBAATAR[1*], Oyungerel GANBAATAR[1]
[1]*Faculty of Raw Materials and Environmental Engineering, German-Mongolian Institute for Resources and Technology (GMIT), Nalaikh, Mongolia*
*E-mail: enkhzaya@gmit.edu.mn

Abstract

The transition to globally recognized sustainability standards in mining presents both an opportunity and a challenge for resource economies. This paper explores the implementation of the "Towards Sustainable Mining" (TSM) standard in Mongolia through a case study of Mongolian Mining Corporation (MMC or Energy Resources LLC) — Mongolia's first company to complete a full TSM cycle, including external verification. Using a mixed-methods approach, the study draws on survey data from 69 operational staff and interviews with 11 departmental managers to evaluate institutional readiness, operational challenges, and organizational learning. Key findings reveal internal barriers, including insufficient training, documentation systems deficiencies, translation inconsistencies, and constrained resources – which are shown, via a Multi-Criteria Decision Analysis (MCDA) – to be interlinked and rooted in capacity and communication gaps. The analysis shows that departments with pre-existing ISO certifications faced significantly fewer difficulties, suggesting that integrated management systems are essential precursors for successful TSM adoption. Moreover, the cost and time involved demonstrate the importance of strategic planning and institutional readiness. We argue that MMC's experience offers transferable lessons not only for other Mongolian mining companies, but also for other resource-rich but institutionally developing nations. Practical recommendations include national-level training frameworks, dedicated implementation teams, and standardized document management systems. As global efforts move toward harmonized sustainability standards, Mongolia's early adoption of TSM positions it to influence the regional sustainability discourse in mining. This paper contributes to the literature on standards diffusion, institutional readiness, and ESG governance, with policy and practical implications for companies, governments, and international actors.

Keywords: Sustainable mining, ESG, Towards Sustainable Mining (TSM), Mongolia

EFFECT OF CHARACTERISTICS OF CIRCULATING WATER ON THE FLOTATION PROCESS OF ERDENETIIN OVOO PORPHYRY COPPER-MOLYBDENUM DEPOSIT

Ganbat MUNKHTUYA[1*], Erdenebileg TSEDEVSUREN [1], Batmend TSEVEENJAV[1], Myagmarsuren BAYANMUNKH[1]
[1]*German-Mongolian Institute for Resources and Technology (GMIT), Nalaikh, Mongolia*
*E-mail: g.munkhtuya@gmit.edu.mn

Abstract

The purpose of the study on the influence of circulating water is to determine the relationships between factors influencing the flotation process, to more effectively monitor the stability of technological processes, and to increase the efficiency of enrichment. In nature, lake water is in constant flux according to the seasons. Lake water has a maximum density of 1 g/cm³ at 4°C and changes depending on the temperature. Therefore, lake water is constantly in flux in spring and autumn. In winter and summer, however, denser water remains at the bottom of the lake and forms multiple layers depending on the temperature. Since the properties of the process circulating water in the Erdenet Mining tailings pond water change depending on the season, fluctuations in metal yield are to be expected. This study investigated the seasonal changes in the properties of recycled process water (dissolved oxygen, ion content, temperature, etc.) that affect the technological process, and the seasonally fluctuating quality of the circulating water can be stabilized.

Keywords: Circulating water, recovery, flotation, technological process complexity

DETECTION OF ENTERIC BACTERIA IN SELBE RIVER, MONGOLIA WITH DISSOLVED OXYGEN AND BOD ASSIMILATIVE CAPACITY OF THE RIVER

Bodigerel LKHAGVASUREN[1], Enkhzul ENKHSAIKHAN[1] Usukhbayar PUNTSAGSUREN[1], Ariunaa SARAADAN[2], Ariuntuya TSERENDORJ[1*]
[1]*Faculty of Raw Materials and Environmental Engineering, German-Mongolian Institute for Resources and Technology (GMIT), Nalaikh, Mongolia*
[2]*Institute of Plant Protection in Academic Science of Mongolia, Ulaanbaatar, Mongolia*
*E-mail: ariuntuya@gmit.edu.mn

Abstract

The indicator bacteria and pathogenic bacteria Salmonella and Shigella were tested in the laboratory with two different methods, the Petri-dish method, and the IDEXX tray method. The findings of this study reveal concerning levels of bacterial pollution in the Selbe River, illustrating the serious impact of unplanned urban growth along its banks.Laboratory tests using both the Colilert-18 IDEXX Tray and agar plate methods showed high levels of bacteria, with some samples even exceeding the limits of the tests. The average bacterial concentrations detected were 23.55 CFU/ml for E. coli, 2.1 CFU/ml for Salmonella, and 225.7 CFU/ml for Shigella—all of which are significant indicators of contamination. The presence of these bacteria, particularly in such high concentrations, suggests fecal contamination and highlights the public health risks for people living nearby and using the river. This pollution is likely tied to untreated waste and poor sanitation facilities in densely populated ger areas, combined with urban runoff that worsens with seasonal rains. These results emphasize the need for better waste management and ongoing water quality monitoring to help restore the river's health. Improving sanitation infrastructure and implementing stronger urban planning along the river could reduce pollution and make the water safer for residents and the environment. This study reinforces the importance of taking immediate steps to protect the Selbe River, which ultimately supports the larger Tuul River Basin.

Keywords: Indicator bacteria, Salmonella, Shigella, E.coli, River

ASSESSING LAND GOVERNANCE FRAMEWORKS TO SUPPORT ENVIRONMENTAL AND LAND USE PLANNING IN RESOURCE-ORIENTED DEVELOPMENT

Unenbuyan GANTIG[1*]
[1]*Public Administration, Department of Public Administration, National Academy of Governance in Mongolia*
*E-mail: gantigub@gmail.com

Abstract

Effective land governance is critical for balancing economic development with environmental sustainability, especially in resource-rich developing countries like Mongolia. This study examines the intersections between land governance frameworks and environmental and land use planning within the context of increasing demands for raw material extraction, urban expansion, and green infrastructure development. In particular, it evaluates how current institutional and legal mechanisms support or constrain sustainable land management, especially in areas undergoing rapid resource-oriented engineering development. The research utilizes a case study approach focused on central and northern regions of Mongolia where land use pressures from mining, renewable energy initiatives, and urban expansion are intensifying. Data was collected from national policy documents, land administration records, environmental assessments, and semi-structured interviews with local administrators, engineers, and planners. A land governance assessment framework (LGAF) was adapted to evaluate performance across five key dimensions: legal and institutional framework, land use planning, tenure security, public participation, and environmental integration. Preliminary findings suggest that while Mongolia has made progress in formalizing land rights and digitizing cadastral systems, integration between environmental planning and land use decision-making remains weak. Environmental impact assessments are often conducted in isolation from land allocation decisions, leading to conflicts, inefficient land use, and degradation of ecologically sensitive zones. Furthermore, governance fragmentation between national and local authorities has created inconsistencies in land use enforcement and undermined accountability in resource-related projects. The study argues for a more integrated approach to land governance that places environmental criteria at the center of land use planning processes. Recommendations include harmonizing the legal basis for land and environmental planning, establishing inter-agency coordination platforms, and strengthening community participation in spatial decision-making. These measures would contribute to advancing a circular economy and support green development technologies by ensuring land resources are managed sustainably and equitably. This research aligns with RESAT 2025 themes by linking land governance to raw material processing, environmental engineering, and circular economy transitions. It demonstrates that land governance assessment is not only a technical necessity but a policy tool to support long-term environmental resilience and resource efficiency. As countries pursue decarbonization and sustainable development goals, robust and adaptive land governance systems will be essential in guiding where and how technologies, infrastructure, and industries are deployed.

Keywords: Land governance, Environmental planning, Sustainable land use, Resource development

ENHANCING CONTROL ENGINEERING EDUCATION THROUGH SIMULATION-BASED LAB WORK USING OPEN-SOURCE MULTIBODY DYNAMICS SOFTWARE

Young Suk KIM[1*], Odbileg NOROVRYENCHEN[1]
[1]*Faculty of Electrical and Mechanical Engineering, German-Mongolian Institute for Resources and Technology, (GMIT), Nalaikh, Mongolia*
*E-mail: yskim@gmit.edu.mn

Abstract

Control engineering is inherently rich in mathematics, which often presents significant challenges for students when taught through traditional lecture-based methods alone. ITo address this issue, this study proposes the integration of simulation-based laboratory practices as a complementary approach in control engineering education. Specifically, we demonstrate the use of an open-source multibody dynamics software to support conceptual understanding and practical application. As a case study, the classic inverted pendulum control problem—widely recognized in control engineering curricula—is employed. The inverted pendulum is physically modeled within the multibody dynamics environment. A PID (Proportional-Integral-Derivative) controller is then implemented to stabilize the system. Through various simulations and performance analyses, the results illustrate how this modeling approach effectively bridges theoretical concepts with practical insights. This method not only enhances student engagement but also fosters deeper comprehension of complex control systems. The findings suggest that integrating open-source simulation tools into control engineering courses can significantly improve the learning experience and educational outcomes.

Keywords: Control engineering education, Simulation-based learning, Inverted pendulum, Multibody dynamics software

MAPPING WILDFIRE DYNAMICS IN EASTERN MONGOLIA: INTEGRATING REMOTE SENSING FOR SUSTAINABLE RESOURCE MANAGEMENT

Enkhjin ENKHBOLD[1], Gantuya GANBAT[1*]
[1]*German-Mongolian Institute for Resources and Technology (GMIT), Nalaikh, Mongolia*
*E-mail: gantuya@gmit.edu.mn

Abstract

This study presents a comprehensive spatiotemporal analysis of wildfire patterns across Mongolia from 2005 to 2025 using satellite imagery. The research identifies and characterizes wildfire frequency, distribution, and trends at national and provincial levels, with a focus on eastern provinces. Wildfire patch centroids were extracted and analyzed using spatial clustering techniques, kernel density estimation, and emerging hotspot analysis via space-time cube tools. Results show that while fire points are scattered across western Mongolia, the largest burned areas and most persistent hotspots are concentrated in the eastern steppe regions, particularly near the Russian border. Temporal trend analysis revealed that spring (March- May) is the peak fire season, accounting for 62% of burned areas, followed by summer (21%) and autumn (16%). Although the total number of fires shows a decreasing trend, the intensity and extent of individual fire events remain significant, especially in 2012, 2015, and 2023. Comparative assessment with official fire incident reports from the Mongolian Statistical Information Service highlights both consistencies and discrepancies with satellite-derived data. The findings contribute to a better understanding of wildfire dynamics in Mongolia and support improved fire risk management and policy development. To assess wildfire risk and its environmental drivers, Maxent model was applied using presence-only fire patch data and environmental variables such as vegetation index (NDVI), land surface temperature, precipitation (SPI), wind speed, and slope. The model results revealed that land surface temperature and wind speed were the most influential predictors of wildfire occurrence in Eastern Mongolia, indicating that dry, warm, and windy conditions significantly increase fire probability. The model results effectively delineate high-risk zones, providing valuable insights for fire prevention and management. The findings contribute

to a better understanding of Mongolia's wildfire dynamics and offer a scientific basis for targeted wildfire risk mitigation strategies.

Keywords: Wildfire, Spatiotemporal analysis, Eastern Mongolia, MODIS, Risk assessment

MONGOLIA'S RARE EARTH ELEMENTS: MARKET POTENTIAL AND STRATEGIC INSIGHTS FOR GERMAN INDUSTRY ENGAGEMENT

Thomas HOLLENBERG[1,2], Oyungerel BALGANSUREN[3*]
[1]DHC - Dr. Hollenberg Consulting GmbH, Germany
[2]*University Council of the German-Mongolian Institute for Resources and Technology (GMIT), Nalaikh, Mongolia*
[1]*German-Mongolian Institute for Resources and Technology (GMIT), Nalaikh, Mongolia*
*E-mail: b.oyungerel@gmit.edu.mn

Abstract

Mongolia possesses significant untapped potential in rare earth elements (REE), essential for green energy transition, high-tech manufacturing, and defence applications. Despite its geological wealth, Mongolia remains a minor contributor to global REE supply, constrained by infrastructure gaps, environmental concerns, and limited downstream processing capacity. This research explores Mongolia's REE market outlook through an interdisciplinary approach combining geological resource mapping, policy analysis, and international trade potential. Particular focus is given to the feasibility of strategic partnerships between Mongolia and Germany, addressing supply chain diversification under the EU Critical Raw Materials Act and Germany's Raw Materials Strategy. Case studies of advanced REE deposits such as Khalzan Buregtei and Mushgai Khudag are examined in terms of ore quality, radiological risks, and development readiness. Environmental regulations, social license considerations, and governance structures under Mongolia's Minerals Law are also analyzed. The study concludes that German industry engagement in Mongolia's REE sector offers a sustainable and geopolitically strategic alternative to existing supply chains. Recommendations are presented for bilateral cooperation, including joint ventures, technology transfers, and responsible sourcing mechanisms aligned with EU ESG criteria.

