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Treatment of Landfill Leachate using Membranes: Pilot-Scale Assessment

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ABSTRACT

Write your abstract of 400 words

A pilot study was conducted to evaluate the feasibility of membrane-based treatment for high-strength landfill leachate containing elevated concentrations of ammonia (~2,700 mg/L), total dissolved solids (>13,000 mg/L), organics, and PFAS compounds. The goal was to achieve treated water quality suitable for land irrigation, with a targeted treatment capacity of 250 kL/day.

Two membrane types were tested: a seawater reverse osmosis (SWRO) membrane and a high-rejection nanofiltration membrane (NF90). The most stringent target was 0.5 mg/L ammonia in the permeate, and this parameter significantly influenced the test method and subsequent process design. As a result, pre-treatment included acidification (pH 6.0–6.5 using sulfuric acid) to enhance ammonia rejection as ammonium, and also minimise calcite scaling potential. Both membranes were operated under controlled flux conditions at constant pressure with concentrate recycling. Flux decline was monitored as the osmotic pressure increased.

The SWRO membrane achieved 75% recovery at 58 bar, with strong rejection of TDS, metals, and PFAS. However, ammonia concentrations in the permeate (~61 mg/L) exceeded discharge limits (0.5 mg/L). The NF90 membrane achieved 70% recovery at a lower pressure (39 bar). This offered reduced energy consumption but produced a larger waste stream and achieved insufficient ammonia rejection (99 mg/L). SWRO was selected as the membrane process option for subsequent assessment and design.

Break point chlorination and second-pass RO were identified as candidate post-treatment steps to meet ammonia discharge requirements. Breakpoint chlorination was selected based on a techno-economic comparison of options.

The study demonstrated that a membrane-based approach can effectively treat complex leachate when coupled with tailored pre-treatment and ammonia polishing. The

collected data provided a robust basis for full-scale system design, offering an adaptable framework for similar applications treating high-strength leachate to meet strict discharge criteria.

KEY WORDS

Include any key words

Reverse Osmosis, Nanofiltration, Leachate, Wastewater, Advanced Wastewater Treatment

BIOGRAPHY

Include a short biographical (100 words) for the presenting author

Jonathan Quintanar Velasco is a Project Engineer with over 10 years of experience in water and wastewater treatment across industrial and municipal sectors. He holds a Chemical Engineering degree from the National Autonomous University of Mexico and Master's degrees in Engineering and Project Management from the Queensland University of Technology. Jonathan has international professional experience in Mexico, France, and Australia. His expertise includes process design, pilot testing, commissioning, and optimisation of membrane, filtration, and advanced water and wastewater treatment systems.

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