How salt recovery impacts the economics and practicality of the ZDD process

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Multi-State Salinity Coalition
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Composition of City of Alamogordo groundwater (average of 3 wells)

Ion	mg/L	meq/L
Calcium	413	20.63
Magnesium	88	7.21
Potassium	4.7	0.12
Sodium	164	7.15
Bicarbonate	108	1.77
Chloride	133	3.74
Sulfate	1433	29.84
Silica	28	0.46
TDS	2400	

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The existing ZDD* process (Zero Discharge Desalination)

- Treat NF concentrate with electrodialysis metathesis (EDM).
- In EDM the ions of troublesome salts in NF concentrate exchange partners with NaCl to form highly soluble Na salts and Cl salts.
- Each of the two EDM concentrate streams contains about 1% of the water from the original feed.
- The other 98% of the groundwater is NF permeate.

*** T. A. Davis is a principal in ZDD Inc., licensee of the ZDD technology.**

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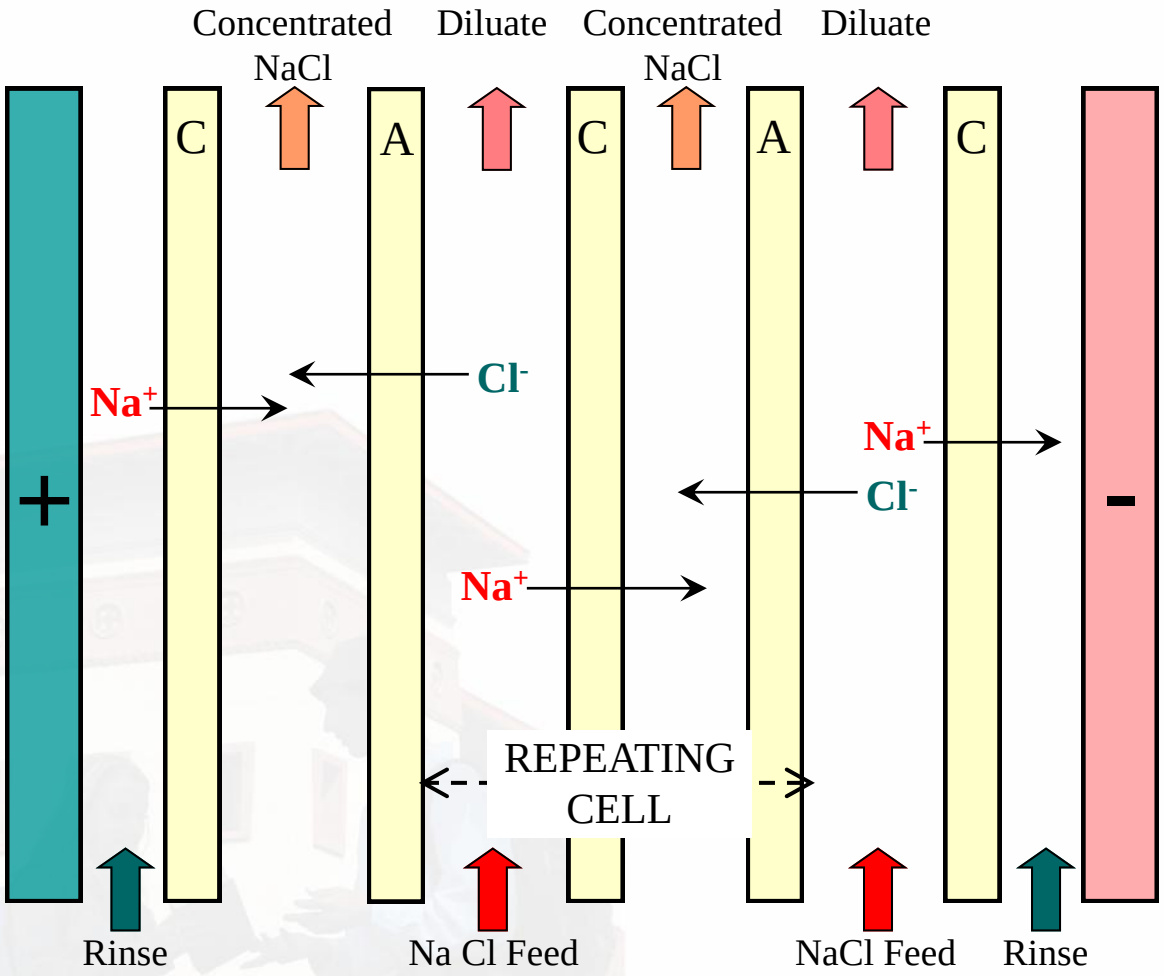
Standard electrodialysis (ED)