Keywords: Rare earth elements, Mongolia, Green technology, Germany-Mongolia cooperation, sustainable mining.

REVIEW OF SUSTAINABLE WATER TECHNOLOGIES FOR HEAVY METAL REMOVAL

Bolormaa PUREVJAV[1*], Bern KLEIN[2], Enkhzaya CHULUUNBAATAR[1], Gantuya GANBAT[1]
[1]*Faculty of Raw Materials and Environmental Engineering, German-Mongolian Institute for Resources and Technology (GMIT), Nalaikh, Mongolia*
[2]*Mining Engineering Department, Canada,*
*E-mail: bolormaa.p@gmit.edu.mn

Abstract

In recent years, concerns such as climatic changes, global warming, energy depletion, and other environmental challenges have spurred the development of green technologies. One critical issue is water contamination by heavy metals, which poses significant risks to both the environment and public health. This literature review examines advancements in water recycling, treatment, and purification technologies designed for heavy metal removal. The findings suggest that adsorption-based methods, such as the use of activated carbon, nanomaterials, and biochar, offer high removal efficiency. However, these methods face challenges, including saturation and regeneration issues, as well as limitations in capacity, selectivity for specific pollutants, high costs, and potential environmental concerns. Membrane filtration technologies have proven effective in separating contaminants, but they often require substantial energy inputs. Bioremediation approaches provide an environmentally friendly solution, yet scalability remains a major hurdle. Electrochemical techniques, such as electrocoagulation and electrodialysis, enable efficient

removal with reduced reliance on chemicals. Electrochemical techniques face several challenges, but ongoing research and technological advancements continue to address them by improving electrode materials, optimizing system design, and reducing energy consumption, making electrochemical techniques a promising option for sustainable water treatment. Additionally, green chemical precipitation methods, which use plant-based coagulants, offer a sustainable approach to reducing metal concentrations. The review emphasizes the importance of hybrid systems that integrate multiple technologies to enhance removal efficiency, lower operational costs, and ensure long-term environmental sustainability. It also highlights the challenges in advancing, implementing and scaling up green technologies in the pursuit of sustainability.

Keywords: Water, Technology, Sustainability.

CFD-BASED OPTIMIZATION OF STOVE DESIGNS FOR SUSTAINABLE HEATING IN MONGOLIAN GERS

Battulga NASANJARGAL[1*], Gantuya GANBAT[1]
[1]*German-Mongolian Institute for Resources and Technology (GMIT), Nalaikh, Mongolia*
*E-mail: battulga@gmit.edu.mn

Abstract

Efficient and safe heating is essential for maintaining thermal comfort and reducing indoor air pollution in traditional Mongolian gers, particularly during heating season. This study presents a computational fluid dynamics (CFD) investigation of thermal performance in various stove geometries commonly used in gers. Multiple stove designs were modeled to analyze combustion-driven heat transfer and air circulation patterns within the confined space of a stove. The simulations focused on evaluating temperature distributions, flow dynamics, and heat flux across the stove body and surrounding area under fuel combustion conditions. To ensure model reliability, simulated stove wall and inner stove temperatures were validated against experimental measurements obtained during controlled fuel ignition tests conducted in the field. The comparison revealed strong agreement, confirming the validity of the CFD approach. Results demonstrated that stove geometry significantly influences the performance of the stove. These findings highlight the importance of stove design optimization for both energy efficiency and occupant health in ger households. The study offers a foundation for the development of improved heating solutions tailored to Mongolia's unique housing and climatic conditions. The integration of CFD tools with empirical field data presents a promising approach for evaluating and enhancing traditional stoves, contributing to sustainable and low-emission heating technologies in cold-climate settings.

Keywords: CFD simulation, Ger stove, Stove geometry, Heat transfer.

BIODEGRADATION OF POLYHYDROXYALKANOATES (PHAS) IN VARIOUS ENVIRONMENT AND ISOLATION OF PHA-DEGRADING BACTERIA

Odbat ERDENECHIMEG[1], Sivashankari RAMAMOORTHI[2], Chimed GANZORIG[1*], Takeharu TSUGE[2]
[1]*School of Materials and Chemical Technology, Institute of Science Tokyo*
[2]*Department of Chemical and Biological Engineering, National University of Mongolia*
*E-mail: ch_ganzorig@num.edu.mn

Abstract

In this study, soil samples were collected from the Suzukakedai and Ookayama campuses of the Institute of Science Tokyo to isolate bacteria capable of degrading PHBV. A total of 92 single-colony isolates were successfully obtained. Sequencing of the 16S rRNA gene and comparison with the NCBI BLAST database revealed that three representative isolates shared over 99% similarity with species belonging to the Streptomyces genus. The degradation of thin films of PHBV, as well as other synthetic bioplastics including PLA, PBS, and PBAT, was investigated

under two environmental conditions: pond water and pond mud. PHBV showed more active biodegradation in the mud, with more evident surface erosion and morphological changes. After 33 days, the mass of PHBV decreased by 14% in the mud, while it showed minimal change of only 0.1% in pond water. PBS exhibited a 9.1% reduction in pond water and 2.4% in mud, indicating faster degradation in pond water. Although PBAT showed less mass loss compared to PHBV and PBS, it degraded at similar levels in both pond water and mud, with reductions of 1.2% and 1.3%, respectively. The surface of PLA became rougher and more irregular in texture due to the influence of mud and mechanical factors; however, no significant changes in mass or thickness were observed. These results indicate that the biodegradation of PHA-type and other bioplastics is highly dependent on environmental conditions, particularly microbial composition and physicochemical factors. This study also provided valuable experience in microbiological and biodegradation testing methodologies, forming a foundation for future research on polymer degradation under the environmental conditions of Mongolia.

Keywords: PHA, Biodegradable

BESTGER - MONGOLIAN NATIONAL GREEN BUILDING RATING SYSTEM

Batgerel TSEREN[1*]
[1]*Mongolian Green Building Council*
*E-mail: tserenbatgerel@gmail.com

Abstract

To align with the contribution goals, set by the Paris Agreement, Mongolia can focus on the construction industry to maximize its impact on greenhouse gas emissions (GHG) and sustainable development goals (SDG). The government has signaled its commitment in this regard through Mongolia's Green Development Strategy which emphasizes improving energy efficiency and introducing green technology to construction. The mission of the Mongolian Green Building Council is to develop a green building evaluation system in Mongolia in collaboration with relevant government, private, and financial stakeholders. BestGER (Best Governance, Efficiency, and Resilience) is Mongolia's first green building rating system, developed by the Mongolian Green Building Council (MGBC). The system aims to promote sustainable building practices, decrease energy and water consumption, reduce the environmental impact of buildings, and improve their resilience to fires, floods, and climate change. The Mongolian Green Building Council (MGBC) conducted a comparative analysis of international green building rating systems, including IFC EDGE, the U.S. LEED certification, Germany's DGNB, and the UK's BREEAM. Following this analysis, MGBC developed a national rating system tailored to Mongolia's needs—Best Governance in Efficiency and Resilience (BestGER). BestGER consists of two tiers: the Comprehensive rating system, designed for large, multi-story residential and commercial buildings; and the Simple rating system, intended for smaller housing types in ger areas, such as detached homes, duplexes, and low-rise apartments of 2–3 stories. Mongolia is experiencing rapid urbanization, with about 70% of its 3.3 million population now living in cities. Ulaanbaatar alone accounts for half the population and 63% of the national GDP. By 2040, over a million people are expected to move to the country's three largest cities, intensifying pressure on infrastructure, especially in informal "ger areas" where low-income households face poor living conditions and high structural risks, particularly in seismic zones like Erdenet. A key cause of unsafe housing is a legal gap in the Construction Law, which exempts single-family homes under 600 square meters from permitting and inspection. As a result, many homes are built without professional oversight. To address this, BestGER Simple includes mandatory criteria for structural integrity and seismic resilience to improve safety and living standards in these vulnerable areas.

Keywords: BestGER, Green building rating systems, Seismic resilience, National green housing standards

POROUS CERAMICS BY DIRECT FOAMING AND ITS APPLICATIONS

Kamrun Nahar FATEMA[1], Liew Yun MING[2], Heah Cheng YONG[2], Sungchil LEE[3], and Ik Jin KIM[3*]
[1]*School of Mechanical Engineering, Chonnam National University, Gwangju 61186, Republic of Korea*
[2]*Geopolymer and Green Technology, Centre of Excellence (CEGeoGTech), Universiti Malaysia Perlis (UniMAP), Perlis, Malaysia*
[3]*Faculty of Mechanical and Electrical Engineering, German-Mongolian Institute for Resources and Technology (GMIT), Nalaikh, Mongolia*
*E-mail: ikjin@gmit.edu.mn

Abstract

Porous ceramics possess unique structural properties such as low thermal conductivity, high surface area, controlled permeability, and low density, making them valuable for a wide range of applications. They are used in insulation, catalyst carriers, filters, bio-scaffolds for tissue engineering, and composite manufacturing. However, existing processing methods for porous ceramics, namely replica techniques and sacrificial templates, are complex, release harmful gases, have limited microstructure control, and are expensive. In contrast, the direct foaming method offers a simple and cost-effective approach. By modifying the surface chemistry of ceramic particles in a colloidal suspension, the hydrophilic particles are transformed into hydrophobic ones using surfactants. This method produces porous ceramics with interconnected pores, creating a hierarchical structure suitable for applications like nano-filters. This study emphasizes the importance of interconnected porosity in developing advanced ceramic materials with tailored properties for various applications.

Keywords: Porous ceramics, Direct foaming, Colloidal suspension, Interconnected pores

CHEMICAL REDUCTION BASED SYNTHESIS COPPER NANOPOWDER FROM COPPER CONCENTRATE AT THE ERDENETIIN OVOO DEPOSIT

Munkhjin BYAMBACHULUUN[1], Narangerel ADIYASUREN[1], Ganzorig CHIMED[1*]
[1]*Center for Nanoscience and Nanotechnology, Department of Chemical and Biological Engineering, School of Engineering and Technology, National University of Mongolia, Ulaanbaatar, Mongolia*
*E-mail: ch_ganzorig@num.edu.mn

Abstract

This study explores the synthesis of copper nanopowder directly from copper concentrate sourced from Erdenetiin Ovoo deposit, as an alternative to conventional methods using pure copper salts. The copper content in the concentrate was first determined through iodometric titration. The concentrate was digested with concentrated nitric acid to oxidize copper to Cu^{2+}ions, followed by nitrate removal using hydrochloric acid (with sulfuric acid as an alternative for comparison). The extracted Cu^{2+} ions were then reduced to metallic copper using hydrazine hydrate and sodium borohydride, and the resulting nanopowders were characterized using XRD and Nanophox analysis. The findings demonstrate a viable route for producing copper nanoparticles from mineral concentrates, offering potential cost and resource efficiency benefits.

