CRYO-DESALINATION

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WHY CRYO-DESALINATION?

- Less energy than thermal or membrane desalination processes
- Low-cost materials operating at low temperatures resulting in little corrosion
- Less maintenance because no scaling or membrane fouling
- No chemical cost or pollution
- No constraint on equipment size so no economies of scale

[1] Ryosuke Fujioka, Li Pang Wang, Gjergj Dodbiba ⁎, Toyohisa Fujita. “Application of progressive freeze-concentration for desalination”

ORIGINAL PROTOTYPE

- Based on a patent by Dr. Norbert Buchsbaum
- Multi-component system that requires various heat exchangers and a separation column
- Proved to be expensive for our means

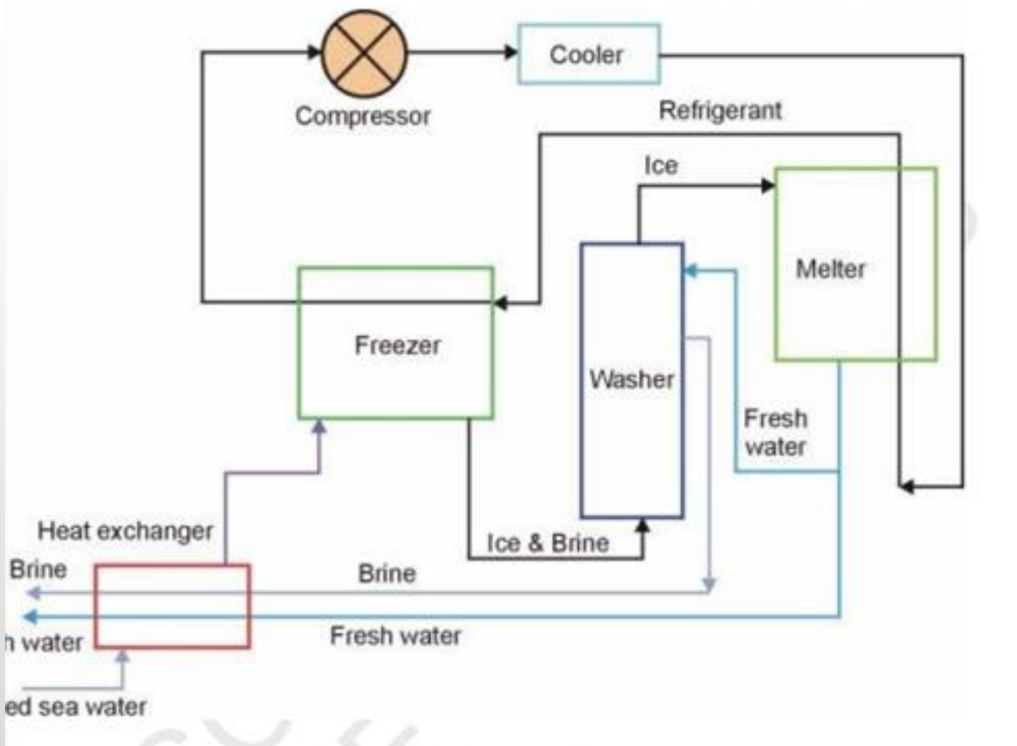


Figure 1. An indirect freezing process.