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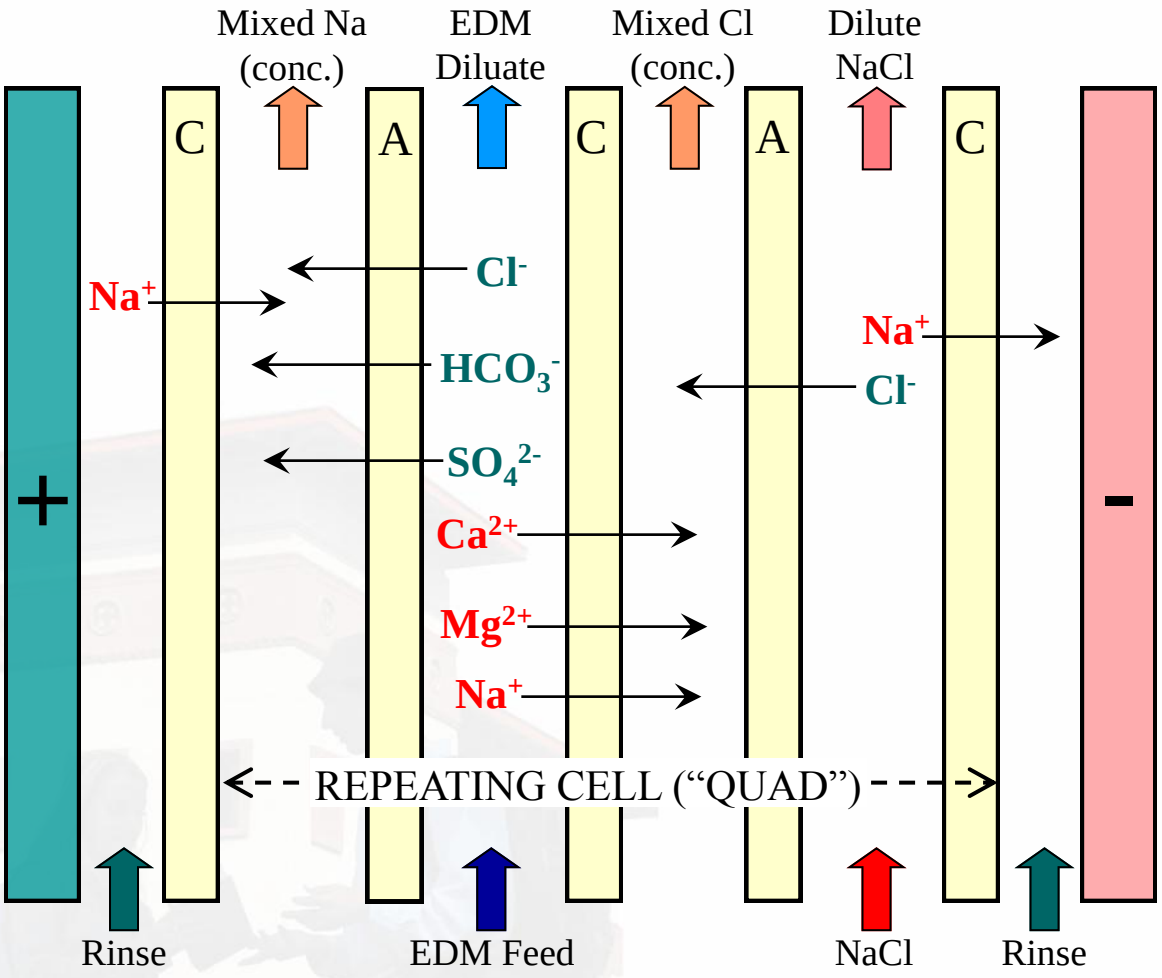
EDM: Electrodialysis Metathesis