Keywords: Copper nanopowder, Copper concentrate

IONOMETALLURGICAL TEST WORK ON GOLD AND COPPER CONCENTRATE

Purev-Ochir TOGTOKHBAATAR[1*], Charlotte ASHWORTH GÜTH[2], Gero FRISCH[2]
[1]*Faculty of Raw Material and Environmental Engineering, German Mongolian Institute for Resources and Technology (GMIT), Nalaikh, Mongolia*
[2]*Department of Inorganic Chemistry, TU Bergakademie Freiberg, Freiberg, Germany*
*E-mail: purevochir@gmit.edu.mn

Abstract

Leaching investigations using deep eutectic solvents (DES) have been carried out to investigate the feasibility of an ionometallurgical approach to processing copper concentrates. The concentrate under investigation consisted mainly of chalcopyrite, pyrite, bornite, quartz, molybdenite, and trace amounts of native gold. The most efficient leaching procedure involved leaching in ethaline (a 1:2 molar ratio of choline chloride and ethylene glycol) at 70 ºC, with 25 mM I2 as an oxidising agent. The optimum conditions resulted in high yields of both copper (100%) and gold (95%) after a relatively short leach duration (72 hrs). Analysis of the leaching residues revealed selective leaching of chalcopyrite over pyrite. This has additional significant advantages not only for subsequent target metal extraction from the leachate, but also for possible recycling of the residues to be used as an additive to promote leaching rates, due to galvanic effects of pyrite.

Keywords: Copper, Gold, Iodine, Chalcopyrite, Ionometallurgy

PURIFICATION AND STRUCTURAL OPTIMIZATION OF NATURAL MOS2 EXTRACTED FROM MONGOLIAN MOLYBDENITE CONCENTRATE

Bayardulam JAMIYANSUREN[1], Bolormaa GENDENSUREN[2], Battsengel BAATAR[1*], Narangarav TERBISH[1]
[1]*German Mongolian Institute for Resources and Technology (GMIT), Nalaikh, Mongolia*
[2]*School of Chemical Engineering, University of Ulsan, Ulsan, Republic*
*E-mail: battsengel@gmit.edu.mn

Abstract

Molybdenum disulfide (MoS2) has gained significant attention for its wide-ranging application in catalysis, lubrication, optoelectronics, and energy storage. However, most research relies on synthetic MoS2, which is expensive and resource intensive. Mongolia, one of the world's largest Molybdenum producers, export molybdenite primarily as a raw material little value attention. To enhance its industrial usability, this study focuses on developing a scalable purification and structural optimization method for natural MoS2 extract from Mongolian molybdenite concentration. A two-step purification process involving froth flotation and acid leaching was employed to remove silicate, iron oxides, and other impurities, achieving a final purity of ≥92%. Structural optimization was conducted through LiOH intercalation, expanding the interlayer spacing 0.9±0.3 nm, improving reactivity and lithium-ion diffusion properties. Characterization techniques including XRD, SEM, RAMAN spectroscopy, and BET surface analysis confirmed successful impurity removal and structural modification. These findings demonstrate that natural MoS2 can be refined into a high-purity, structurally optimized material suitable for a wide range of applications, from lubricant to advanced technologies such as lithium-ion batteries, catalyst and electronic devices. This research adds value to Mongolia's natural resources, providing a sustainable alternative to synthetic MoS2 while supporting industrial scalability.

Keywords: MoS2, Molybdenite, Purification, Intercalation.

RARE EARTH RECYCLING FROM NDFEB MAGNETS VIA PYROMETALLURGY & MOLTEN SALT ELECTROLYSIS

Ulziikhuu OTGONBAYAR[1], Chinedu Francis ANOCHIE[1], Daniel VOGT[1*], Alexandros CHARITOS[1]
[1]*Institute of Nonferrous Metallurgy and Purest Materials (INEMET), TU Bergakademie Freiberg, Germany*
*E-mail: Daniel.Vogt@inemet.tu-freiberg.de

Abstract

Neodymium-Iron-Boron (NdFeB) magnets are a major application of Rare Earth Elements (REEs), offering high energy density and temperature stability in sintered forms, and design flexibility in polymer-bonded variants. These magnets are used across scales—from hard drives to electric vehicles and wind turbines. The associated REEs—Nd, Pr, Dy, and Tb—are considered Critical Raw Materials (CRMs) in the EU due to their economic value and supply risk, largely driven by China's dominance in mining and processing. By 2050, EU demand could reach 35,000 tons. To mitigate this, efficient REE production from primary and secondary sources is crucial. Recycling methods for NdFeB magnets fall into two types: short-loop and long-loop. Short-loop recycling involves coating removal, hydrogen decrepitation, and milling to recover magnet powders, but faces challenges with contamination and oxidation. Long-loop recycling extracts REEs using hydrometallurgical or pyro-hydrometallurgical processes to produce Rare Earth Oxides (REOs), suitable for making new magnets. Although complex, long-loop recycling delivers high-quality output comparable to virgin sources. A key final step is molten salt electrolysis, used to convert REOs into metallic forms. This presentation focuses on a high-temperature pyrometallurgical process developed at TUBAF/INEMET for NdFeB recycling. Using Fe_2O_3 as an oxidizer and B_2O_3 as a flux, the method produces a REE-rich neodymium-borate slag (>90 wt.% REOs) and a metallic alloy (primarily Fe and Co). This process, operating above 1300°C, is especially effective for polymer-bonded magnets, which are not easily processed by hydrometallurgy. The slag's high REE content and oxidized state allow for efficient downstream hydrometallurgical treatment without issues like H_2 evolution. In addition, am alternative approach aiming at REE2O3 concentration in a further slag system is shown (CaO-Al 2O3-SiO2 system). The presentation also covers recent work at INEMET/TUBAF's molten salt electrolysis lab. Industrial practices are reviewed, including concerns over CO_2 and perfluorocarbon (CFx) emissions from carbon anodes. The lab uses FTIR gas analysis to monitor emissions and detect the anode effect. Tests with synthetic and recycled Nd_2O_3 confirmed Nd metal formation and the presence of oxyfluoride phases. Further experiments with REO recyclates from the EIT Raw Materials project DysCovery (via KTH Sweden) yielded Nd-rich alloys, though some oxyfluoride persisted due to slow dissolution. This work forms part of the DysCovery, REEsilience, and Harmony projects, with funding gratefully acknowledged.

Keywords: Pyrometallurgy, Molten-salt-electrolysis, Magnet recycling, Rare-earth-processing

THERMAL DISSOLUTION OF COAL: A PATHWAY TO HIGH-VALUE CARBON MATERIALS

Vladimir SAFIN[1*], Budeebazar AVID[2], Peter KUZNETSOV[1], Nergui NAVCHTSETSEG[2], Ludmila KUZNETSOVA[1], Anastasia OBUKHOVA[1]
[1]*Institute of Chemistry and Chemical Technology SB RAS, Federal Research Center, Russia*
[2]*Institute of Chemistry and Chemical Technology, Mongolian Academy of Sciences, Mongolia*
*E-mail: safin.v.a@yandex.ru

Abstract

Currently, the production of carbon materials and composites is experiencing rapid growth. Despite the promising prospects for their widespread industrial application, progress in this field remains constrained by the high cost of synthesis, which involves complex technological procedures, high temperatures, and expensive catalysts. Russia and Mongolia possess vast coal reserves and are actively engaged in their extraction. Although coal holds significant potential as a source of diverse chemical substances, but most of the mined coal is burned for heat and electricity generation. This situation can be improved through the widespread adoption of comprehensive processing of solid combustible fossil fuels. One such processing method is the thermal dissolution of coal, which yields an extract primarily composed of aromatic and polyaromatic substances. These are the key precursors for various carbon materials. These highly aromatic fractions can also be used to produce high-demand materials such as pitch and needle coke. The structure of the organic matter of coal from Russia and Mongolia, along with their chemical and technological properties, was investigated using a suite of modern high-precision methods. The study focused on identifying the relationship between their structure and reactivity during thermal solvolysis in various hydrocarbon solvents. Technical fractions derived from coal and petroleum processing served as the solvents. It was established that thermal dissolution of coal in hydrocarbon media can be achieved within a temperature range of 350–380°C, producing no more than 1 wt.% of gaseous byproducts. A thorough analysis of the structure, composition, and properties of the obtained extracts was conducted. After removing substances with boiling points below 280–300°C, an extractive pitch was obtained, suitable for use in producing anodes for aluminum electrolysis. Unlike coal tar pitch, the extractive pitch contains 8–10 times less benzo(a)pyrene. Using solvent fractionation and atmospheric and vacuum distillations, a series of subfractions were isolated. Pyrolysis of these subfractions at temperatures ranging from 450–1000 °C yielded cokes with diverse structures and properties, including highly anisotropic cokes approaching the quality of needle coke. The study of the subfraction and carbonizate compositions provided a foundation for controlling the quality of the resulting coke.

Keywords: Coal structure, Thermal solvolysis, Carbon materials, Needle coke

THEORETICAL STRATEGIES FOR ENHANCING CATALYTIC PERFORMANCE IN ADVANCED HYDROGEN STORAGE SYSTEMS

Sung Gu KANG[1*]
[1]*School of Chemical Engineering, University of Ulsan, Ulsan, Republic of Korea*
*E-mail: sgkang@ulsan.ac.kr

Abstract

This work presents a comprehensive theoretical investigation into next-generation hydrogen storage materials, with an emphasis on metal hydrides and liquid organic hydrogen carriers (LOHCs). Particular attention is given to the development of efficient dehydrogenation catalysts for widely utilized LOHC compounds. Employing a range of state-of-the-art computational approaches, we systematically explored the structural and electronic determinants governing hydrogen release behavior. Detailed mechanistic analyses of dehydrogenation pathways were conducted for various candidate catalysts, leading to the identification of a performance-based descriptor that enables rational catalyst screening. The insights gained from this study provide a foundational framework for the design and optimization of high-efficiency hydrogen storage

systems, contributing meaningfully to the advancement of sustainable energy solutions.

Keywords: Hydrogen storage, LOHCs, Catalysts, DFT

COLLABORATIVE GIS FOR SUSTAINABLE WASTE MANAGEMENT: THE CASE OF ULAANBAATAR IN 3R4UB

Francesco S. SAMMARCO[1*], Gaia DALDANISE [2], Fabio Maria ESPOSITO[3], Gabriella ESPOSITO DE VITA[2], Gantuya GANBAT[4], Marina RIGILLO[1]

[1]Department of Architecture (DiARC), University Federico II of Naples, Italy

[2]National Research Council of Italy (CNR), Institute of Research on Innovation and Services for Development (IRISS), Italy

[3]National Research Council of Italy (CNR), Institute for Population and Social Policy Research, Italy

[4]German-Mongolian Institute for Resources and Technology (GMIT), Nalaikh, Mongolia

*E-mail: francescostefano.sammarco@unina.it

Abstract

This paper presents the outcomes of the international project "The 3Rs for a sustainable use of natural resources in Ulaanbaatar – 3R4UB", focused on developing an innovative model of collaboration between citizens and public authorities in the field of sustainable waste management. Ulaanbaatar (UB), the capital of Mongolia, faces major challenges linked to rapid urban growth, inadequate infrastructure, and fragmented planning policies. The city is characterised by three coexisting urban forms: the planned city (Soviet legacy), the spontaneous city (informal ger settlements), and the city in transition (hybrid areas between planned and informal development). The research introduces the "Ulaanbaatar Spatial Sustainable Waste Management" (UBSWM) approach, which integrates spatial data analysis through GIS tools with participatory planning practices. The method combines quantitative data (e.g., infrastructure density, waste production per capita) and qualitative inputs (e.g., visual storytelling, citizen science activities, awareness-raising campaigns in schools). These are synthesised through a collaborative geodatabase and an open-access ArcGIS Story Map platform that visualises critical dynamics in waste flows and spatial inequalities in infrastructure and services. The methodology is structured in three phases: (1) identification of objectives, with a focus on integrating circular economy principles and SDGs (in particular SDGs 8, 11, 12, and 13) into urban waste planning; (2) operational mapping in three pilot areas representing the diversity of UB's urban fabric, leading to the location of eco-hubs and educational interventions; and (3) spatial and visual restitution of findings through narrative cartography and thematic maps, enabling data accessibility and stakeholder engagement. Results demonstrate that visual and spatial representation of urban waste flows—complemented by community-based educational activities—can serve as an effective tool to inform public policies and foster inclusive urban governance. The pilot action in selected schools involved over 25,000 students and their families, leading to measurable improvements in recycling practices and environmental awareness. The final output—a multi-layered Story Map—functions as both an analytical tool and a narrative device, making complex environmental and social issues visible to a broad audience. The approach shows potential for replication in other urban contexts with similar socio-environmental challenges. It reinforces the importance of combining GIS-based analysis with citizen engagement, particularly in rapidly transforming cities where informal settlements and environmental vulnerabilities intersect. The UBSWM framework contributes to bridging the gap between urban planning, environmental policy, and educational strategies, and supports the creation of more inclusive, resilient, and sustainable urban systems.

