Electrodialysis Technology For Salt Recovery From Aluminum Salt Cake Waste Brines

Presented by
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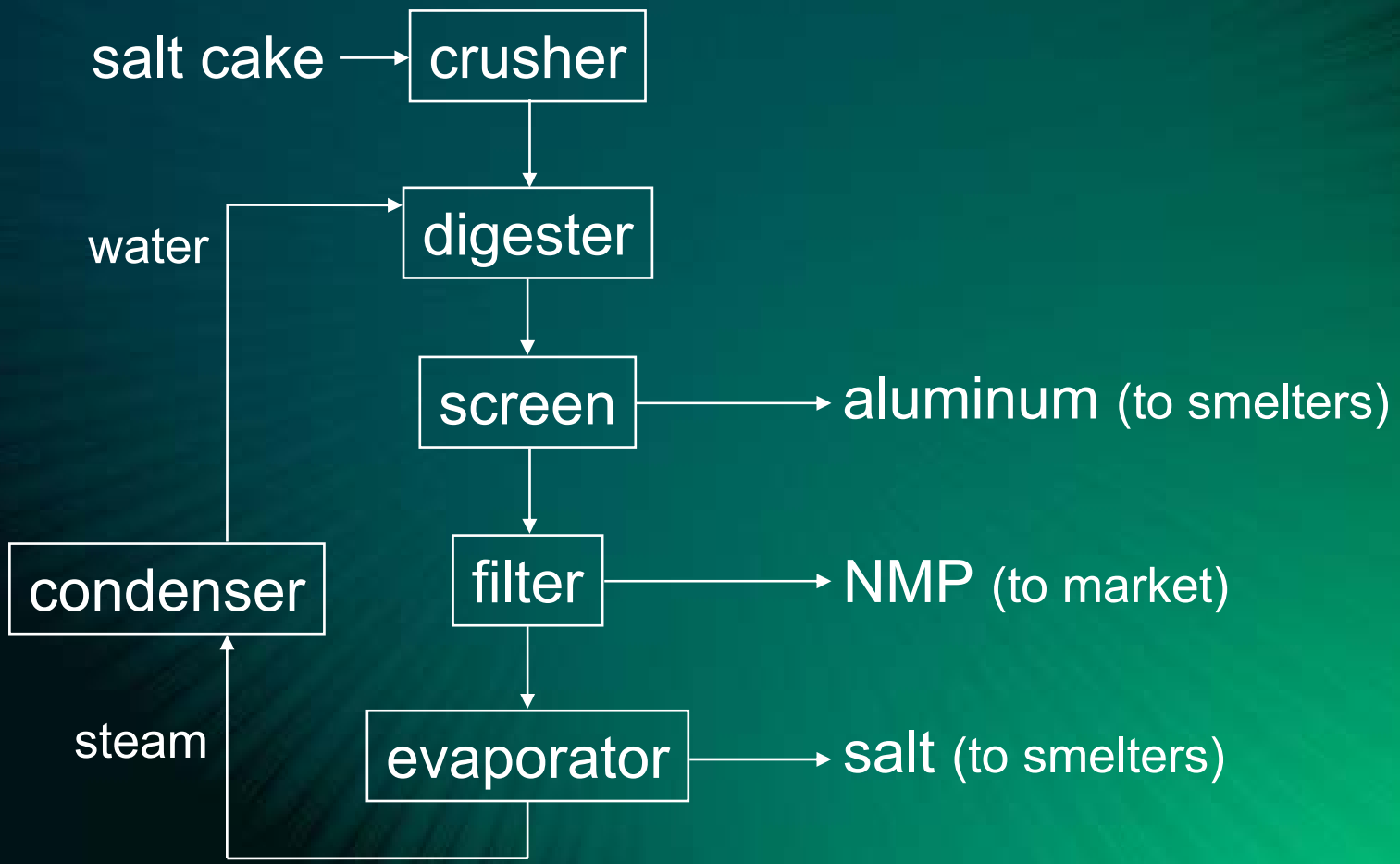
Approach to Recycling Salt Cake

