



Kristian Marril Bacarro

Master's Degree
Mechanical Engineering

Office: 1335 ERB

Email: bacarro@wisc.edu

Hometown: Los Angeles, CA

Project: Nuclear-Coupled ZLD Seawater Desalination

Advisor(s): Mark Anderson, Luca Mastropasqua,
Mohan Qin

Sponsor: DOE



Background

- Seawater desalination is a proven technology that has the potential to alleviate water scarcity while providing an opportunity to extract valuable commodity minerals such as lithium, magnesium, and uranium from the seawater brine.
- Nuclear power cycles provide both electricity and low-temperature steam—both of which can be utilized to drive desalination and selective mineral extraction processes.
- Coupling the nuclear power cycle with desalination has the potential to lower the costs of zero-liquid-discharge desalination through electrical and thermal integration.

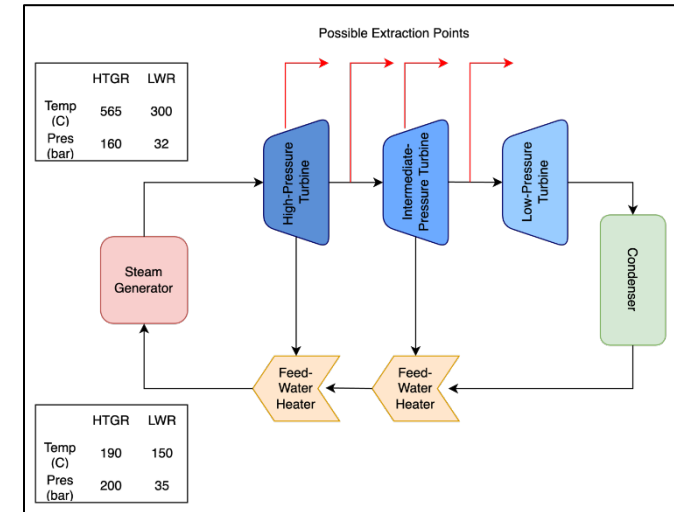


Figure 1: Possible extraction points from nuclear power cycle

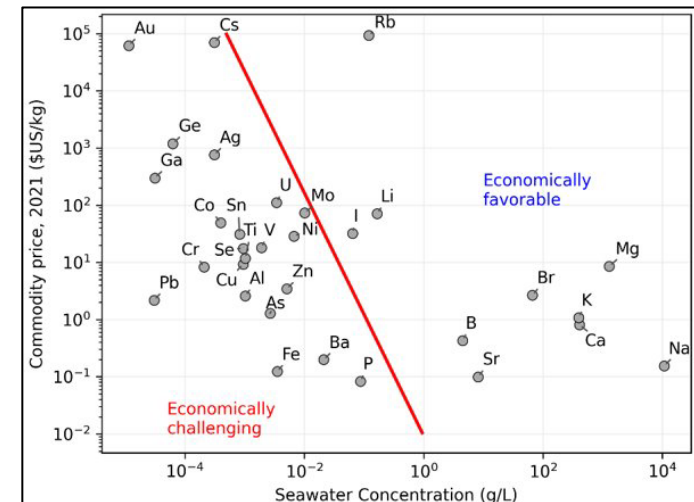


Figure 2: Commodity price for minerals dissolved in seawater versus concentration. Concentration data is taken from [1] with prices updated to present according to [2-4].

[1] K. Dungan, G. Butler, F. R. Livens, and L. M. Warren, "Uranium from seawater – Infinite resource or improbable aspiration?," *Progress in Nuclear Energy*, vol. 99, pp. 81–85, Aug. 2017, doi: 10.1016/j.pnucene.2017.04.016.

[2] U. Bardi, "Extracting Minerals from Seawater: An Energy Analysis," *Sustainability*, vol. 2, no. 4, pp. 980–992, 2010, doi: 10.3390/su2040980.

[3] P. Loganathan, G. Naidu, and S. Vigneswaran, "Mining valuable minerals from seawater: a critical review," *Environ. Sci.: Water Res. Technol.*, vol. 3, no. 1, pp. 37–53, 2017, doi: 10.1039/C6EW00268D.

[4] "Mineral commodity summaries 2022," Reston, VA, Report 2022, 2022. doi: 10.3133/mcs2022.



Project Goals

- Develop system processes for extraction of select high-value minerals from desalination brine, optimizing for lowest water production cost.
- Provide feasibility study and techno-economic analysis of a nuclear-integrated, zero-liquid discharge (ZLD) seawater desalination and selective mineral extraction system.
- Lab-scale experimental validation of ZLD desalination system.

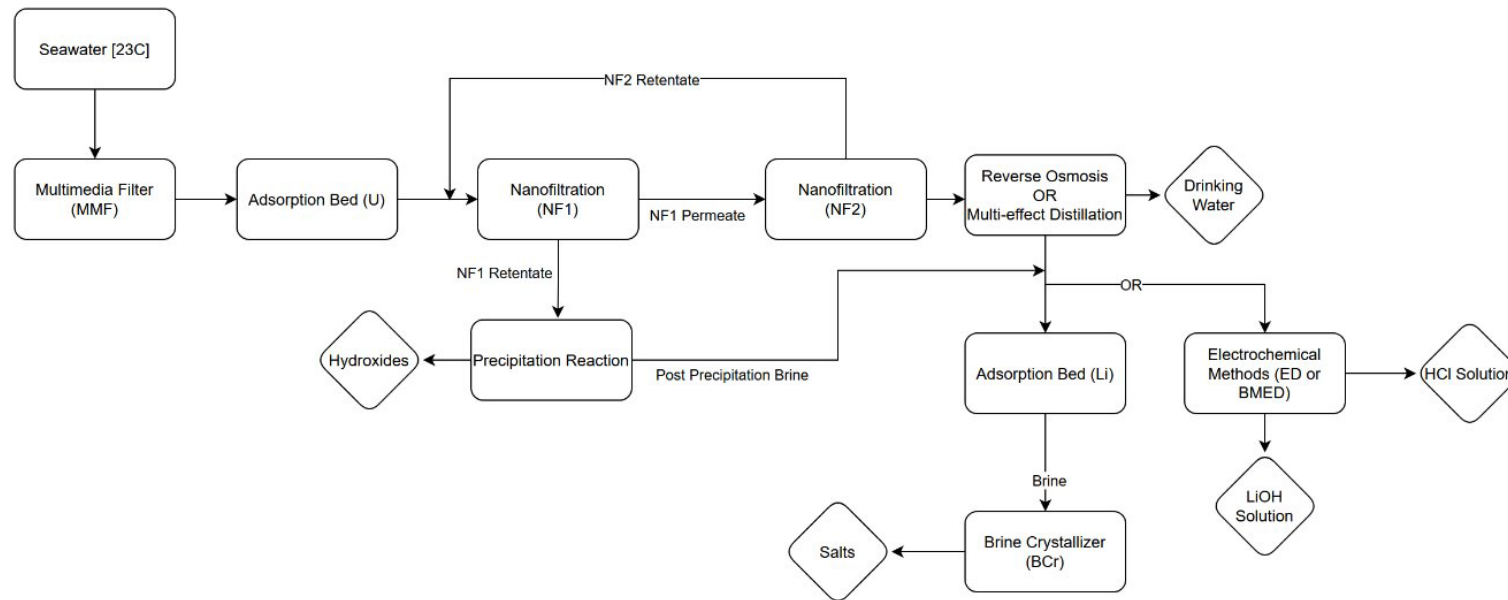


Figure 3: System process of ZLD desalination system