Keywords: Collaborative planning, Sustainable waste management, GIS, Citizen science.

STOCHASTIC OPTIMAL CONTROL OF HEATING SYSTEMS WITH A GEOTHERMAL ENERGY STORAGE

Ralf WUNDERLICH[1*]
[1]*Brandenburg University of Technology, Cottbus, Germany*
*E-mail: ralf.wunderlich@b-tu.de

Abstract

We consider a residential heating system with renewable and non-renewable heat generation and different consumption units and investigate a stochastic optimal control problem for its cost-optimal management. As a special feature, the heating system is equipped with a geothermal storage that enables the intertemporal transfer of thermal energy by storing surplus heat for later use. In addition to the numerous technical problems, economic issues such as cost-optimal control also play a central role in the design and operation of such systems. The latter leads to challenging mathematical optimization problems, as the response of the storage to charging and discharging decisions depends on the spatial temperature distribution in the storage. We take into account uncertainties regarding randomly fluctuating heat generation from renewable energies and the environmental conditions that determine heat demand and supply. The dynamics of the multidimensional controlled state processes is governed by a partial, a random ordinary and two stochastic differential equations. We first apply a spatial discretization to the partial differential equation and use model reduction techniques to reduce the dimension of the associated system of ordinary differential equations. Finally, a time-discretization leads to a Markov decision process for which we apply a state discretization to determine approximations of the cost-optimal control and the associated value function.

Keywords: Stochastic optimal control, Heating system, Geothermal energy storage

POSTER ABSTRACTS

CORRELATION BETWEEN DIFFERENT ADHESION MEASUREMENT METHODS ACCORDING TO BINDER CONTENT

In-Seo KIM[1], Gendensuren BOLORMAA[1], Ji-Young NAM[1], Eun-Suok OH[1*]
[1]*School of Chemical Engineering, University of Ulsan, Ulsan, Republic of Korea*
*E-mail: esoh1@ulsan.ac.kr

Abstract

The binder is a crucial component in the manufacture of lithium-ion batteries (LIBs). It provides structural stability by binding electrode materials, maintains electrical conductivity by linking active materials and conductive additives, and enhances ionic conductivity by facilitating contact between the electrode and electrolyte. These properties are largely attributed to the adhesion of binder. This study conducted peel-off and scratch tests on both of cathode and anode electrodes under various binder with different concentrations. The impact of the binder's adhesive strength on the electrodes' mechanical properties and electrical performance was more clearly demonstrated through the analysis of the results. This comparative study provides valuable foundational data for optimizing binder composition and suggests potential pathways to enhance the performance of LIBs.

Keywords: Lithium-Ion battery, Binder, Adhesion, Secondary battery

RESEARCH ON SYNTHESIS AND PROCESS FOR PERFORMANCE OPTIMIZATION OF MID-NICKEL SINGLE-CRYSTAL CATHODE MATERIALS FOR LITHIUM-ION BATTERY

Ye-Jin SUNG[1], So-Yeon AN[1], Seo-Yoon OH[1], Ye-Eun HWANG[1], Eun-Suok OH[1*]
[1]*School of Chemical Engineering, University of Ulsan, Ulsan, Republic of Korea*
*E-mail: esoh1@ulsan.ac.kr

Abstract

Lithium-ion secondary batteries are among the most commercially viable rechargeable batteries, offering superior performance and widespread applications in portable electronic devices and electric vehicles. In particular, mid-nickel cathode materials (50% ≤ Ni < 70%) have recently gained attention due to their cost-effectiveness and structural stability, despite exhibiting lower energy density than high-nickel (Ni ≥ 70%) cathode materials. During the cathode electrode manufacturing process, a rolling step is essential to compress the coated cathode material onto the current collector, eliminating internal voids. However, in polycrystalline cathode materials, excessive pressure can lead to surface cracks or particle fracture, which in turn degrades battery capacity. To address this issue, single-crystal cathode materials have emerged as a promising alternative. Single-crystal cathode materials consist of metal particles fused into a single structure, making them more resistant to cracking and significantly reducing the risk of gas generation inside the battery. This study aims to optimize the synthesis, milling, and washing process conditions to establish an efficient fabrication process for mid-nickel single-crystal cathode materials with excellent electrochemical properties. To achieve this, SEM and PSA analyses were conducted to examine particle morphology and size distribution, while powder and electrode resistance measurements were performed to assess the physical properties of the cathode material. Additionally, XRD and DSC analyses were used to evaluate its structural and thermal stability. Furthermore, half-coin cells were fabricated to compare and assess electrochemical performance through cycle, C-rate, EIS, and CV analyses.

Keywords: NCM622, Cathode materials, Single-crystal, Lithium-ion battery.

COMPUTATIONAL EXPLORATION OF PTN CLUSTERS ON TI-BASED MXENES FOR METHYLCYCLOHEXANE DEHYDROGENATION CATALYSIS

Thi Bich Tram BUI[1], K. S. S. V. Prasad REDDY[1], Sung Gu KANG[1*]
[1]*School of Chemical Engineering, University of Ulsan, Ulsan, Republic of Korea*
*E-mail: sgkang@ulsan.ac.kr

Abstract

The efficient storage and transport of hydrogen are pivotal hurdles in the pursuit of sustainable global energy systems. Among various strategies, liquid organic hydrogen carriers (LOHCs) such as methylcyclohexane (MCH) have gained attention for their practicality and reversibility. This study investigates the catalytic dehydrogenation of MCH to toluene on Ti2C and Ti3C2 MXene monolayers through density functional theory (DFT) approaches. Key mechanistic and catalytic factors, including adsorption behavior, d-band center shifts, and energy barriers for sequential dehydrogenation steps were comprehensively evaluated. The comparative analysis reveals that Ti2C outperforms Ti3C2, exhibiting a lower activation barrier, particularly in the rate-limiting step. To amplify catalytic effectiveness, Ti2C was further employed as a substrate for small platinum clusters (Ptn, where n = 3–6). Among these, the Pt3/Ti2C configuration emerged as the most active, substantially decreasing the energy barriers associated with MCH dehydrogenation. These insights demonstrate the potential of Pt3/Ti2C as a high-performance catalyst, offering a promising route toward the practical implementation.

Keywords: Hydrogen storage, LOHCs, Methylcyclohexane, DFT

SURFACE-DISPLAYED COBALT-AFFINITY RECOMBINANT ESCHERICHIA COLI FOR THE POTENTIAL APPLICATIONS OF COBALT RECOVERY FROM WASTEWATER AND PHOTOCATALYTIC DYE DEGRADATION

Jonguk LEE[1], Saranya SHANMUGASUNDARAM[1], Soon Ho HONG[1*]
[1]*School of Chemical Engineering, University of Ulsan, Ulsan, Republic of Korea*
*E-mail: shhong@ulsan.ac.kr

Abstract

The novel recombinant Escherichia coli strain was construct through cell surface display for the treatment of cobalt contaminated wastewater and dye contaminated wastewater. First, structural analysis of known cobalt binding peptide was conducted and core binding sites were figured out which showing better cobalt binding ability. The cobalt peptides were attached to OmpC to construct cobalt adsorbing recombinant Escherichia coli. The recombinant strain efficiently absorbed and retrieved cobalt from cobalt wastewater by adsorbing 1895 μmol/g DCW of cobalt. Following adsorption, cobalt nanoparticles were synthesized through thermal decomposition of cobalt adsorbed recombinant strain at 500˚C. The nanoparticles exhibited noteworthy photocatalytic properties, demonstrating a substantial capacity for degrading dyes when used as a catalyst at a concentration of 10 mg/dl. These results presenting potential solutions for effective and environmentally friendly approaches to address cobalt and dye contaminated wastewater treatment process.

Keywords: Cobalt adsorption, Dye degradation, E. coli, Wastewater treatment

IMPACT OF THE NI-OXYGEN VACANCY INTERFACE CREATED AFTER THE REDUCTION OF THE NIAL2O4 PHASE ON RESISTANCE TO COKE FORMATION DURING DRY REFORMING OF METHANE

Nhiem PHAM-NGOC[1], Azam JAMSAZ[1], Phuong Anh NGUYEN[1], Song CHAO[1], Youngil LEE[1], Eun Woo SHIN[1*]
[1]*School of Chemical Engineering, University of Ulsan, Republic of Korea*
*E-mail: ewshin@ulsan.ac.kr

Abstract

The prevention of coke formation during the dry reforming of methane (DRM) is critically dependent on the effective distribution of active sites within Ni/Al2O3 catalysts. This study introduces a one-pot synthesis method for creating macroporous Ni/Al2O3 catalysts (denoted as OM), which promotes the homogeneous formation of disordered NiAl2O4 within a three-dimensional macroporous structure. Upon successive reduction, this disordered NiAl2O4 phase transforms into highly dispersed Ni nanoclusters accompanied by the generation of nearby oxygen vacancies, creating a Ni-oxygen vacancy interface. In DRM reactions, the OM catalyst demonstrated superior performance, achieving higher CH4 conversion rates and improved carbon balance compared to a macroporous Ni/Al2O3 catalyst prepared by the traditional impregnation method (IM) and non-macroporosity catalyst with the same Ni content of 10 wt%. Specifically, the OM catalyst exhibited enhanced resistance to coke formation, as evidenced by thermogravimetric analysis (TGA) showing a lower weight loss due to coke formation (3%) compared to the IM catalyst (12%) and NMA-IM catalyst (42%) after 90-hour TOS. Notably, the amount of graphite coke in the OM catalyst was 5 times lower than in the IM catalyst and 34 times than in the NMA-IM catalyst, highlighting the effectiveness of the Ni-oxygen vacancy interface in facilitating CO2 activation and suppressing coke generation. This study underscores the potential of the one-pot synthesis approach in developing more efficient and coke-resistant catalysts for DRM and similar catalytic processes.

Keywords: Disordered structure, One-pot method, Ni-oxygen vacancy, Coke resistance.

EXAMINING THE INFLUENCE OF CATIONS ON MODULATING THE ELECTROCHEMICAL PROPERTIES OF NICKEL-COPPER OXY(HYDROXIDE) FOR ENHANCED AMMONIA OXIDATION REACTION

Pragyan SHARMA[1], Jin Suk CHUNG[1*]
[1]*School of Chemical Engineering, University of Ulsan, Ulsan, Republic of Korea*
*E-mail: jschung@ulsan.ac.kr

Abstract

Ammonia (NH3) has received considerable attention in recent years due to several advantages, including its COx-free nature and a well-established infrastructure for transportation and storage. The oxidation of NH3 (Ammonia Oxidation Reaction, AOR) to generate clean hydrogen occurs at a significantly lower thermodynamic potential compared to water (0.06 V versus 1.23 V), making it an energy-efficient process. Nickel-copper (oxy)hydroxide (NiCuOOH) is recognized as an effective catalyst for facilitating the AOR. Numerous factors, such as the morphology and composition of the catalyst, as well as the pH of the electrolyte, have previously been examined to optimize its electrochemical performance. However, the influence of ions present in the electrolytic solution has been largely overlooked. In this study, we investigated the impact of various cations on enhancing AOR activity. Electrochemical techniques, including Cyclic Voltammetry, Linear Sweep Voltammetry, Electrochemical Impedance Spectroscopy, and Chronoamperometry, were employed to analyze the differences in catalytic response.