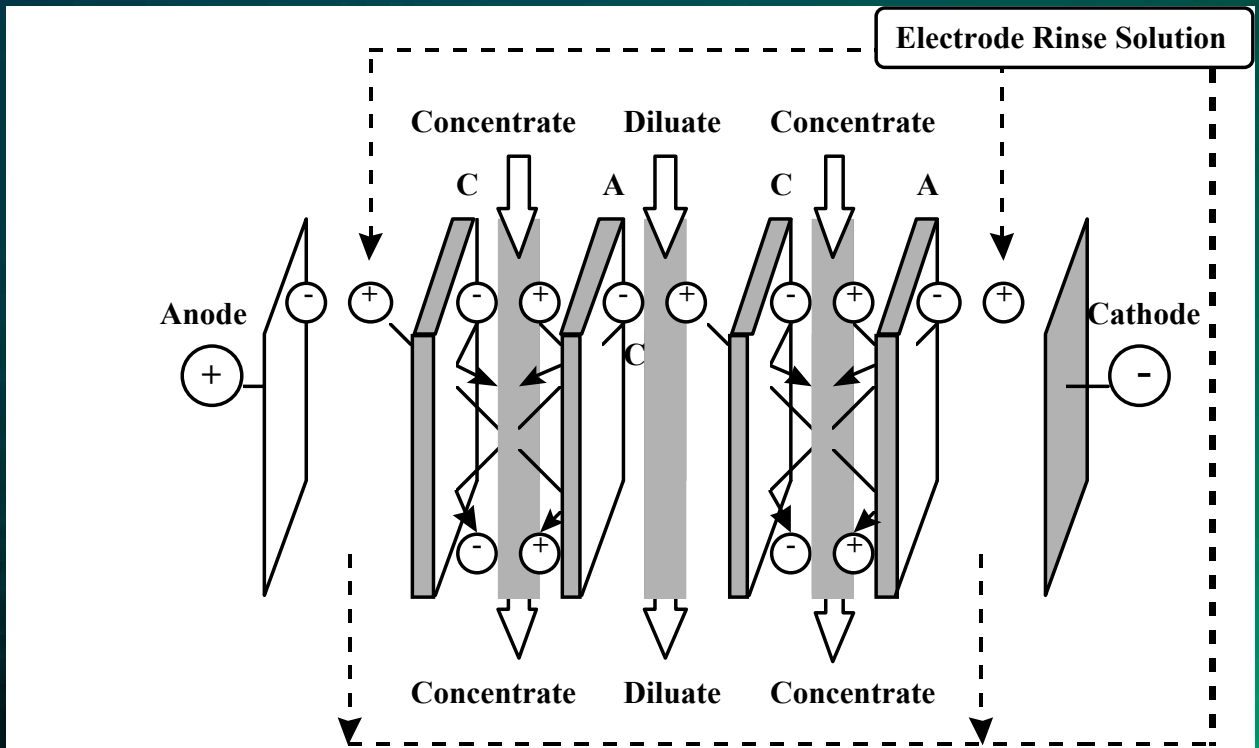


Salt Cake Recycling Barriers in U.S.

- No market for recovered NMP.
  - Alumitech, our industrial partner, has been successfully been working on solutions to this problem.