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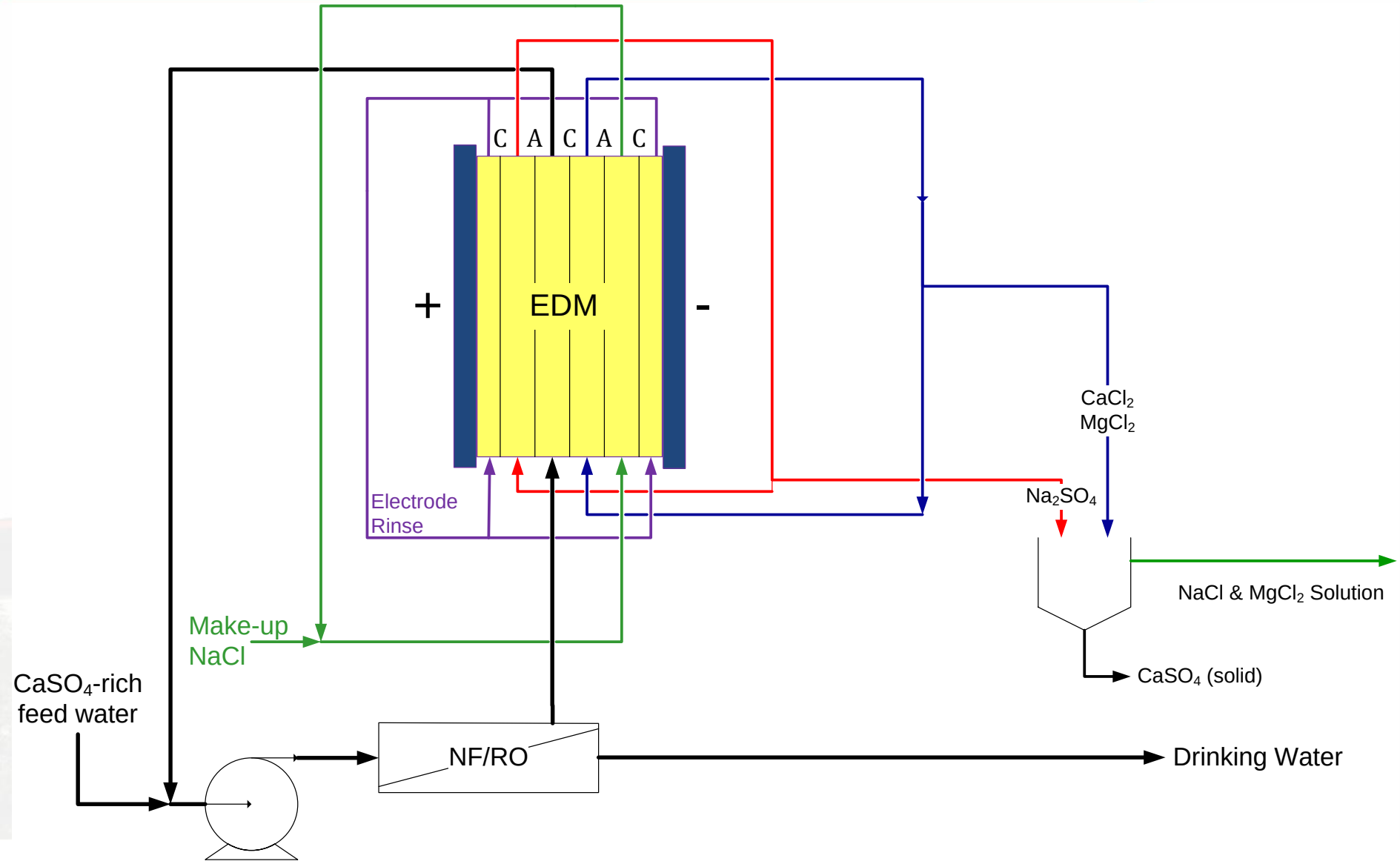
ZDD process piloted at BGNDRF



Recovery of NaCl improves economics of ZDD process

- Purchase of NaCl is half of the ZDD operating cost.
- NaCl must have low levels of Ca & SO_4.
- NaCl in supernatant can be recovered and purified by ED with membranes selective to monovalent-ion transport.
- Target NaCl recovery is 90%.
- NaCl-depleted supernatant can be returned to NF feed – Zero Discharge.