Keywords: Ammonia oxidation, Electrocatalysis, Hydrogen production

MULTI-OBJECTIVE OPTIMIZATION OF LIGNIN-TO-VANILLIN PROCESS FOR MINIMIZING COST AND CO2 EMISSIONS USING MACHINE LEARNING-BASED SURROGATE MODELING

Yun Gyu LEE[1], Dong Hwi JEONG[1*]
[1]*School of Chemical Engineering, University of Ulsan, Ulsan, Republic of Korea*
*E-mail: jdonghwi@ulsan.ac.kr

Abstract

The biomass conversion process is a sustainable technology that reduces dependence on fossil resources. In particular, lignin is attracting attention due to its potential for valorization in various industries, such as polymers, fuels, and additives. However, economic and environmental enhancements are required for industrial implementation. In this study, a multi-objective optimization was conducted to simultaneously minimize the operating cost and CO_2 emissions of an existing lignin-to-vanillin production process. The process was simulated using Aspen Plus, and both techno-economic and environmental assessments were performed to evaluate the operating cost and CO_2 emissions. A surrogate model was developed using Gaussian Process Regression (GPR), trained on utility cost and CO_2 emission data with respect to six selected variables. Finally, optimal operating conditions were determined through multi-objective optimization based on the NSGA-II algorithm. As a result, operating cost was reduced by 10.3% and CO_2 emissions were reduced by 33.3% under optimal operating conditions.

Keywords: Lignin-to-vanillin process, Multi-objective optimization, Machine learning, Surrogate modeling

PROCESS SIMULATION, TECHNO-ECONOMIC AND ENVIRONMENTAL EVALUATION OF HYDROGEN-BASED REDUCTION IRONMAKING PROCESS

Yoo Ri KIM[1], Jeong Cheol LEE[1], Shi Kyung YOON[2], Dong Hwi JEONG[1*]
[1]*School of Chemical Engineering, University of Ulsan, Ulsan, Republic of Korea*
[2]*Hydrogen Ironmaking Research Group, POSCO Research Laboratories, South Korea*
*E-mail: jdonghwi@ulsan.ac.kr

Abstract

Hydrogen, receiving increasing attention to reduce greenhouse gas emissions, is an eco-friendly energy source and is used in various ways such as fuel, reducing agents, and raw materials. In industries related to hydrogen utilization, the steel industry is one of the most energy-intensive processes and emits a significant amount of CO2. Therefore, ironmaking processes using hydrogen as a reducing agent are being researched and developed to reduce CO2 and move toward a sustainable process. In this study, we developed the hydrogen-based reduction ironmaking process model using a commercial simulation tool. As a result, techno-economic and environmental assessments were conducted to estimate the production cost and CO2 emissions, which were calculated to be 903 USD/tonne and 534 kgCO2/tonne of direct reduced iron (DRI), respectively. Based on this simulation model, the hydrogen-based direct reduction ironmaking process was compared with the conventional blast furnace process to evaluate the advantages and limitations, and to discuss potential improvements. Sensitivity analysis was conducted based on the use of green hydrogen and green electricity, considering the integration of renewable energy, to evaluate the potential impacts of technological developments and future policy changes.

Keywords: Process simulation, Ironmaking, Economic assessment, CO2 emissions

FABRICATION OF METALLIC MEMBRANES AND THE IMPACT OF CATALYTIC LAYER THICKNESS ON PERMEATION BEHAVIOR

Hyeon Uk KIM[1], Ik Seong AHN[1], Chan Hyun LEE[1*]
[1]*School of Chemical Engineering, University of Ulsan, Ulsan, Republic of Korea*
*E-mail: chhylee@ulsan.ac.kr

Abstract

Hydrogen is getting a lot of attention to address the environmental problem occurred by greenhouse gas emission from fossil fuel. Hydrogen can convert into electricity energy using hydrogen fuel cell without any pollution material emission. However, hydrogen generated from fossil fuels, so called as grey hydrogen, occupies more than 90% of total hydrogen production. Therefore, it is necessary to be combined with hydrogen purification steps for utilizing hydrogen fuel cell. The standard composition for fuel-cell grade hydrogen has been specified by the ISO 14687 standard; H2 > 99.97%, CO2 < 2ppm, CO < 0.2ppm. Hydrogen purification using palladium (Pd)-based metallic membranes represents a viable method for producing high-purity hydrogen, thanks to the unique permeation behavior of hydrogen through the metallic layers. Conventional metallic membranes have been fabricated by coating thin FCC metallic layers on the both sides of bulk supporting layers, such as porous stainless steel and BCC (body-centered cubic) metals.

In this study, we prepared metallic membranes with varying thicknesses on the feed and permeate sides to investigate the trends in permeability permeation flux associated with these differences and to determine the optimal thickness for each side. The thickness of Pd layer was carefully controlled using vacuum sputtering method, with thicknesses ranging from 10 to 100 nm. From the permeation test, we determined the optimized thickness for the Pd thin layer on bulk Ta metallic layer. The resulting composite membrane exhibited exceptionally high permeability, and demonstrated robust mechanical strength; capable of withstanding up to 6 bar pressurized condition. Furthermore, we found that the rates of hydrogen dissociation and association are notably affected by the thickness of the Pd catalytic layer. This insight would make better developing cost-efficient Pd-based metallic membranes with high permeability. Additionally, the Pd/Ta composite membranes showed significant potential as a separation material for producing fuel-cell grade hydrogen.

Keywords: Metallic membrane, Hydrogen purification, Catalytic layer, Permeation flux.

DEVELOPMENT OF THERMAL SWING ADSORPTION (TSA) PROCESS FOR MOISTURE REMOVAL FROM POME-DERIVED BIOMETHANE

Jae Hyeon PARK[1], Chan Hyun LEE[1*]
[1]*School of Chemical Engineering, University of Ulsan, Ulsan, Republic of Korea*
*E-mail: chhylee@ulsan.ac.kr

Abstract

Palm oil mill effluent (POME), generated during palm oil production, can cause severe environmental pollution if discharged without proper treatment. Biogas produced through the anaerobic digestion of POME passes through a series of purification processes, including desulfurization and water absorption, to increase methane concentration. Moisture removal from the bio-methane after the water absorption process is essential for its compression into bio-CNG for ensuring transportation and storage. This study optimized the operational conditions of a thermal swing adsorption (TSA) process to enhance the efficiency of an integrated POME upgrading process. For effective moisture removal, a layered adsorption column composed of activated alumina and zeolite 4A was designed to optimized performance. The breakthrough characteristics of a multilayer adsorption column were evaluated under varying parameters: recycle ratio of the production stream, regeneration temperature, and regeneration time in a continuous TSA process. Under the selected optimal conditions, the system achieved a moisture removal efficiency of 97% and methane purity exceeding 96%. The TSA process performance

was further validated through continuous operation, and its integrated upgrading process was assessed using numerical simulations.

Keywords: Bio-methane, Thermal swing adsorption (TSA), Moisture removal, POME upgrading

FACILE PREPARATION OF PHOSPHOROUS-DOPED GRAPHENE QUANTUM DOTS/BISMUTH IRON VANADATE COMPOSITE AS BIFUNCTIONAL ELECTROCATALYSTS FOR WATER SPLITTING

Beena Mol BABU[1], Min Jae KIM[1], Tata Sanjay Kanna SHARMA[1*], Won Mook CHOI[1*]
[1]*School of Chemical Engineering, University of Ulsan, Ulsan, Republic of Korea*
*E-mail: kannasri00@gmail.com, wmchoi98@ulsan.ac.kr

Abstract

The search for alternative electrode material with high active surface area and electron density for electrocatalytic reactions has generated significant interest in vanadates. In this work, we prepared a bismuth iron vanadate mixed metal oxide (BiFeV) combined with phosphorus-doped graphene quantum dots (P-GQDs) through a hydrothermal approach. The composite (PG-BiFeV) was synthesized through a one-pot method, yielding a hybrid structure with rods attached to spherical formations. The assessment of the electrocatalytic performance of PG-BiFeV for water splitting demonstrated its superior catalytic activity. The composite exhibited low overpotentials of 341 mV for the hydrogen evolution reaction (HER) and 396 mV for the oxygen evolution reaction (OER) at a current density of 100 $mA \cdot cm^{-2}$, in addition to strong long-term stability. Utilizing its bifunctional hydrogen evolution reaction (HER) and oxygen evolution reaction (OER) properties, PG-BiFeV was used in a symmetric electrode configuration for comprehensive water electrolysis. The PG-BiFeV||PG-BiFeV system exhibited enhanced water-splitting performance, characterized by lower cell voltage and notable durability. The findings indicate that PG-BiFeV composites may serve as effective cathode and anode materials for water electrolysis applications.

Keywords: **Bismuth iron vanadate, Graphene quantum dots, Hydrogen evolution reaction, Oxygen** evolution reaction.

STEAM GASIFICATION OF TAVANTOLGOI BITUMINOUS COALS WITH A COMBINED DROP-TUBE AND FIXED-BED REACTOR

Zorigtbaatar ERDENEMUNKH[1*], Baigalmaa GANBOLD[2], Enkhsaruul BYAMBAJAV[2]
[1]*Department of Chemistry & Biological Engineering, School of Engineering & Technology, National University of Mongolia*
[2]*Department of Chemistry, School of Art & Sciences, National University of Mongolia*
*E-mail: zzorigoo558@gmail.com

Abstract

The steam gasification activities of Tavantolgoi bituminous coal samples (TT7005, TT1474, and TT1512) were studied with a combined drop-tube and fixed-bed reactor (ID-20 mm; L-100 cm). Gasification processes were investigated under different reaction conditions. The reaction temperature was in the range of 750° ÷ 850°C, the feeding rate of steam was 0.2 ÷ 0.8 ml/min, and the flow rate of Ar carrier gas was 50 ÷ 100 ml/min. A MicroGC-3000 analyzed the composition of gaseous products. The TT7005 coal sample, containing the largest amount of oxygen and the lowest amount of carbon and ash, showed the highest activity for the drop-tube steam gasification at 850°C (steam feeding -0.2 ml/min; flow rate of Ar -50 ml/min). The TT1474 and TT1512 samples had much lower activities compared to the TT7005 sample for steam gasification. Their carbon contents were the highest among the samples. To examine the effect of co-gasification, the three kinds of coal samples were blended with the different weight ratios of 1:1:1 and 3:1:1. Steam gasification of the blended sample with a weight ratio of 3:1:1 showed a synergetic effect at 850°C, and the experimental value of coal conversion was higher than its calculated value. CO2 in gaseous products evolved from coal gasification was fully absorbed by

monoethanolamine solvent (MEA). Moreover, methanol absorbed 74% vol. of CO2 at 0°C during the gasification process.

SPECTROSCOPIC AND THERMAL ANALYSIS OF CUO-ZNO COMPOSITE PARTICLES SYNTHESIZED BY SOL-GEL METHOD

Davaadulam BATBILEG[1]*, Narangerel ADIYASUREN[1], Ganzorig CHIMED[1]
[1]*Center for Nanoscience and Nanotechnology, Department of Chemical and Biological Engineering, School of Engineering and Technology, National University of Mongolia*
*E-mail: davaadulambatbileg@gmail.com

Abstract

Photocatalysis is a green technology that plays a vital role in achieving sustainable development goals and ensuring a clean environment. Metal oxide materials, in particular, have gained tremendous attention for their versatility in fields such as catalysis, semiconductors, ceramics, sensors, and energy storage. In this work, the sol-gel method has been used to synthesize CuO-ZnO composite particles. To understand their structural transformations, CuO-ZnO composite materials' thermal decomposition and phase evolution. Thermal analysis is crucial for determining the optimal calcination temperature during synthesis. We studied mass loss and phase transitions to identify the temperature, which affects vital photocatalytic parameters including crystallisation, particle size, and surface area. To examine thermal stability and temperature-specific mechanisms, we analysed samples dried at 120°C and 500°C using thermal analysis (TG-DTA), Fourier-transform infrared spectroscopy (FTIR), and X-ray diffraction (XRD). Thermal kinetic evaluation using the Coats–Redfern method resulted in an activation energy of 38.63 kJ/mol with a strong correlation coefficient of R^2=0.986, indicating reliable thermal decomposition behavior. These values reflect moderate thermal stability, which is favorable for the formation of active photocatalytic phases without excessive energy input.

