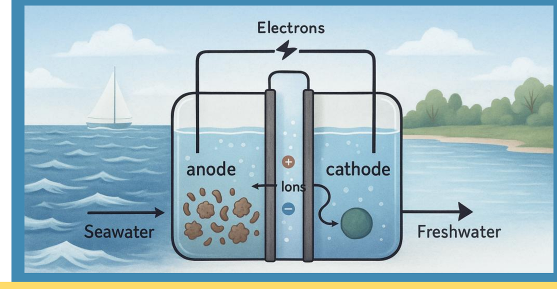
Perovskite-based catalyst for sustainable wastewater treatment and seawater desalination through microbial desalination cell



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Background and Motivation

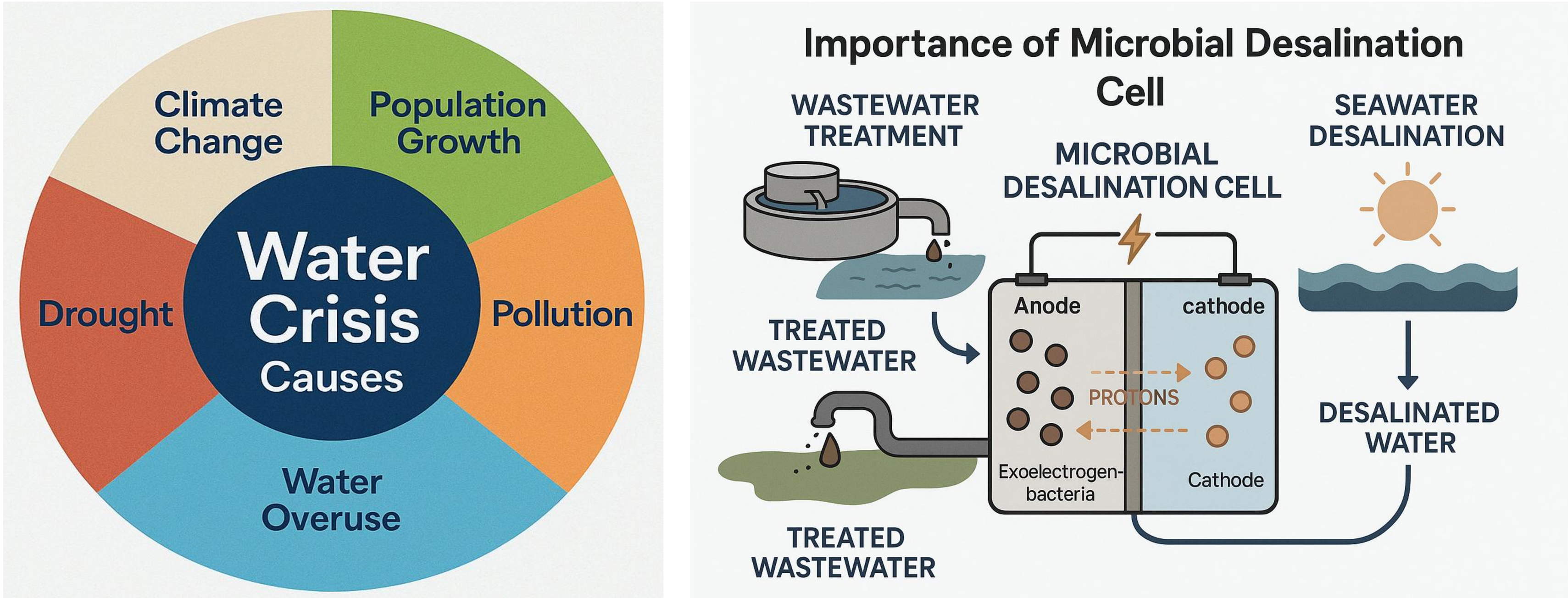


Figure 1. Water crisis and Microbial Desalination Cell as one of the solutions to this probler

Objectives

- Synthesis of cathode catalyst for enhancing the oxygen reduction reaction of the microbial desalination cell through catalyst incorporation.
- Performance evaluation regarding Desalination efficiency, Normalized energy recovery, and Chemical Oxygen Demand removal.

