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A SELECTIVE MOF-MODIFIED MEMBRANE FOR LITHIUM EXTRACTION

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Introduction. Over the last decades, lithium has become the «Energy Metal of the 21st Century» [1] due to the rapidly increasing demand for this resource, driven by the widespread adoption of electric vehicles and advanced electronics that rely on lithium-ion batteries. By 2030, the demand for lithium is projected to be twice the amount of currently confirmed supply [2]. That is why exploring additional lithium sources is essential. A selective membrane offers a promising path of overcoming the stated deficiency by enabling the recovery of lithium from unconventional sources, such as enriched by lithium wastewaters from oil and gas condensate fields.

Body part of the report summary. This research aims to extract lithium using membrane technology (a direct lithium extraction process) as the extractor module. This innovative approach will allow oil-producing companies to generate additional revenue by recovering high-purity lithium from the associated wastewaters produced in oil and gas condensate fields.

The proposed multi-layer composite membrane is based on polyamide (PA) and is modified with a metal-organic framework zeolitic imidazolate framework-8 (ZIF-8). PA serves as a cost-effective and stable support material for metal-organic frameworks, maintaining its integrity during the metal-extraction process. ZIF-8 was chosen for its ion-selective separation capabilities, attributing to its uniform porosity, suitable size properties, and large surface area, all of which make it exceptionally well-suited for lithium recovery applications [3].

To incorporate ZIF-8 onto the membrane surface, we employed a hydrothermal modification technique. This process was repeated multiple times to ensure the formation of a continuous ZIF-8 layer across the entire membrane, as it is crucial for achieving the desired selectivity.

The consequent analysis of membranes by the means of Fourier transform infrared spectroscopy, Scanning electron microscopy, and Energy-dispersive X-ray spectroscopy confirmed the successful synthesis, revealing the presence of ZIF-8 layer on the surface of membranes. Subsequently, all synthesised modifications were compared based on their selectivity towards lithium ions – primary selectivity tests in a model of an electrochemical cell were carried out for membranes, incorporating from 1 up to 10 ZIF-8 layers. The obtained results allowed us to conclude on the most promising modification.

Conclusions. We conducted a thorough analysis of lithium extraction methodologies, resulting in the identification of the ion-selective membrane as the most promising approach for extracting lithium from oilfield waters. Afterwards, we explored practical modifications to the multi-layer membrane to achieve desired selectivity parameters.

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References:

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