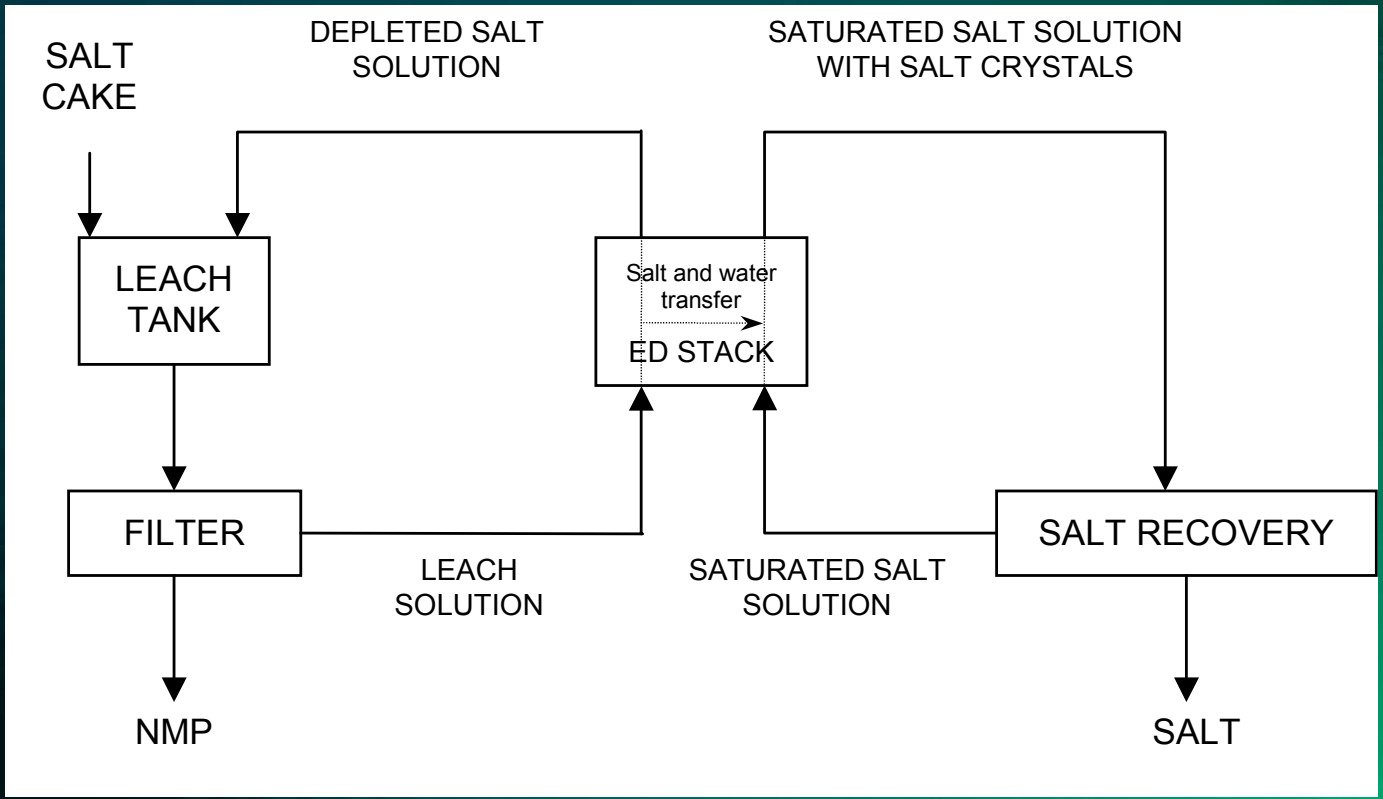
- Salt recovery by evaporation alone is too expensive.
  - Argonne has been investigating an electrodialysis approach for either direct recovery of salt crystals or as a concentrator to a much lower cost evaporator.