FINDING A NEW SYSTEM

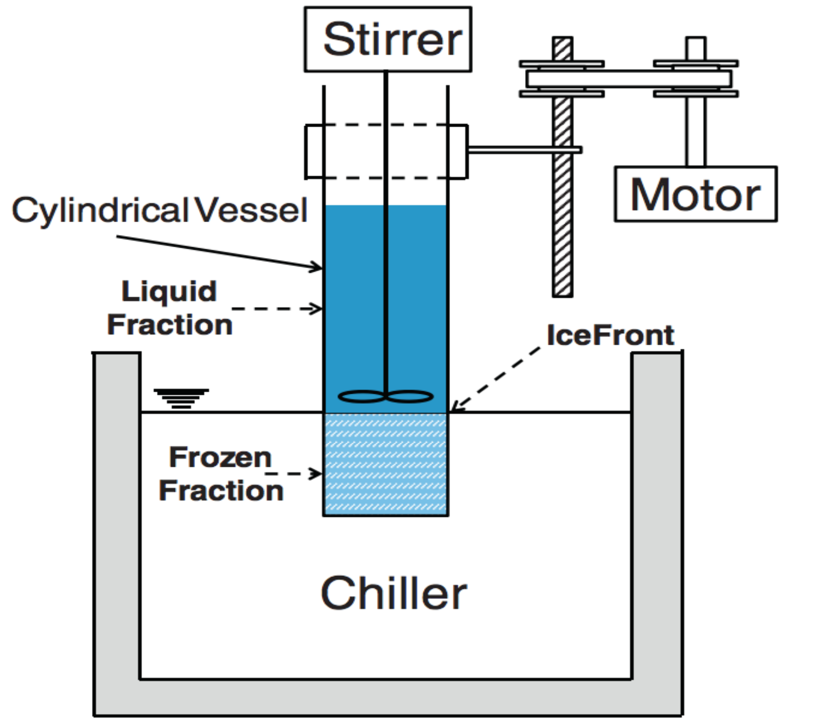
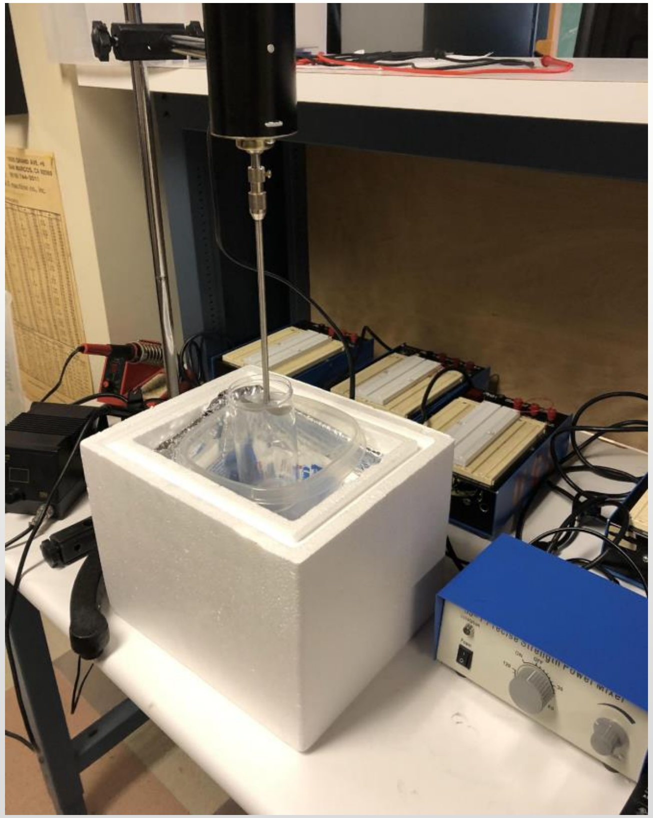
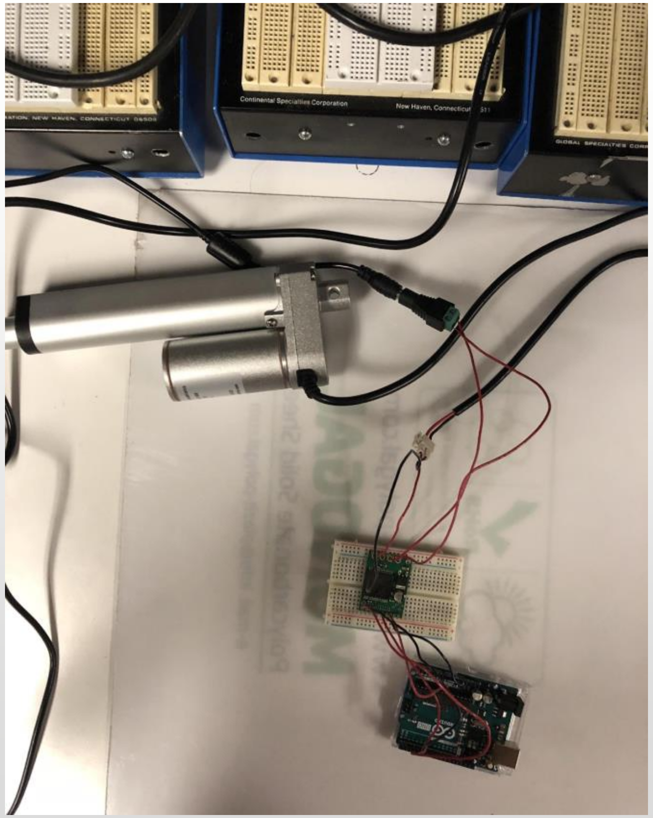


Fig. 1. The laboratory equipment for progressive freeze-desalination.

- Research conducted by the University of Tokyo determined progressive freezing as a viable option for desalination
  - Studied effects of initial concentration, stirring speed and speed of ice front advance
- Low design and maintenance costs
- Easy to transport

LAST YEAR’S PROTOTYPE





Issues with the prototype

- Saltwater did not freeze
  - Dry ice packs were not cold enough
  - Purchasing dry ice for each experiment is not sustainable
  - Acrylic vessel was too thick
  - Need to minimize heat transfer from surroundings
- One trial spanned over 6 hours

New prototype

- Our new prototype uses an aluminum vessel with poly-ethylene insulation to control the rate of heat transfer
- Instead of progressive freezing, we fully submerge our vessel and use intermittent stirring to prevent the ice from sticking to the walls of the vessel.
- For the coolant, we use isopropyl alcohol and dry ice cubes to maintain a temperature of -10C to -18C.

Testing Data

Trial	Duration of freezing (minute)	Coolant Temperature Range (°C)	Vessel Temperature and Time at Position of Freezing (°C) (Minute)	Salt Content before Extraction (ppm)	Salt Content after Extraction (ppm)	Percent Yield
2	20	> -58	-0.7, 11.00	7630	7205	78.5%
3	20	-39 to -27.7	-1.1, 14.67	8100	6673	77%
4	20.03	-24 to -18.2	-0.4, 13.40	8060	4980	21.5%
5	47.05	-8 to -17.2	-3.3, 39.40	7940	3673	30%

Goals for improving current design

- Create a steadier temperature gradient

- Make the process autonomous:

  I.e. stirring process, filling vessel, ice removal

- Determine a reliable coolant source

PHASE 2

- Once we can successful create potable water, then we'll scale up
  - Increase the size of the vessel
  - Improve cooling system to maximize efficiency
- Using all of this to determine the best ratio of size to efficiency

PHASE 3

- The ultimate goal is to create a multi-tube system to maximize yield of potable water
- Want to determine how much energy is used per liter of water produced and compare this with energy consumption from reverse osmosis desalination
- We will also determine the approximate cost of a progressive freezing cryo-desalination facility, and whether it is viable on a large scale

Acknowledgements:

TESC

AIChE

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