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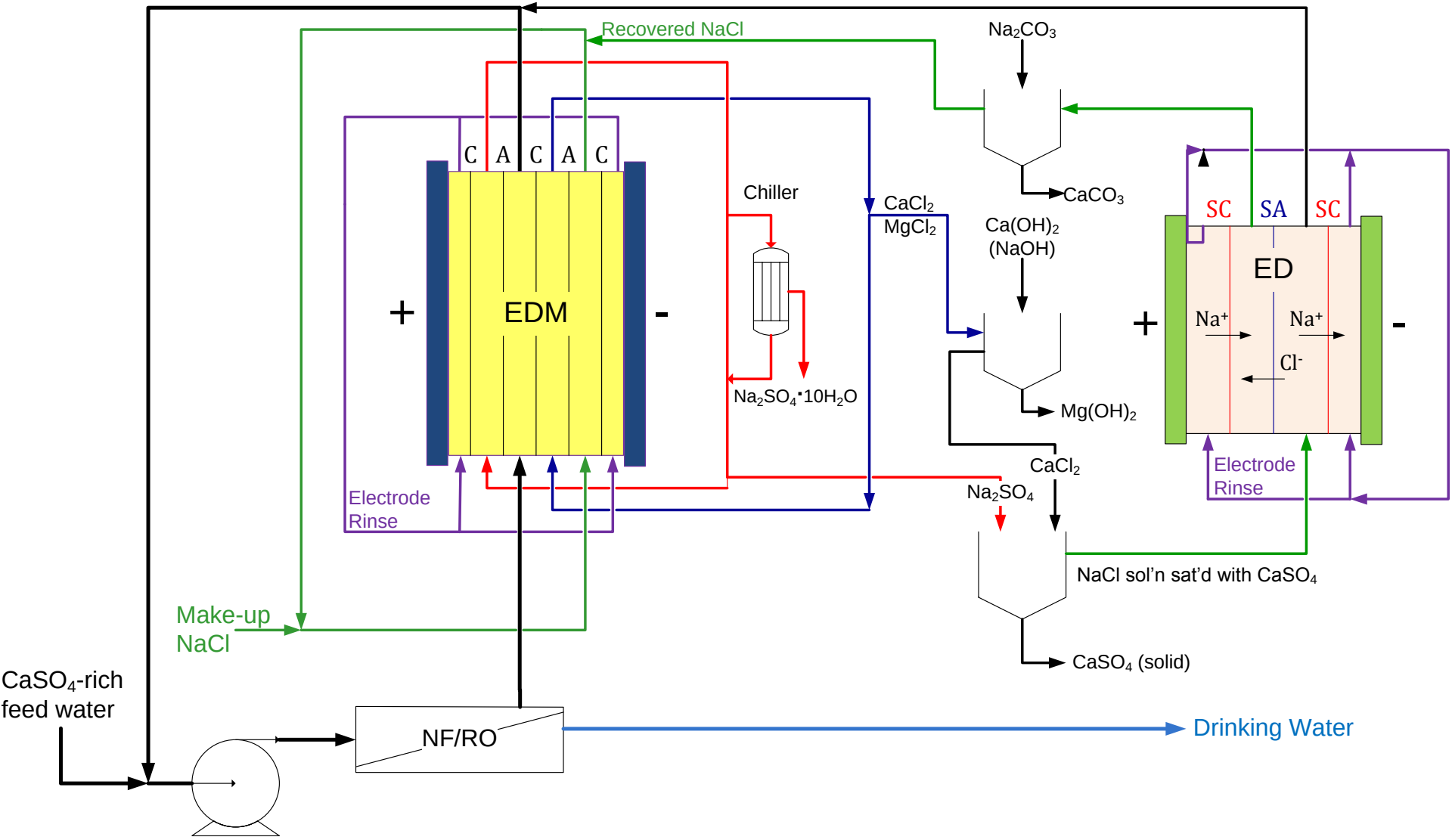
ZDD process with byproduct recovery



Lab apparatus for NaCl recovery

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NaCl recovery experiments

- High quality ED concentrate
  - NaCl > 4 eq/L (20% w/w)
  - SO_4 < 0.04 eq/L
  - Ca < 0.2 eq/L
- Reduction of Ca in concentrate
  - $Ca^{++} + Na_2CO_3 \rightarrow CaCO_3 + 2Na^+$
  - Minimum $CaCO_3$ solubility 0.0003 eq/L
- Recovered NaCl has higher quality than commercial salt.

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Conclusions

- ZDD process removes $CaSO_4$ as a solid byproduct and has the potential to recover $Mg(OH)_2$, NaCl, and Na_2SO_4.
- ZDD has achieved 98% recovery compared to 75% recovery with BWRO alone.
- Recovery of NaCl from $CaSO_4$ supernatant improves the economics of ZDD.
  - Reduces salt purchases
  - Recovered NaCl has high quality
  - 100% recovery eliminates cost of disposal well