Electrodialysis Stack



C: Cation transfer membrane
A: Anion transfer membrane

Electrodialysis-based Process for Salt Recovery From Salt Cake Leach Solutions



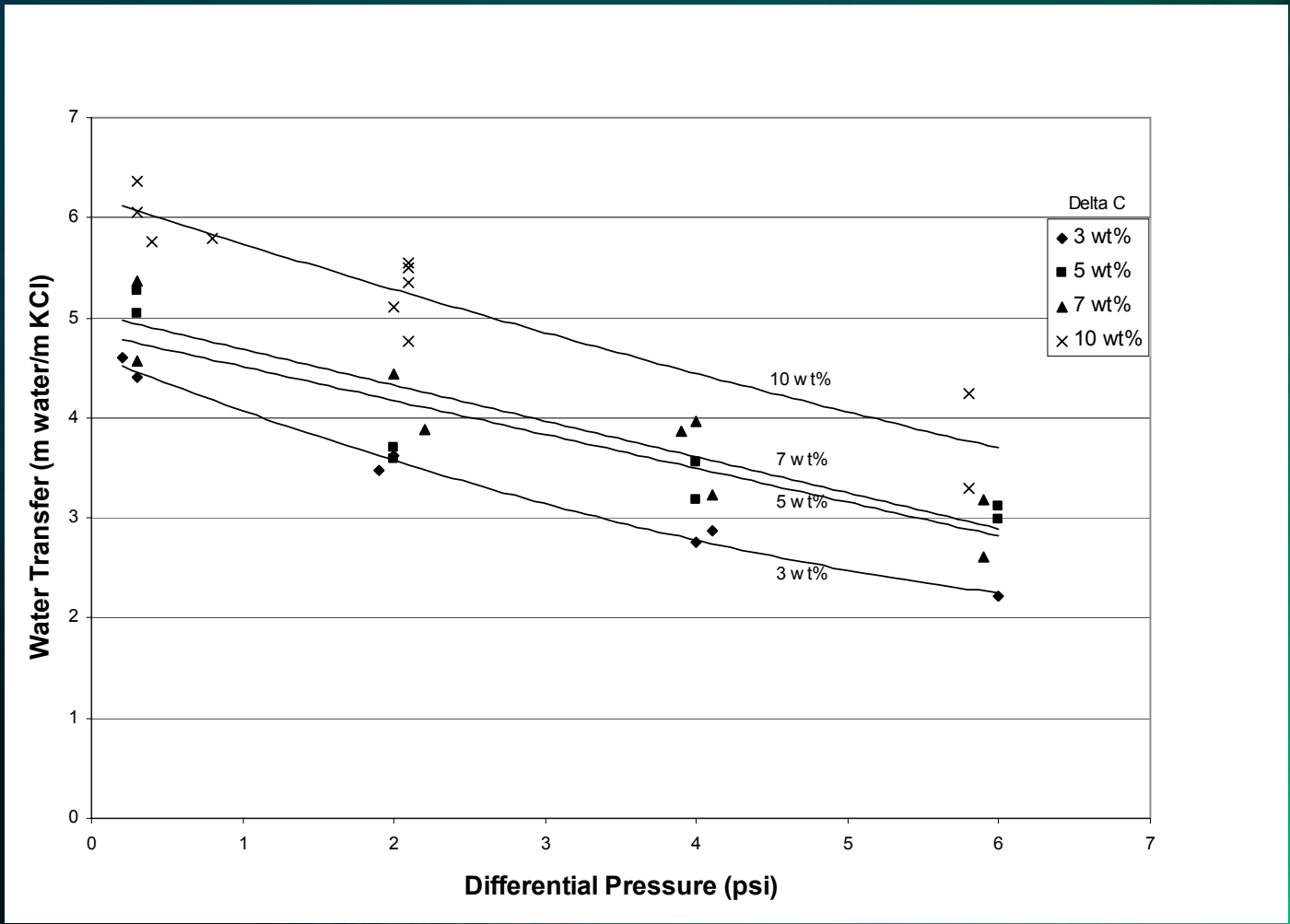
Laboratory Electrodialysis System

Tokuyama Model TS2-5

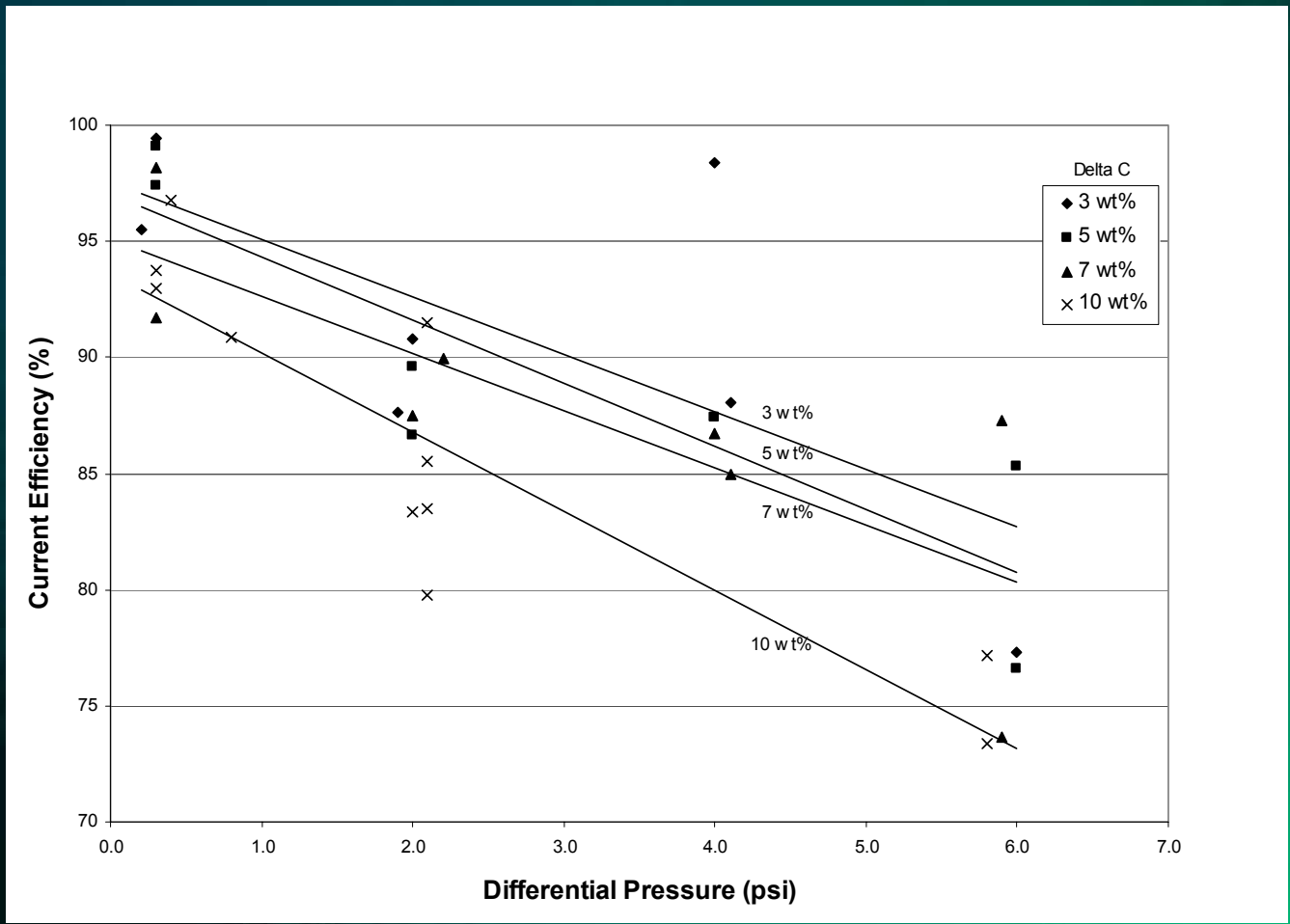
Objectives of Laboratory Research

- Determine conditions to minimize water transfer across the membrane.
- Determine if salt could be precipitated out in the stack.
- Evaluate different membranes and electrode rinse solutions for effectiveness and power efficiency.

