Clathrate-Assisted Freezing/Melting Seawater Desalination

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97.4 % of the water on Earth is salty, making fresh water resource management the ultimate challenge for humanity. As such, the impact of a low-cost desalination technology would dwarf that of any other scientific accomplishment in the long run. Freezing/melting (FM) and clathrate desalination are potentially low cost solutions, but brine adhesion to ice crystals is an unresolved technological barrier. This project demonstrates a novel method for improving FM desalination economics by encasing ice crystals in hydrophobic clathrate shells to expel surface brine. Clathrate shell coating tests were conducted using a surrogate clathrate former and a hydrophobic nano-scale promoter at -3°C on ice tablets and crystals soaked in a 70,000ppm NaCl solution. Tests using ice tablets confirmed clathrate shell formation using water from the brine layer. Changes in surface characteristics during clathrate shell formation, recorded using a 1000X microscope, showed the promoter speeded up the clathrate formation by 200%. Processing the hydrophobic treated ice crystals using a prototype centrifugal filter shed >95% of the surface brine. A bench-scale conical centrifugal filter further demonstrated the feasibility of scale-up operations for continuous clathrate assisted brine removal. Additionally, the chemicals used in clathrate-assisted FM desalination are safe, low-cost, and reusable. Reportedly, FM desalination costs $0.34/m3 and clathrate desalination costs $0.43-$0.63/m3. Clathrate-assisted FM desalination removes >95% of the adhered brine and uses <1% of the chemicals required by clathrate desalination, therefore producing higher purity water at lower costs (circa $0.25/m3) compared to the gold standard of $0.75/m3 by reverse osmosis for seawater desalination.

Awards Won:
Third Award of $1,000
King Abdulaziz &amp
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