**Brief information about the project**

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| Title | IRN AP25794605<br>"Purification of mercury ions in wastewater using a composite membrane based on MXene-nanocellulose" |
| Relevance | The presented research proposes a synergistic approach to simultaneously address solid waste management and wastewater treatment, while promoting sustainability and circular economy principles. The scientific innovation is the use of rice husk as a rich source of cellulose for the construction of a complex membrane. The membrane, including nanocellulose as the base and 2D MXene as the diffusion phase, aims to efficiently recover mercury (Hg2+) from contaminated water. |
| Goal | The aim of the research project is to design and develop an advanced composite membrane for highly efficient removal of mercury ions from contaminated water sources. The project focuses on two main aspects: the extraction of nanocellulose from rice husk, an agricultural product that serves as a stable matrix for the membrane, and the strategic integration of MXene materials to improve the structural and adsorption properties of the membrane. |
| Tasks | The research project aims to provide a comprehensive understanding of the synthesis, characterization, and optimization of MXene nanocellulose composite membranes for efficient removal of mercury ions in water treatment:<br>1. Extraction of nanocellulose from rice husk:<br>✓ To study various experimental conditions for the extraction of nanocellulose from rice husk, including acid hydrolysis and enzymatic processes.<br>✓ To optimize parameters such as temperature, reaction time, and reagent concentration to increase the yield and quality of nanocellulose.<br>2. Extraction of MXene from the Max phase:<br>✓ To study the synthesis of MXene from the Max phase based on transition metal carbides (TMCs) or transition metal nitrides (TMNs).<br>✓ To study the doping conditions, including the choice of dopant, doping time, and temperature, to achieve optimal MXene properties.<br>3. Fusion of nanocellulose and MXene for composite membranes:<br>✓ To develop a methodology for the integration of nanocellulose and MXene to form a composite membrane.<br>✓ Optimize the ratio of nanocellulose to MXene to achieve a balance between structural integrity and adsorption capacity.<br>4. Water purification experiments from mercury ions:<br>✓ Conduct water purification experiments using MXene/nanocellulose composite membrane, focusing on mercury ions in the concentration range of 5-50 mg/L.<br>✓ Study the membrane separation conditions, including pressure, pH, membrane thickness and MXene loading (0.5-2 wt.%), to determine their effects on the efficiency of mercury ion removal.<br>5. Optimization of experimental parameters:<br>✓ Systematic optimization of experimental parameters based on the characteristics of the composite membrane when removing mercury ions.<br>✓ Evaluate and adjust conditions such as pressure, pH and MXene loading to improve membrane efficiency.<br>6. Optimized composite membrane reuse cycles:<br>✓ Evaluate the stability and reuse of the optimized composite membrane during multiple water purification cycles. |

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| | ✓ Investigate the flow stability, structural integrity, and adsorption capacity to ensure the long-term viability of the composite membrane for reuse. |
| Expected and Achieved Results | These studies are aimed at obtaining fundamental data and demonstrate the unique adsorption capacity of MXene for hazardous mercury ions in water. The project also aims to develop an optimized method for obtaining MXene-nanocellulose composite membranes by carefully studying the membrane thickness and loading ratio of MXene nanolayers. The proposed low-cost and effective method for the purification of mercury ions, which is an alternative to existing technologies, is of considerable importance for the filing of patent applications.<br><br>- The synthesized product is of significant importance in various industries, from metallurgical chemistry to pharmaceuticals, where effective purification of wastewater from mercury and other heavy metals is the key to optimizing production and sustainability.<br><br>- The results of the study are widely used in Kazakhstan for wastewater treatment and water treatment, contributing to environmental restoration and obtaining a huge profit from tons of rice husk.<br><br>- The socio-economic impact will be twofold: firstly, it will contribute to achieving the common goal of preventing/reducing wastewater pollution and increasing the value of industrial waste; secondly, it will contribute to opening up new opportunities for the modernization of the Kazakhstani rice husk processing and wastewater treatment industry.<br><br>Publications in peer-reviewed international scientific journals<br><br>During the project implementation period, it is planned to publish articles in peer-reviewed foreign or domestic publications recommended by the Science Committee of the Ministry of Science and Technology of the Republic of Kazakhstan. The requirements for the number of articles based on the research results are set out in the Competition documentation. Each article will contain information about the name of the project for which it was funded, indicating the identification registration number (STN) and the source of grant funding.<br><br>Science of the Total Environment (Elsevier, Q1, percentile 95), Journal of Environmental Management (Elsevier, Q1, percentile 96), Journal of Cleaner Production (Elsevier, Q1, percentile 99), Molecules (MDPI, Q1, percentile 78), International Molecular Journal Sciences (MDPI, Q1, percentile 87), Journal of Molecular Liquids (Elsevier, Q1, percentile 92) and other relevant journals according to the requirements of the competition documentation:<br><br>- At least 2 (two) articles and (or) reviews in peer-reviewed scientific publications that are included in the top 3 (three) quartiles in terms of impact factor in the Web of Science database and (or) have at least 50 (fifty) percentile in Citescore in the Scopus database. |
| Names and Surnames of Research Group Members with Their Identifiers (Scopus Author ID, Researcher ID, ORCID, if available) and Links to Corresponding Profiles | Suleimenova Madina,<br><br>Master of Chemical Technology,<br><br>PhD Candidate<br><br>Hirsch Index - 0<br><br>ORCID - https://orcid.org/0000-0001-9113-1687<br><br>Scopus Author ID: 58235548000 |

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| Publications list with links to them | 1. **Suleimenova M, Zharylkan S. Mekenova M, Mutushev A. Azat S, Tolepova A, Baimenov A, Satayeva A, Tauanov Z. Fusion-assisted Hydrothermal Synthesis of Technogenic Waste Derived Zeolites and Nanocomposites: Synthesis, Characterization, and Mercury (II) Adsorption. Sustainability MDPI journal.** ***Engineered Science*** **Accepted[https://doi.org/10.3390/ijms241411317](https://doi.org/10.3390/ijms241411317)**<br>2. Zharylkan S., Sultakhan S., **Suleimenova M.,** Azat S., Sailaukhanuly Y., Tulepov M., **Tauanov Z.** Enhanced Adsorption of Mercury and Methylene Blue Using Silver and Surface Modified Zeolite-NaX derived from Rice Husk.*Engineered Science* (accepted for publication 2024) https://doi.org/10.30919/es1241<br>3. **Сулейменова М.**, Жарылкан С., Мекенова М., Толепова А., Мутушев А., Азат С., **Тауанов Ж.** «Получение синтетического цеолита и нанокомпозита из рисовой шелухи для удаления ионов ртути из воды». Химический бюллетень Вестник КазНУ, рекомендуемый КОКСНВО МОН РК, 2023. Издательство 2-3, том 109. https://doi.org/10.15328/cb1323 |
| Patent information | - |