Effect of Differential Pressure on Water Transfer at Various Concentrations



Effect of Differential Pressure on Current Efficiency at Various Concentrations



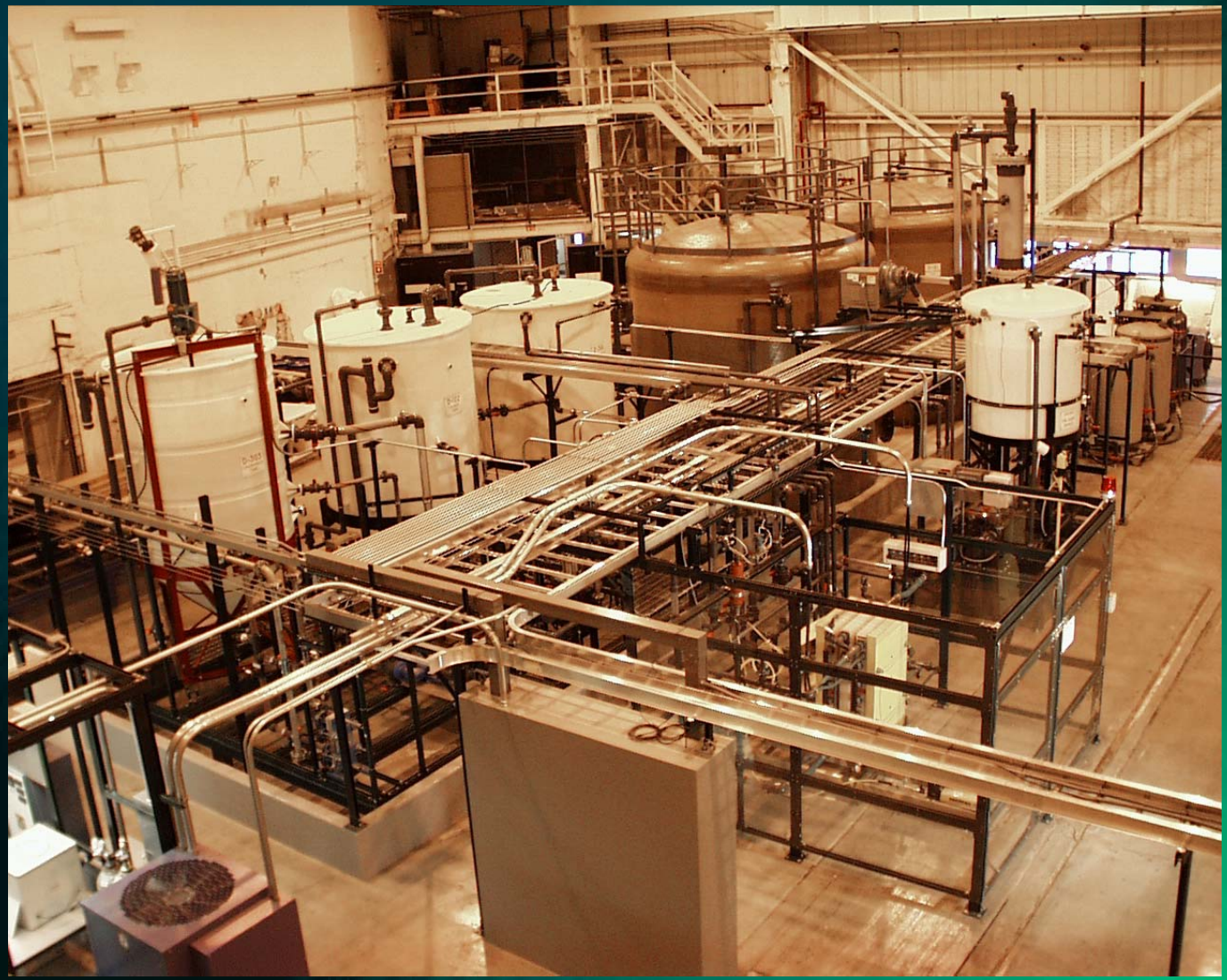
Results of Salt Precipitation in Laboratory Experiments

- Salts were able to be concentrated and precipitated from various feed solutions.
- Water migrating through the membranes had to be minimized to allow for precipitation.
- Spacer thickness is important for determining stack clogging and current efficiencies.

Results of Laboratory Work

- Application of a differential pressure across the membranes resulted in nearly a 50% reduction on water transfer.
- Application of a differential pressure also results in a 20%-25% loss in current efficiency.
- By reducing water transfer, salt precipitation can occur.
- Large scale pilot plant test is required to determine commercial feasibility.