Materials and Methods

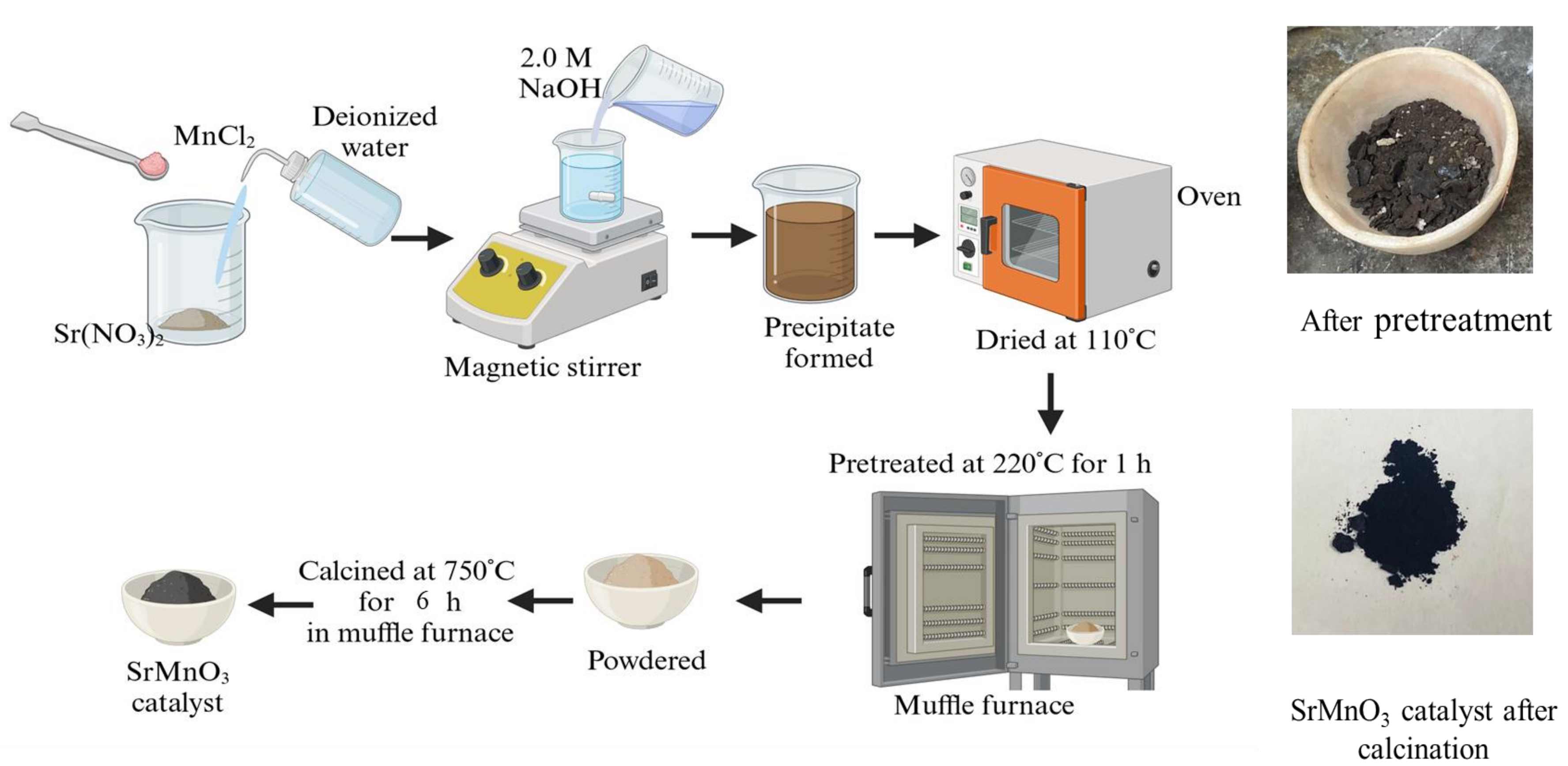


Figure 2. Catalyst preparation to be used as a cathode catalyst

- Catalyst was coated on the cathode.
- Wastewater with chemical oxygen demand of 3000 mg/L and saltwater of seawater concentration 35g/L was provided as influent with a hydraulic retention time of 4 days.

Results and Discussion

- For 35 g/L initial salt concentration, chemical oxygen demand removal was observed approx 82%, while about 84% of desalination efficiency was found (38 % higher) compared to the controlled microbial desalination cell. Normalized energy recovery was 0.44 kWh/m^3.

