Evaluation of Membrane Filtration for the Reuse of Washing Agents in Diesel Spill Remediation

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Key words: humic substances, oil pollution, washing agents, membranes, surfactant

In 2020, a massive diesel fuel spill in the Norilsk region of Russia caused widespread environmental damage, highlighting the need for more efficient fuel spill remediation techniques. Traditional cleanup methods, including the use of washing agents, often lead to secondary pollution and increased waste. To mitigate this, the reuse of washing agents through membrane technology has gained attention as a promising solution. This study focuses on testing various membranes to determine their effectiveness in filtering contaminated washing agents, with the goal of improving diesel spill cleanup efficiency while minimizing environmental impact.

The aim of this work was to test various membranes against contaminated washing agents to identify the best membranes in terms of speed and effectiveness in removing diesel from the contaminated agents.

In the first series of experiments, studies were conducted using a range of polysulfonamide membranes: UMP-100, UPM-200, and UPM-500, which filter based on particle mass. The UMP-100 membrane allows particles with a mass of up to 100 kDa, UPM-200 allows up to 200 kDa, and UPM-500 up to 500 kDa. The UMP-100 membrane is designed for ultrafiltration, while the UPM-500 is used for microfiltration. These membranes were purchased from Vladipor Ltd. Additionally, in experiments involving ceramic filtration, a membrane made of Al_2O_3 with a pore size of 0.05 micrometers was used. This ceramic membrane was sourced from Keramicfiltr Ltd.

Table 1 – Diesel fuel removal effectiveness using different membranes

Membrane name	Diesel fuel removal effectiveness, %	SD (n = 3), %
UPM-500	29	10
UPM -200	85	5

According to the data, the UPM-500 membrane allows some diesel to pass through, while UPM-200 completely blocks diesel but fully allows Tween-80. UPM-100 also fully blocks diesel but allows only about half of the Tween-80.

The UPM-200 membrane is the most suitable for filtration, as it blocks diesel but lets Tween-80 pass. However, its low filtration rate of around 1 ml/min is a drawback, leading to the search for a more efficient membrane.

In experiments with a ceramic membrane made of Al_2O_3 with 0.05 μm pores, 2 liters of eluate containing ~1% Tween-80 and 0.2-0.3% diesel were filtered. The ceramic membrane was able to separate diesel with 44% efficiency, reducing its concentration. The membrane's throughput was 3.6-4.8 L/hour.

The UPM-200 membrane proved most effective in removing diesel (85%) while allowing Tween-80 to pass, though its slow filtration rate limits its practicality. The ceramic membrane, with lower diesel removal (44%) but higher throughput, offers potential for faster processing. Future work should aim to optimize membrane performance to improve both efficiency and speed, enhancing the economic viability of diesel spill cleanup.

Acknowledgements: This research was financially supported by state budgetary task 122040600057-3