We then characterised the composite's chemical composition using Raman spectroscopy while examining its optical and morphology properties through ultraviolet-visible (UV-Vis) spectroscopy and atomic force microscopy (AFM). These findings contribute to understanding the thermal stability, crystallisation behaviour, and phase interactions of CuO-ZnO composites, supporting their use in photocatalysis and functional materials. The results contribute to a better understanding of the temperature-dependent transformations in CuO-ZnO materials and provide a quantitative basis for their potential applications in photocatalysis and multifunctional materials. Future work will aim to include naturally occurring Cu_2O phases in the composite structure to improve green photocatalytic efficiency and expand the use of the material in cleaning up the environment.

Keywords: Photocatalytic, Thermal decomposition, Sol-gel method

KINETIC INVESTIGATION OF SPHALERITE LEACHING IN ETHALINE DEEP EUTECTIC SOLVENT

Maral BAT-ERDENE[1*]
[1]*Faculty of Raw Materials and Environmental Engineering, German Mongolian Institute for Resources and Technology (GMIT), Nalaikh, Mongolia*
*E-mail: b.maral@gmit.edu.mn

Abstract

Zinc is the most used metal after aluminum and copper and an essential metal required for many applications, from metal products to chemical, paint, and agriculture industries. Zinc is recovered from sphalerite as sulfide mineral that is the most prevalent and considerable zinc ore worldwide. However, the process of recovering zinc involves pyrometallurgical and hydrometallurgical processes which both have some setbacks with the emission of gases (SO2) which have environmental consequences and low leaching kinetic and high energy demands respectively for pyrometallurgical and hydrometallurgical processes. The present work reports the direct leaching of zinc from sphalerite in Deep Eutectic Solvents (DES) which offer an advantage over the conventional methods of recovering zinc in terms of cost, minimal environmental risk, and impacts. This study investigates the leaching behavior of sphalerite using ferric chloride and cupric chloride as oxidizing agents in both conventional aqueous systems and deep eutectic solvent (DES)-based systems, specifically employing ethaline, across a temperature range from 25°C to 80°C. A combination of batch leaching experiments and kinetic modeling was employed to evaluate zinc dissolution efficiency and to identify the predominant rate-controlling mechanisms governing the process. The results clearly indicate that zinc recovery is significantly influenced by both the choice of oxidant and the solvent medium. Among the oxidants tested, ferric chloride consistently outperformed cupric chloride in terms of zinc extraction efficiency. The most favorable outcome was observed in the ethaline–ferric chloride system at 80°C, where a maximum zinc recovery of 72% was achieved. Kinetic analysis, conducted using shrinking core models and activation energy calculations, revealed that the leaching process was predominantly controlled by chemical reaction kinetics across all experimental systems and time scales. An exception was noted in the aqueous–cupric chloride system at shorter leaching durations (less than or equal to 2 hours), where diffusion through the product layer emerged as the rate-limiting step. The calculated activation energy values, which ranged from 3 to 124.2 kJ/mol, further supported these mechanistic interpretations. These findings highlight the promising potential of deep eutectic solvents—particularly ethaline—as environmentally friendly and highly tunable media for efficient zinc extraction.

Keywords: Sphalerite leaching, Deep eutectic solvents (DES), Ethaline, Shrinking core model.

PREPARATION AND CHARACTERIZATION OF ZnO: Al THIN FILMS USING LOW TEMPERATURE AQUEOUS SOLUTION METHOD

Maral BOLOR-ERDENE[1], Oyunjargal TUMURBAATAR[1], Ganzorig CHIMED[2*]
[1]*Department of Chemical and Biological Engineering, New Mongol College of Technology, Ulaanbaatar, Mongolia*
[2]*Center for Nanoscience and Nanotechnology, Department of Chemical and Biological Engineering, School of Engineering and Technology, National University of Mongolia, Mongolia*
*E-mail: ch_ganzorig@num.edu.mn

Abstract

Transparent conducting oxide (TCO) thin films are widely used in modern optical and optoelectronic technologies, including solar cells, sensor displays, and light-emitting diodes. Among the various TCO materials, indium tin oxide (ITO) is the most commonly used. However, due to the increasing scarcity of indium metal in recent years, its high extraction cost, extensive water usage and pollution during mining, and toxic effects on human health, aluminum-doped zinc oxide (AZO) has been investigated as a potential alternative. By preparing AZO thin films in an aqueous environment under laboratory conditions, it becomes possible to produce low-cost and safer TCOs on an industrial scale while minimizing environmental pollution. In this study, a total of four

AZO thin films were fabricated using two methods: sol-gel and nanoparticle-based synthesis. Two of these films were thermally annealed at 500°C for 2 hours. The optical properties of the films were analyzed using UV-Visible spectroscopy (UV-VIS), and surface morphology changes due to annealing were characterized using atomic force microscopy (AFM). The AZO thin films prepared by both methods exhibited absorption in the ultraviolet (UV) region and transmittance of 60–80% in the visible region, with optical band gap energies ranging from 3.22 to 3.96 eV. In terms of surface morphology, the unannealed AZO films were relatively rough and non-uniform, whereas after annealing, the surface became smoother and more homogeneous. These results indicate that AZO thin films can be successfully fabricated using aqueous-based synthesis methods.

Keywords: AZO, ITO, Sol-gel, Nanoparticle

INTEGRATING FLOOD MITIGATION AND GROUNDWATER RECHARGE IN WATER SCARCE MINING AREA OF SOUTHERN MONGOLIA

Tuguldur BAT-ITGELT[1*], Ariuntuya TSERENDORJ[2], Alireza ARAB[3]

[1]*Faculty of Raw Materials and Environmental Engineering, German-Mongolian Institute for Resources and Technology (GMIT), Nalaikh, Mongolia*

[2]*Faculty of Raw Materials and Environmental Engineering, German-Mongolian Institute for Resources and Technology (GMIT), Nalaikh, Mongolia*

[3]*Department of Hydrogeology and Hydrochemistry, Technische Universität Bergakademie Freiberg (TUBAF), Germany*

*E-mail: batitgel.tuguldur@gmit.edu.mn

Abstract

The Gobi region of Mongolia, characterized by its arid climate and lack of natural groundwater recharge, is increasingly facing intense flash flood events due to climate change. Despite being a dryland, the area experiences short-duration, high-intensity rainfall events that generate destructive runoff. Compounding this challenge, the region's mineral abundance is driving rapid growth in water demand, particularly for mining activities. Groundwater remains the sole water source, yet it is unsustainably extracted without natural replenishment. This thesis investigates a nature-based solution: harvesting flash floodwater to support groundwater sustainability through managed infiltration. A Multi-Criteria Decision-Making (MCDM) approach integrated with the Analytic Hierarchy Process (AHP) was applied using nine thematic layers (slope, soil type, land use, lithology, drainage density, lineament density, rainfall, groundwater depth, and runoff potential) to identify suitable zones for floodwater infiltration across a 1,600 km² study area. The Rational Method was employed to estimate the volume of runoff generated during a 5-year return period rainfall event. The analysis revealed that 75.74 km² (approximately 4.73%) of the total area is highly suitable for infiltration structures. Within this area, an estimated 20384.41638 m³ of floodwater can be harvested and redirected into aquifers per event. The findings support the strategic implementation of infiltration-based structures such as retention basins and recharge ponds to mitigate flood damage and enhance groundwater sustainability in climate-vulnerable, water-scarce mining regions.

Keywords: Multi-Criteria decision making (MCDM), GIS-based analysis, Flash floods, Infiltration suitability

ELEMENTAL AND MINERALOGICAL ANALYSIS OF RARE EARTH ELEMENTS IN IRON ORE CONCENTRATE WASTE

Battsengel BAATAR[1*], Bayardulam JAMIYANSUREN[1], Baasandorj MYAGMARSUREN[1]
[1]*Faculty of Raw materials and Environmental Engineering, German-Mongolian Institute for Resources and Technology (GMIT), Nalaikh, Mongolia*
*E-mail: battsengel@gmit.edu.mn

Abstract

Rare earth elements (REEs) are critical for a wide range of renewable and clean energy technologies, making their recovery from secondary sources increasingly important. One such alternative source is the waste generated from iron ore processing plants. To evaluate the technical feasibility of REE beneficiation from iron ore concentrate waste, both elemental and mineralogical analyses were performed. The mineralogical characterization of iron ore, its concentrate, and associated waste materials was conducted using a Mineral Liberation Analysis (MLA-SEM) and X-ray diffraction (XRD). Elemental analysis of REEs was carried out using inductively coupled plasma mass spectrometry (ICP-MS). The results showed that the total REE content was 422 ppm in the iron ore, 305 ppm in the wet waste, and 272 ppm in the dry waste from the iron ore concentrate. Mineral liberation analysis indicated that the predominant gangue mineral is serpentine [$(Mg,Fe)_3Si_2O_5(OH)_4$], comprising 33.7 wt% of the sample. The REE-bearing mineral apatite was present in low abundance (0.13 wt%), while significant concentrations of silicate gangue minerals such as garnet (5.6 wt%), feldspars (9.24 wt%), and quartz (3.87 wt%) contribute to the overall mineralogical complexity.

Keywords: Rare earth elements, Iron ore, Concentrate waste, Mineralogy.

ESTIMATING THE IMPACT OF CLOUD COVER ON SOLAR ENERGY UTILIZATION IN MONGOLIA

Ganbold BOLDBAATAR[1], Jambajamts LKHAMJAV[1*]
[1]*Department of Meteorology and Hydrology, National University of Mongolia, Mongolia*
*E-mail: jambajamts@num.edu.mn

Abstract

According to national and international research organizations, the pace of climate change in Mongolia is quicker than in other parts of the world. The government is working to boost the usage of solar power in Mongolia, among other ways to adapt to this climate change. Our presenting work is to estimate the impact of cloud cover, which is one of the possible obstacles to the use of solar energy in the future. The cloud cover is responsible for balancing long-wave and short-wave radiation in the climate system. The study of solar energy resources in Mongolia is well done, but the study of cloud cover is incomplete and there is an urgent need to study the interrelationships. We are to investigate how cloud cover over time and determine the potential for using solar energy in Mongolia using data from the ERA5 reanalysis dataset.

Keywords: Climate change, Solar energy, Cloud cover, Energy resources

INVESTIGATION OF SLURRY RHEOLOGY FUNDAMENTALS, MEASUREMENTS AND APPLICATIONS IN THE MINING INDUSTRY

Batchimeg BATBAYAR[1*]
[1]*German-Mongolian Institute for Resources and Technology (GMIT), Nalaikh, Mongolia*
E-mail: batchimeg.sr@gmail.com

Abstract

The study of slurry rheology is essential as it plays a significant role in the mining industry. This presentation introduces the fundamental principles of rheology and explores the different types of rheological flow behaviour and their classifications. An overview of flow behaviour modelling and commonly employed measurement methods are also highlighted, along with practical applications of rheology in mining operations such as grinding, flotation, thickened slurry transportation, and tailings disposal design. In practical experimental settings, rheometric methods were utilized to specify the slurry's characteristics, emphasizing thorough assessments of yield stress, shear rate, and viscosity. The results are presented methodically, demonstrating their importance and relevance in slurry transportation systems and other associated processes. This investigation significantly adds to our knowledge of rheology and raises awareness of its fundamentals and uses. It might also help engineers learn more about this crucial topic and emphasize its importance to the mining sector in Mongolia. The study highlights how a thorough understanding of rheology can support efficient mining operations by illuminating the ramifications of rheological behaviors and features.