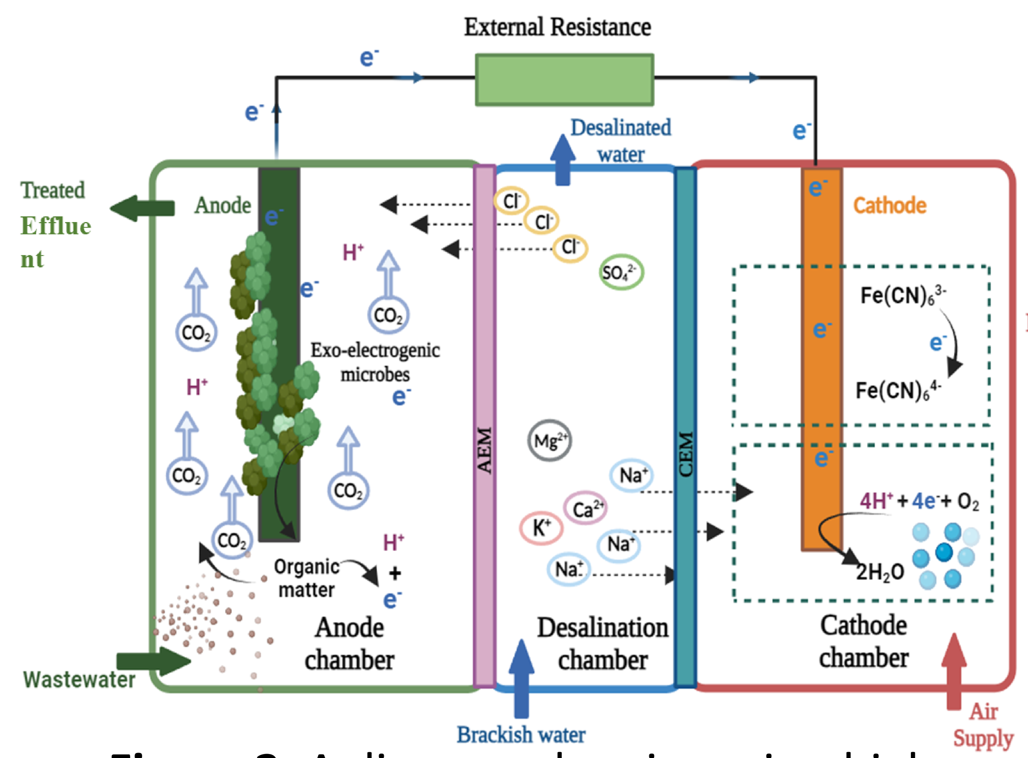


Figure 3. A diagram showing microbial desalination cell set-up

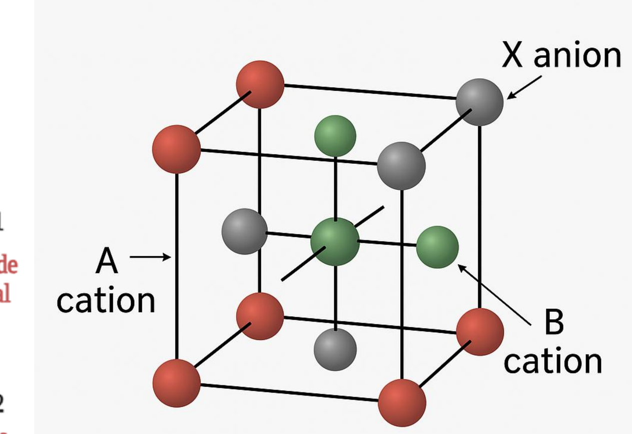


Figure 3. Perovskite structure

Figure 4.

