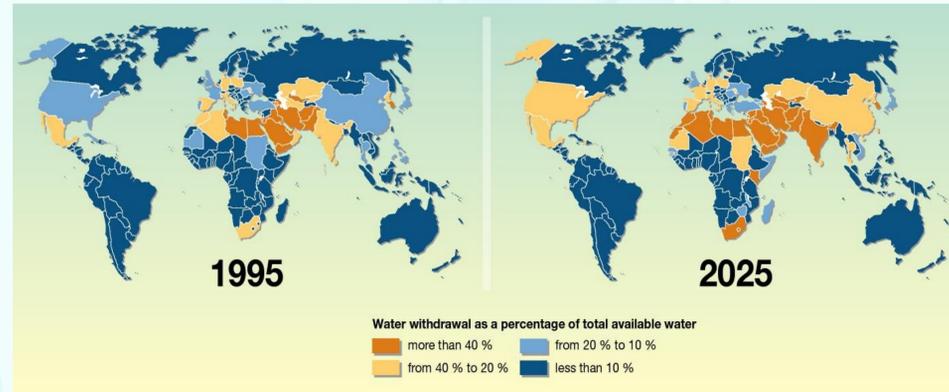


# Cryo-Desalination Project

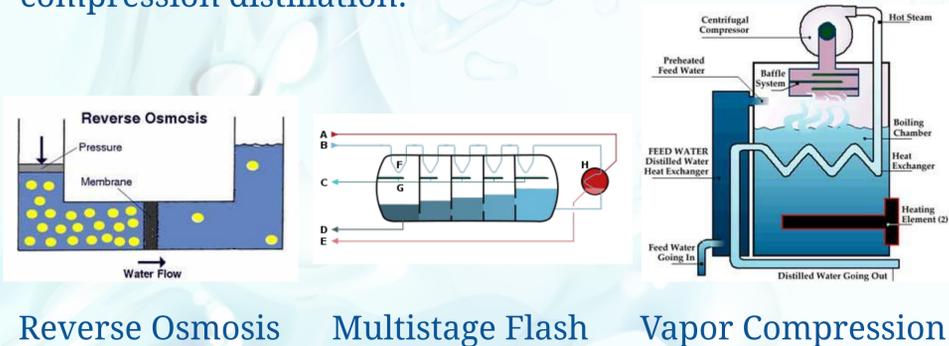
2019: AIChE Projects – Prototype Showcase

## Background

Nearly 71% of the world's surface is covered in water, but only 2.5% is potable. As Earth's population increases, water scarcity is becoming a major problem. The goal of desalination is to convert the remaining 68.5% into usable fresh water.



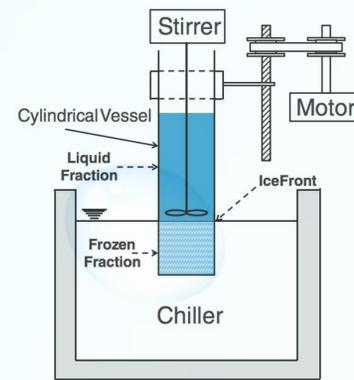
Common techniques for desalination include reverse osmosis, multistage flash distillation, and vapor compression distillation.



## Project Mission

Engineer a small scale system for the **distillation of salt water** using a method that is cost and energy efficient.

## Current Design



Our current design is based off a study done at the University of Tokyo, which used **progressive freezing**. By manipulating the stirrer and motor rates, one can optimize the amount of clean water extracted.

## Theory

Cryodesalination is a desalination process that involves freezing a saltwater source to produce freshwater that is salt-free. The inspiration behind this process comes from Blagden's Law for freezing point depression, which shows that the decrease in a solution's freezing point is proportional to the amount of solute added to the original solvent, thus explaining why saltwater has a lower freezing point than pure water.

Along with this, fractional freezing is a method used to separate liquids of different melting points. This process is done by passing salt water through a cooling column to cool the temperature of the mixture as close to freezing as possible. Once the water freezes, the brine will completely separate from the ice due to their different densities. This process is done multiple times to ensure purity of the final product.

## Current Prototype & Results

Current setup of our system with the isopropyl alcohol-dry ice bath and insulated aluminum vessel can be seen in **Figure 1**, and ice formation from the system can be seen in **Figure 2**.



Figure 1



Figure 2

The experimental data collected is consistent with the theory and more data will be collected as we adjust the parameters to find the most efficient and cost-effective system.

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%

## Path Forward

- Develop a energy sustainable cooling system.
- Gather statistically significant data in order to create an effective natural separation system.
- Fully automate the system.

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