Keywords: Rheology, Slurry, Application, Mining

PROCESSING TECHNOLOGICAL SOLUTIONS FOR ACID MINE DRAINAGE OF COPPER ORE STOCKPILES (ON THE EXAMPLE OF ERDENET OVOO MINE)

Nergui NOSRON[1, 2, 3*], Ulziisaikhan NAIDANDORJ[3]
[1]*School of Geology and Mining, Mongolian University of Science and Technology, Ulaanbaatar, Mongolia*
[2]*Erdenet Institute of Technology, Mongolian University of Science and Technology, Erdenet, Mongolia*
[3]*Gal Sentii LLC, Erdenet, Mongolia*
*E-mail: Nergui.surgalt@gmail.com

Abstract

Acid mine drainage (AMD) is a serious environmental challenge commonly associated with mining operations, particularly those involving sulfide minerals. At the Erdenet Mining Corporation in Mongolia, AMD forms as acidic, metal-laden runoff from long-term accumulation of oxidized and sulfide ore stockpiles that are not processed within the main beneficiation circuit due to their low economic grade. These off-balance ores contribute to persistent AMD issues, posing risks to surrounding ecosystems and water resources due to high acidity and elevated heavy metal concentrations, especially copper. This study presents a comprehensive, research-driven approach to AMD remediation that simultaneously addresses environmental concerns and enables recovery of valuable metals. The proposed solution integrates field investigation, laboratory analysis, and pilot-scale testing to develop and validate a multi-stage AMD treatment system tailored for cold-climate mining conditions. The central component of the system is a three-stage, pressure-driven membrane filtration process, which demonstrated high efficiency in contaminant removal and copper concentration. Experimental results showed that the filtration process achieved over 95% removal of dissolved heavy metals and other pollutants, while concentrating copper content in the retentate stream. This made it suitable for subsequent metal recovery operations. To recover the concentrated copper, a solvent extraction–electrowinning (SX–EW) process was applied. Using LIX984N extractant in an 11-stage solvent extraction configuration, copper was efficiently separated and purified, achieving a recovery rate exceeding 90%. The copper concentration was reduced from 16.8 g/L to less than 2 g/L in the raffinate, indicating the effectiveness of the extraction process. Electrowinning further enabled the production of high-purity copper cathodes from the loaded organic phase, providing a value-added

product from what would otherwise be a waste stream. In addition to metal recovery, the treated water was successfully neutralized and met the Mongolian General Standard for Effluent Water (MNS 4943:2015), allowing for safe discharge or reuse in mining operations. The entire process was designed with considerations for operational efficiency, environmental sustainability, and economic feasibility. Its compact system layout, potential for automation, and adaptability to Mongolia's climate and mining conditions make it an attractive model for broader application. Based on pilot-scale performance, the integrated system is projected to recover up to 1,200 tonnes of copper annually, depending on the concentration and volume of AMD feed. The study demonstrates that coupling advanced membrane filtration with SX–EW technology not only mitigates environmental risks associated with AMD but also unlocks economic opportunities through metal recovery. This closed-loop approach represents a sustainable, technically viable solution for AMD management in the Mongolian mining sector and offers transferable insights for similar mining regions worldwide.

Keywords: Acid mine drainage, Membrane filtration, Solvent extraction

SIMULATION OF COPPER RECOVERY FROM ACID MINE DRAINAGE USING 3 STAGE MEMBRANE FILTRATION AND SX-EW PROCESS IN ASPEN PLUS

Nergui NOSRON[1, 2], Khuslen ANKHBAYAR[3], Bolor-Erdene BYAMBABASAN[3], Ulziisaikhan NAIDAN[2], Enkhbayar DONDOG[2], Zoljargal NARANBAATAR[3], Ganzorig CHIMED[3*]

[1]School of Geology and Mining, Mongolian University of Science and Technology Ulaanbaatar, Mongolia

[2]Gal Sentii LLC, Erdenet, Mongolia

[3]Center for Nanoscience and Nanotechnology, Department of Chemical and Biological Engineering, School of Engineering and Technology, National University of Mongolia, Mongolia

*E-mail: ch_ganzorig@num.edu.mn

Abstract

Aspen Plus software is employed to simulate and analyze copper recovery efficiency from acid mine drainage (AMD) generated at Gal Sentii LLC at Erdenet, Mongolia. The AMD originates from oxidized and sulfide ore stockpiles and contains high concentrations of dissolved copper and other contaminants. A three-stage membrane filtration process is modeled to concentrate copper ions from AMD, achieving over 95% contaminant removal. The concentrated retentate is further processed using a solvent extraction-electrowinning (SX-EW) method to recover metallic copper. Key parameters, including membrane selectivity, flow rates, temperature, and extraction stages, were optimized using Taguchi experimental design. The simulation considered the following variables: copper concentration in AMD (ppm), membrane pressure (bar), pH of feed solution, solvent-to-feed ratio, extraction temperature (°C), and number of extraction stages. Optimal conditions were found at a feed pH of 1.8, membrane pressure of 6 bar, and solvent-to-feed ratio of 2:1, resulting in a simulated copper recovery efficiency of over 92% across 11 extraction stages. The final treated water met national discharge standards. The integrated Aspen Plus model presents a technically viable strategy for AMD remediation and resource recovery, offering a replicable model for mining operations in cold-climate regions.

Keywords: Acid mine drainage, Aspen Plus simulation, Copper recovery, Membrane filtration, SX-EW, Taguchi method, Environmental remediation, Erdenet Mining

WATER HAMMERING IN SLURRY OF LIME DISTRIBUTION PIPELINE AT OYU TOLGOI, LLC

Turtsetseg NANJID[1], Odbileg NOROVRYENCHIN[2*], Sungchil LEE[2]
[1]*Oyu Tolgoi LLC, Mongolia*
[2]*Faculty of Mechanical and Electrical Engineering, German-Mongolian Institute for Resources and Technology (GMIT), Nalaikh, Mongolia*
*E-mail: odbileg@gmit.edu.mn

Abstract

This study investigates the transient hydraulic phenomena—specifically, the water hammer effect—within the slurry of lime distribution system utilized in the flotation circuit at Oyu Tolgoi LLC, a major copper concentrate production facility. The flotation process critically depends on the addition of slaked lime to regulate the pH level, making the integrity and reliability of the lime slurry distribution system vital for operational safety and economic efficiency. To analyze and mitigate the adverse impacts of water hammer, the dynamic hydraulic simulation software Wanda Engineering 4.5 was employed. This specialized tool enables high-fidelity transient flow modeling by simulating pressure surges resulting from abrupt changes in flow velocity, such as those induced by pump trips or rapid valve closures. In this study, the focus is confined to water hammer events triggered by valve closure scenarios. Key parameters investigated include valve type, valve closure duration and profile, and the solid concentration of the lime slurry. Simulation results underscore the sensitivity of pressure transients to these parameters. A stepwise valve closure profile—characterized by a rapid initial closure followed by a gradual final closure—proved most effective in attenuating pressure surges. Specifically, a stepwise closure over one second reduced peak pressure from approximately 2.9 bar (observed with uniform closure) to about 2.2 bar immediately upstream of the valve. Among the valve types studied, the butterfly valve exhibited the least pressure amplification under transient conditions, outperforming pinch, gate, and ball valves. A five-second closure of the butterfly valve resulted in a peak transient pressure of 2.053 bar, closely aligning with the steady-state pressure of 2.023 bar. These findings offer actionable insights for optimizing valve operation strategies and selecting appropriate valve types to minimize hydraulic transients and enhance the reliability of lime slurry distribution systems in mineral processing operations.

Keywords: Water hammer, Transient flow, Lime slurry, Hydraulic simulation, Wanda engineering 4.5, valve closure, Butterfly valve, Pressure surge, Copper flotation, Oyu Tolgoi.

VEGETATION-CLIMATE RESPONSES IN MINING AREAS IN THE MONGOLIAN PLATEAU

Urangoo BAASANDORJ[1], Nandin-Erdene GESERBAATAR[2], Gantuya GANBAT[1*]
[1]*Faculty of Raw Materials and Environmental Engineering, German-Mongolian Institute for Resources and Technology (GMIT), Nalaikh, Mongolia*
[2]*Information and Research Institute for Meteorology, Hydrology and Environment, Mongolia*
*E-mail: gantuya@gmit.edu.mn

Abstract

In recent decades, fluctuations in temperature, precipitation, and other climatic parameters have significantly influenced vegetation and land cover dynamics across the Mongolian Plateau. This study investigates long-term changes in climate and vegetation in selected mining-influenced areas of the Mongolian Plateau, including Umnugovi Province of southern Mongolia, adjacent regions of the Inner Mongolian Autonomous Region (China), the soums of Dornod Province in eastern Mongolia and their bordering settlements, as well as the northern soums of Selenge and Darkhan Provinces. The analysis is based on satellite-derived indicators, including the Normalized Difference Vegetation Index (NDVI) and Land Surface Temperature (LST) from the MODIS sensor onboard NASA's Terra satellite, spanning the period from 2000 to 2024. In addition, evapotranspiration (ET) data were incorporated to provide a more comprehensive understanding of vegetation-climate interactions.

Temporal trends and spatial patterns were analyzed using normalizing and standardized values of NDVI, LST, and ET. Based on these indicators, four distinct vegetation-climate response types were classified:

- Type I: high NDVI, low LST and ET, with low changes
- Type II: low NDVI, high LST and ET, with low changes
- Type III: high NDVI, low LST and ET, with high changes
- Type IV: low NDVI, high LST and ET, with high changes.

In Umnugovi Province and neighboring areas of Inner Mongolia, Type I and Type IV accounted for 18.9% and 37.4% of the total area, respectively. In eastern Mongolia (Dornod and adjacent settlements), Type I and Type IV covered 28.8% and 34.0%, respectively. The northern regions (Selenge and Darkhan) exhibited smaller proportions of these types, with 5.0% for Type I and 15.7% for Type IV. These classifications highlight the spatial heterogeneity in vegetation-climate responses under changing climatic conditions and emphasize the value of remote sensing data in informing regional environmental management, land-use policy, and climate adaptation strategies, particularly in mining-affected landscapes.

Keywords: Vegetation-climate response, Response types, Spatio-temporal analysis, Mongolian plateau

RESEARCH ON ZERO-WASTE TECHNOLOGY FOR IRON ORE BENEFICIATION AND PROCESSING

Lkhagvabaatar KHUZAABAYAR[1*], Chinzorig BAVUU[1], Sunjidmaa DANZANDORJ[2],
[1]*School of Geology and Mining Engineering, MUST, Mongolia*
[2]*School of Civil Engineering and Architecture, MUST, Mongolia*
E-mail: Lkhagvabaatar.kh@mrpam.gov.mn

Abstract

In Mongolia, the average waste yield from iron ore beneficiation plants currently operating in the economic cycle is around 45–50%. The waste generated by these plants often has a particle size of less than 10 mm. According to legal and regulatory requirements, mining waste must be stored in dedicated tailings facilities constructed with proper dams, and once a mine or plant is decommissioned, the site must be rehabilitated and handed over to the local authorities. This research explores the feasibility of developing a complete technology for processing iron ore and exporting the concentrate while producing a new type of thermal insulation construction material from the waste. The study is based on experimental research outcomes. According to national legislation, Mongolia is required to fully and comprehensively utilize mineral resources identified through geological exploration. To achieve this, resource utilization planning and beneficiation technology testing must be conducted, which serve as the basis for developing the technical and economic justification for mining projects.

Objective: To develop a zero-waste technology for comprehensive beneficiation and processing of iron ore. Tasks:

- To conduct a technological review of iron ore beneficiation plants
- To carry out experimental studies for producing thermal insulation materials from beneficiation waste
- To design a zero-waste technological flowchart for beneficiation and processing

The experimental work resulted in the development of a "zero-waste utilization technology scheme" for iron ore—covering utilization, beneficiation, and processing of tailings. Implementing this scheme in production will reduce reclamation costs, free up land occupied by tailings storage facilities for construction, and provide a foundation for the economic use of reclaimed land in agriculture and farming. As part of an ongoing iron ore mining and beneficiation project, the research team has expanded its focus. In collaboration with the Advanced Construction Materials and Structures Research Center of MUST, experimental studies have been carried out to produce a new type of thermal insulation construction material using waste generated from iron ore beneficiation plants. These studies have already yielded promising results.

