

## DIRECT LITHIUM EXTRACTION APPROACH BASED ON MOF MEMBRANE

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**Introduction.** Lithium is considered to be the «Energy Metal of the 21st Century» as the demand for this valuable metal has been rapidly increasing due to the widespread adoption of electric vehicles and advanced electronics that rely on lithium-ion batteries [1]. Nowadays, we are approaching a stage at which the desired quantities of metal will be unattainable using existing conventional extraction technologies. For example, investment agencies predict that demand for lithium will double the current confirmed supply by 2030. Furthermore, the market of lithium-ion batteries is expected to grow at an annual compound rate of up to 30% [2].

**Body part of the report summary.** This research focuses on developing a direct lithium extraction technology based on a highly selective metal-organic framework (MOF) membrane. The membrane can be used to extract lithium from unconventional brine sources in the Russian Federation, particularly – from oilfield wastewaters.

The membrane is based on a polymer substrate and is modified with a selective towards lithium metal-organic framework [3]. The modification process was repeated multiple times and resulted in a formation of a multi-layer composite structure. Notably, with the introduction of additional coating, the progressively smoother membrane surface was observed: MOF crystals grew to be embedded with one another to produce a tight, continuous, and defect-free film layer.

The unmodified substrate and the MOF-modified membranes were characterized using X-ray diffraction, Fourier-transform infrared spectroscopy, scanning electron microscopy, and energy-dispersive X-ray spectroscopy. The presence of MOF on the membrane surface confirmed the successful synthesis workflow. Subsequently, the various membrane modifications were evaluated in terms of their lithium-ion selectivity and permeability using an electrochemical cell, with membranes containing between one and ten MOF layers being compared. Based on these results, the modification with the most optimal balance between the selectivity and permeability was identified for further tests in terms of  $\text{Li}_2\text{CO}_3$  production.

**Conclusions.** Developed membranes present a highly promising solution for extracting lithium from aqueous sources, including the lithium-enriched brines from oil and gas condensate fields. Furthermore, the approach outlined for the production of a selective MOF membrane is simple and can be effectively scaled up. Therefore, in order to address the predicted lithium shortage in the market and to enable the subsequent real-world use of the membrane, the future research will primarily focus on validating the proposed technology in terms of its industrial applicability.

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### References:

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2. International Energy Agency, The Role of Critical World Energy Outlook Special Report Minerals in Clean Energy Transitions.
3. Tian X. et al. Enhancing Membrane Materials for Efficient Li Recycling and Recovery // *Advanced Materials*. 2025. Vol. 37, No 5.