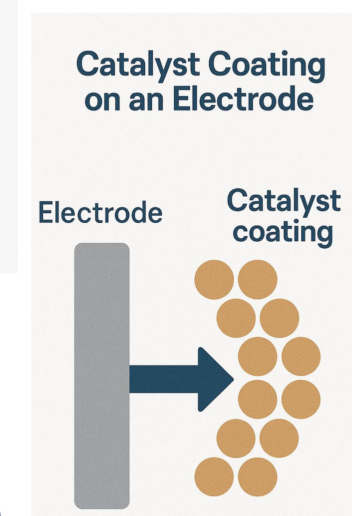
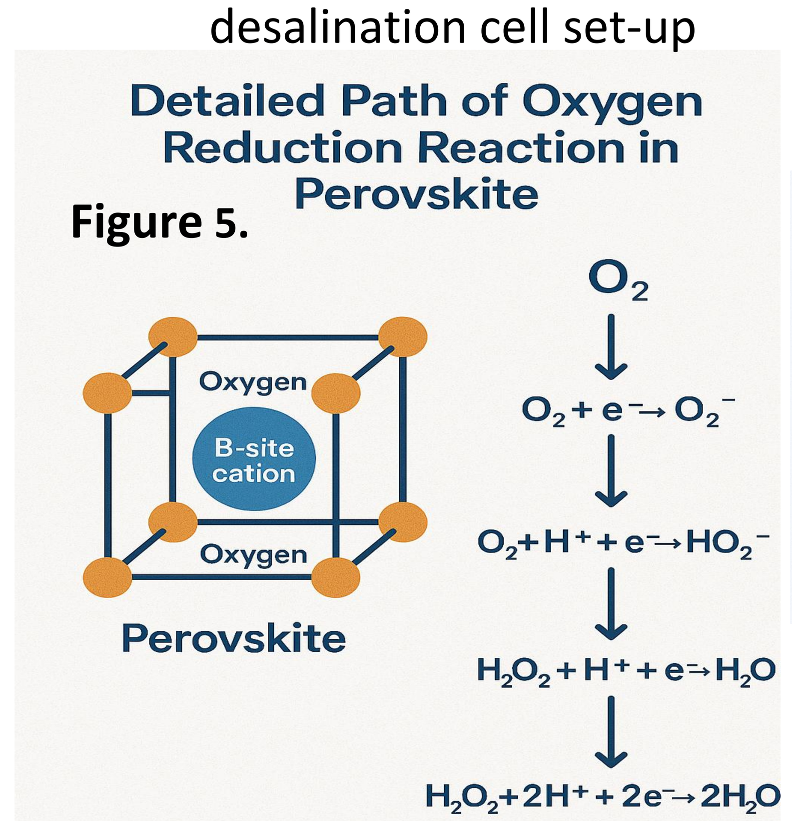


Figure 5.