Keywords: Waste, Insulation material, Efficiency

STRATEGIC STUDY OF TECHNOLOGY FOR THE DEVELOPMENT OF MINING-METALLURGY COMPLEX

Bolor-Erdene OTGONKHUU[1*]
[1]*School of Geology and Mining Engineering, Mongolian University of Science and Technology, Ulaanbaatar, Mongolia*
*E-mail: O.Boggie33@gmail.com

Abstract

The rapid development of mining, infrastructure, and construction industries in Mongolia has led to an increasing demand for ferrous metals and their derivative products. Currently, the majority of ferrous products are imported from abroad. Within Mongolia, the ferrous metallurgy sector is represented by entities such as the Darkhan Metallurgical Plant, the Erdenet Plant Repair and Mechanical Factory, and several smaller plants and workshops. These facilities produce steel and cast-iron products using scrap metal as the primary raw material in electric arc and induction furnaces. However, the availability of scrap metal, both domestically and internationally, has been steadily decreasing. Consequently, there is a growing necessity to shift towards using Mongolia's abundant iron ore reserves as the primary feedstock for steel production. Despite having approximately 1.8 billion tons of iron ore reserves, Mongolia has yet to establish a fully integrated iron and steel industry capable of processing these ores into finished steel products. Iron ore extracted by local companies is predominantly exported as raw ore or concentrates, bypassing the opportunity for further domestic processing.

Keywords: Iron ore, concentrate pellets, cast iron, Steel products

A STUDY ON THE TECHNOLOGY FOR PRODUCING THERMAL INSULATION MATERIAL FROM IRON ORE BENEFICIATION PLANT WASTE

Sunjidmaa DANZANDORJ[1*], Chinzorig BAVUU[2], Lkhagvabaatar KHUZAABAYAR[2]
[1]*School of Civil Engineering and Architecture, MUST, Mongolia*
[2]*School of Mining Engineering, MUST, Mongolia*
*E-mail: sunjidmaa@must.edu.mn

Abstract

This research paper examines three types of waste from different iron ore beneficiation plants in Mongolia, which differ in mineral composition. The purpose of this is to produce thermal insulation materials from these tailings by developing a simple method for creating porous structures. The optimal firing temperatures, the effect of fluxing additives, and the methods for creating porosity were studied. The waste materials were sourced of the Bargilt iron ore beneficiation plant in Darkhan soum, Khentii province; the Tumurtiin-Ovoo zinc-iron ore deposit in Sukhbaatar soum, Sukhbaatar province; and the Bayangol iron ore deposit in Yeruu soum, Selenge province. According to the test results Bargilt waste mainly consists of magnetite, mica, and zeolite, Bayangol waste mainly includes of quartz, feldspar, and mica, Tumurtiin-Ovoo waste primarily contains quartz, albite, and iron minerals. By firing Bargilt waste at 1000°C without additives, a porous material with average density of 1000 kg/m3 and thermal conductivity of 0.11 W/m·K was obtained. From Bayangol waste, when fired at a temperature of 1000 °C with fluxing additives, a porous material with an average density of 800 kg/m3 and a thermal conductivity coefficient of 0.085 W/m•K was obtained, and from Tumurtiyn-Ovoo waste with fluxing additives, a porous material with an average density of 500 kg/m3 and a thermal conductivity coefficient of 0.095 W/m•K was obtained. Window glass waste was used as fluxing additives in the amount of 20%. The porous structure was created before firing by a chemical reaction between aluminum powder and alkali. Keywords: Compressive strength, Porous structure, Mining waste, SEM, XRD, Thermal conductivity.

NIGHTTIME LIGHT AS A PROXY FOR SOCIOECONOMIC AND ENVIRONMENTAL CHANGE IN URBAN AND MINING CONTEXTS

Munkh-Erdene TUVSHINKHUU[1], Enkhjargal SODNOMDARJAA[1], Gantuya GANBAT[1*]
[1]*Faculty of Raw Materials and Environmental Engineering, German Mongolian Institute for Resources and Technology (GMIT), Nalaikh, Mongolia*
*E-mail: gantuya@gmit.edu.mn

Abstract

This study applies data from Nighttime Light (NTL) alongside socioeconomic and environmental parameters to examine two contrasting locations in Mongolia: the urban region of Ulaanbaatar city and the Energy Resource LLC (ER) open-pit coking coal mining site. The primary objective is to evaluate the extent to which NTL intensity correlates with key indicators such as Gross Domestic Product (GDP), population, Energy use per capita (EUPC), and carbon dioxide (CO2) emissions. Spatial and temporal analysis of NTL patterns reveal a strong relationship between light intensity and the socioeconomic variables considered. In Ulaanbaatar, NTL data captures patterns of urban expansion and aligns closely with trends in economic development and demographic growth. In contrast, the NTL signature at the ER mining site, the NTL data illustrates activity zones and infrastructure related to coal extraction, reflecting a more variable pattern sensitive to market dynamics and logistic changes. The study further explores innovative interpretations of NTL in both urban and industrial contexts. Urban NTL patterns typically represent complex, large-scale mixed-use lighting environments, while mining-related NTL can distinctly identify functional areas, such as extraction zones and transport corridors. The COVID-19 pandemic period provided a unique lens, revealing a decoupling between NTL and traditional indicators: despite notable declines in GDP, CO2 emissions, energy consumption declined during the pandemic, NTL and population remained relatively stable. This suggests limitations in the use of NTL as a proxy indicator during periods of global disruption. Overall, the results highlight the value of NTL data as both a quantitative metric and a visual diagnostic tool for spatial planning and monitoring in urban and industrial settings. Its relevance is particularly pronounced in data-scarce regions such as Mongolia, where official statistics may be limited, delayed, or inconsistent.

Keywords: Nighttime light data, Mongolia, Mine area, Correlation analysis.

STUDY ON THE PRODUCTION OF TRIPLE SUPERPHOSPHATE (TSP) FERTILIZER FROM PHOSPHATE CONCENTRATE BY ACID LEACHING METHOD

Davaabal BATMUNKH[1], Javzandulam CHULUUNTUMUR[1], Bayarzul UYAT[1], Oyun-Erdene GENDENJAMTS[1], Altantuya OCHIRKHUYAG[1*]
[1]*Laboratory for Advanced Materials Chemistry and Technology, Institute of Chemistry and Chemical Technology, Mongolian Academy of Sciences, Mongolia*
*E-mail: altantuya_o@mas.ac.mn

Abstract

More than 60 phosphate deposits and occurrences have been identified in Mongolia, and geological exploration works have been conducted; however, no beneficiation and processing plants have been established to date. In 2023, the total fertilizer usage nationwide was 6,110 tons, increasing to 12,500 tons in 2024, which is 20–30 times lower than required levels for the agricultural sector. This indicates an urgent need to develop domestic mineral and compound fertilizer production, enhance food security, and improve soil fertility. This research thoroughly investigated the composition and physicochemical properties of phosphate concentrate obtained by flotation from the Burenkhaan phosphorite deposit in Khuvsgul Province. The concentrate was subsequently processed through acid leaching to establish a technological process for producing triple superphosphate (TSP) fertilizer. The concentrate used in this study contained 35.91% P_2O_5, 50.53% CaO, and 78.47% BPL, predominantly composed of fluorapatite ($Ca_{10}(PO_4)_6F_2$ – 77.1%) and quartz (SiO_2 – 8.6%). Processing this concentrate with 40–60% phosphoric acid (H_3PO_4) at temperatures of 80–100°C, agitation speeds of 100–200 rpm, and durations of

5–20 minutes yielded high-quality triple superphosphate fertilizer. The resulting TSP fertilizer exhibited total P_2O_5 contents ranging from 42.85–55.28%, 100% plant-available phosphate, and 92.45–100% water-soluble phosphate. These findings demonstrate the feasibility of chemically processing Burenkhaan phosphate concentrate to produce highly effective phosphate fertilizers fully absorbable by soils and plants. Implementing this technology will contribute significantly to the development of the domestic chemical industry, substitution of fertilizer imports, and sustainable agricultural growth.

Keywords: Phosphate mineral, Triple superphosphate, Fertilizer, Agriculture

BASELINE STUDY AND DESIGN SOLUTIONS FOR THE TAILINGS STORAGE FACILITY PROJECT OF THE MINERAL PROCESSING PLANT

Otgon MARUUSH[1*], Chinzorig BAVUU[1*]
[1]School of Geology and Mining Engineering, Mongolian University of Science and Technology, Mongolia
*E-mail: otgon@erdenetmc.mn, chinzorigb@must.edu.mn

Abstract

Tailings management is an essential aspect of mineral beneficiation, ensuring safe disposal and water recirculation. The Erdenet Mining Corporation, Mongolia's largest copper-molybdenum operation, has deposited over 936 million tonnes of tailings since 1978, relying on outdated upstream dam design. With increasing processing capacity—expected to reach 40 Mt/year by 2026—tailings storage poses significant environmental and geotechnical risks, particularly in light of past dam failures worldwide. This study presents a comprehensive baseline assessment of Erdenet's current tailings storage system, evaluating legacy geotechnical data, dam safety, and water recovery inefficiencies. It benchmarks global standards, including GISTM (2020), ANCOLD (2019), and CDA (2014), to identify compliance gaps and risk reduction opportunities. A key finding is the inadequacy of seismic safety under current configurations, confirmed by independent assessments (e.g., ATCW, 2023). To address future needs, the study proposes a new tailings facility design based on Thickened Tailings Deposition (TTD) technology. TTD enables higher solids content (60–62%) via high rate thickeners, leading to enhanced dam stability, reduced water consumption (up to 85-90% reuse), lower dust emissions, and a smaller environmental footprint. The design concept is aligned with global best practices and tailored to the geological constraints of the Erdenet mine site. This research contributes a practical, future-ready model for safe and sustainable tailings storage in large-scale mining, balancing environmental, technical, and social factors.

Keywords: Tailings management, Thickened tailings, GISTM, Geotechnical stability

UNSEEN THREATS: SOIL POLLUTION FROM HOUSEHOLD ASH IN NALAIKH'S GER DISTRICTS

Enkhjargal SODNOMDARJAA[1*], Martin KNIPPERTZ[2]
[1]Faculty of Raw Materials and Environmental Engineering, German-Mongolian Institute for Resources and Technology (GMIT), Nalaikh, Mongolia
[2]Department of Geography, Chair of Physical Geography and Geoecology, RWTH Aachen University, Aachen, Germany
*E-mail: enkhjargal@gmit.edu.mn

Abstract

Rapid urban expansion, poor waste management practices, and a reliance on coal-based energy sources have contributed significantly to soil pollution in Mongolia's urban ger districts. This study investigates the environmental risks posed by ash disposal from household coal burning in the Nalaikh district of Ulaanbaatar, focusing on heavy metal pollution of soils. Nalaikh, a historically important coal mining region located 35 km east of Ulaanbaatar, faces a unique combination of legacy mining impacts and growing residential pressure, particularly in the ger settlements that

house approximately 75% of the district's population. During the winter months, households in ger districts typically burn around up to 25 kg of coal daily, producing around 5 kg of ash/day. Due to limited municipal waste services, this ash is often stored on private land or temporarily dumped in surrounding areas. The ash contains high concentrations of hazardous substances, including heavy metals such as Pb, Zn, Cu, and As, which can migrate into the soil and pose significant health and environmental risks. This study employed a multi-method approach to assess the extent of soil pollution from ash. A total of 45 samples (surface soil, soil-ash mixtures, and pure ash) were collected from 15 locations across the district. The samples were analyzed using portable X-ray fluorescence (pXRF) and Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES). Results revealed elevated concentrations of heavy metals, with some ash samples showing lead (Pb) levels of up to 2950 mg/kg, almost 50 times higher than the national soil quality standards. Spatial analysis showed pollution hotspots near informal ash dumps, former mining sites, and household heating zones. In addition to the laboratory analysis, a household survey was conducted to collect data on coal use patterns, ash management practices, and awareness of environmental impacts. The findings highlight both the scale of the problem and the lack of public awareness and infrastructure for safe ash disposal. The study underscores the urgent need for improved solid waste management strategies in Mongolia's ger districts, including the introduction of safer fuel alternatives, targeted soil remediation efforts, and policy interventions that support sustainable waste handling in residential areas. The results contribute to the broader discourse on green development and circular economy by identifying opportunities for recycling and resource recovery from household ash, while informing evidence-based policy to mitigate environmental and public health risks in urban Mongolia.

Keywords: Coal ash, Ger districts, Soil contamination, Heavy metals.

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