Electrodialysis Pilot Plant



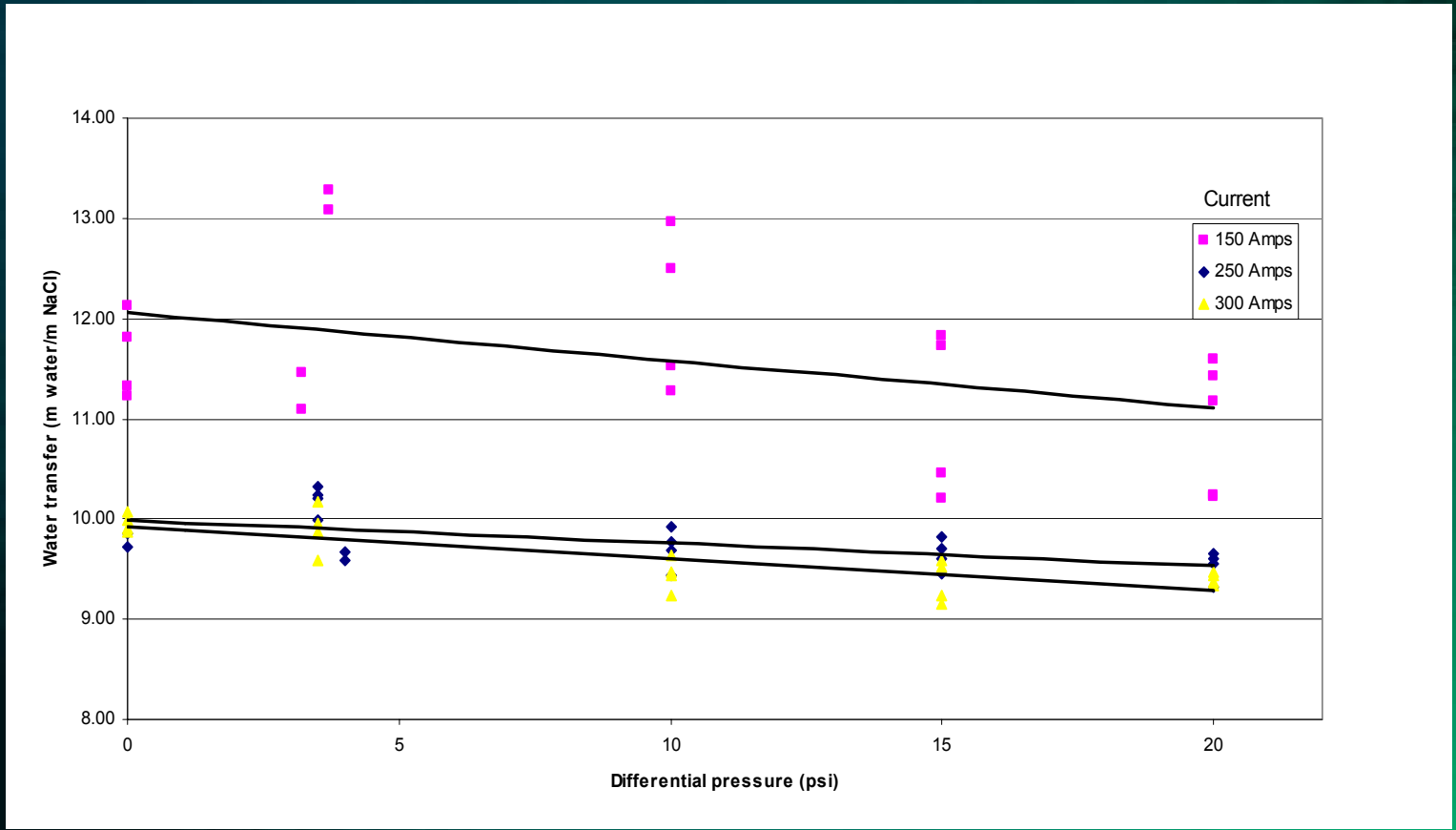
Electrodialysis Stack

Eurodia Model Eur-40-76

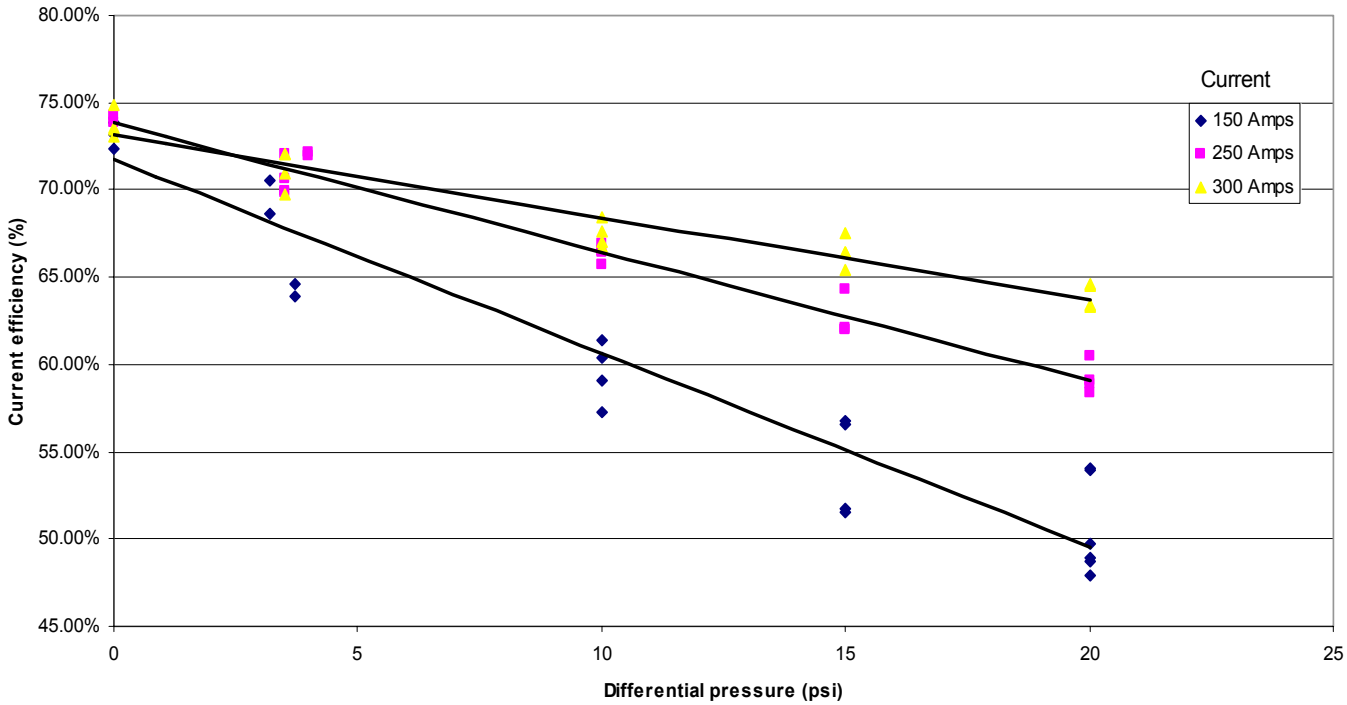
Objectives of the Pilot Plant

- To map out operating parameters of the process on a pilot plant scale.
- To verify the effects of different pressure observed on the laboratory scale with a commercial stack.
- To determine if solids can be generated and recovered from a commercial stack.

Effect of Differential Pressure on Water Transfer at Various Currents



Effect of Differential Pressure on Current Efficiency at Various Currents



Results of Salt Precipitation in Pilot Plant Experiments

- Salts were able to be precipitated from various feed solutions.
- Commercially available spacers were found to be too thin to allow crystals to pass through.
- Thicker spacers would have to be designed to allow for solids recovery.

Results of Pilot Plant Work

- It was found that increasing the current density decreased water transfer while increasing current efficiency.
- It was found that required current densities to fully duplicate the laboratory work could not be reached due to insufficient cooling of the brine solutions.
- Differential pressure across the membranes was found to have minimal effect on water transfer when scaled up to the commercial stack.
- Salt precipitation was able to take place, however, commercially available spacers were found to be too thin to allow for solids recovery.

Summary

- Electrodialysis has successfully been used to concentrate salt cake brines.
- Increased current density was found to decrease water transfer and increase current efficiency.
- Utilizing differential pressure to decrease water transfer did not scale up on a commercial stack.
- Solids were generated, however, we were not able to fully explore techniques to allow them to pass through the stack. We hope to address this at a later date.

Future Work

- Characterize the concentration of industrial brines.
- Modify the plant to allow for higher current densities.
- Modify the spacers to allow for solids recovery.
- To assess membrane/stack durability.
- Explore other applications to utilize the electrodialysis pilot plant facility.

Acknowledgements

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We would also like to thank Alumitech as an industrial partner and for supplying us with industrial brines.