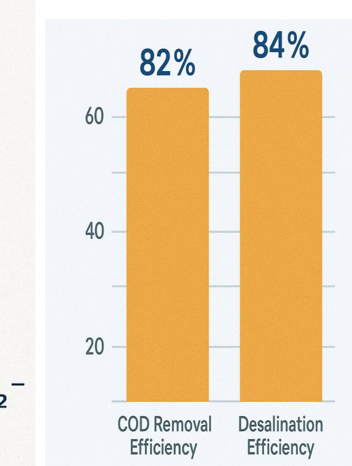


Figure 6. Bar-graph

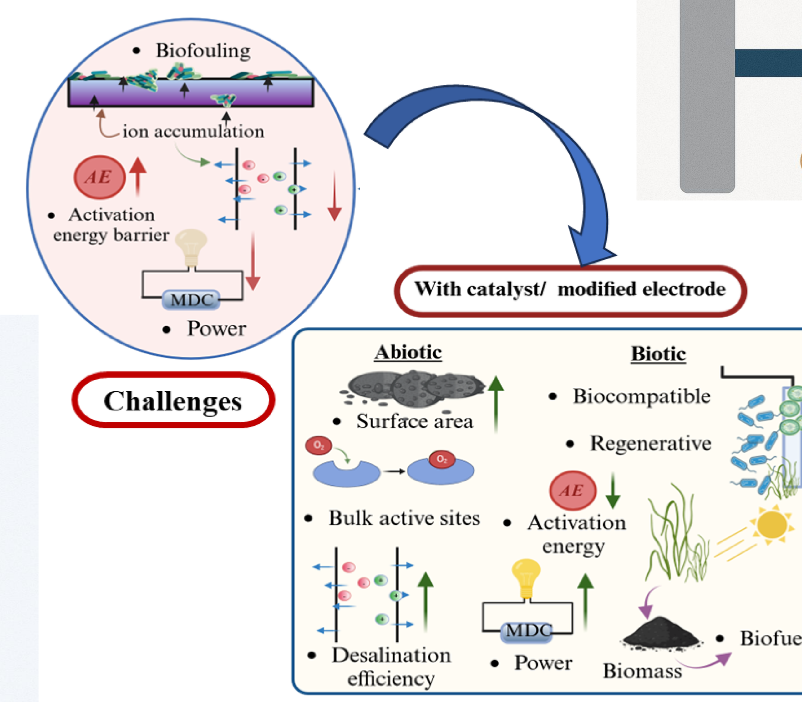


Figure 7. Challenges overcome by the use of a cathode catalyst

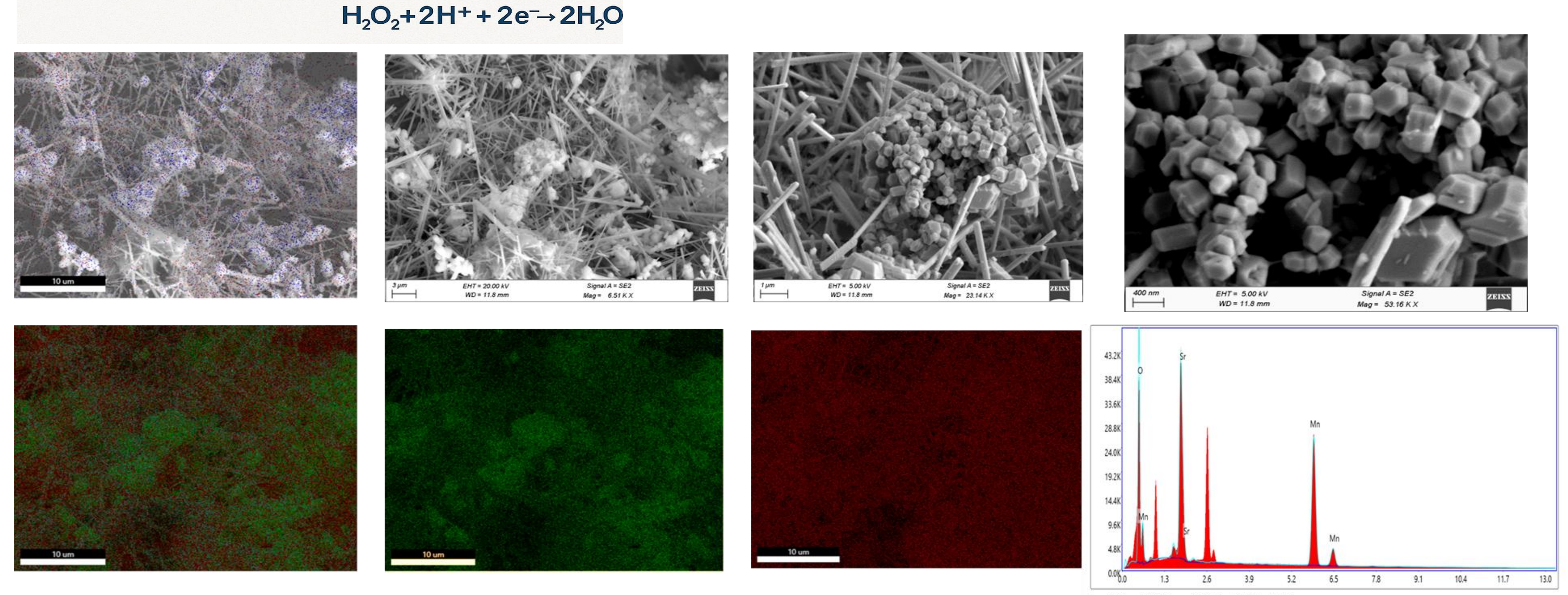


Figure 8. Scanning electron microscopy images at 10 µm, 3 µm, 1 µm, and 400nm, EDAX of the SEM image at 3 µm, and EDAX report of the selected area

Conclusions

- ✅ **Dual Functionality**: MDCs effectively integrate wastewater treatment and desalination, offering a sustainable solution to two major global water challenges.
- ⚡ **Energy Recovery**: These systems generate electricity from organic matter in wastewater, reducing the need for external power sources compared to traditional desalination methods.
- ♻️ **Environmental Sustainability**: By utilizing naturally occurring microbes and avoiding harmful chemicals, MDCs offer an eco-friendly alternative with minimal carbon footprint.
- 💧 **High Desalination Efficiency**: MDCs can significantly reduce salinity levels in seawater, making them suitable for producing potable water.
- 🧪 **Effective Pollutant Removal**: They simultaneously remove organic pollutants from wastewater, improving effluent quality and complying with environmental discharge standards.
- 💰 **Cost-Effective Potential**: With ongoing advancements, MDCs promise lower operational and maintenance costs due to self-sustaining bioelectrochemical processes.
- 🧬 **Scalability and Innovation**: Continuous research and pilot studies are expanding their scalability and performance, supporting real-world application.
- 🌍 **Global Relevance**: MDCs are particularly promising for regions facing water scarcity and energy shortages,

References

- ***Mishra, S.***, *Dhanda, A., Dubey, B. K., & Ghangrekar, M. M. (2024). Enhancing electrokinetics and desalination efficiency through catalysts and electrode modifications in microbial desalination cells. Journal of Environmental Management, 366, 121719.* https://doi.org/10.1016/j.jenvman.2024.121719

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