BioThaw: An Eco-Friendly Biological Deicer
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Market Need
Traditional deicers cause significant road erosion, contaminate waterways, harm household pets, and damage plants and aquatic life.
- North America holds 43% of the global deicer market, using 300 million metric tons annually.
- 42% of the US population is willing to spend more than 25% premium on sustainable products.
- Sustainable alternatives like propylene glycol have begun entering the market, but most have some negative environmental effects or simply dilute traditional chloride products.
- There is currently no biological deicing product.

Sustainable alternatives like propylene glycol are presented as a stable, completely inhibiting ice growth up to -7.1°C (~19.2°F) that promote thermal hysteresis so that the organisms can stay alive under harsh conditions.

Plants, insects, and fish contain antifreeze proteins that promote thermal hysteresis, and some negative environmental effects or simply dilute traditional chloride products.

Antifreeze Protein
Plants, insects, and fish contain antifreeze proteins that promote thermal hysteresis so that the organisms can stay alive under harsh conditions.

BioThaw Specifications
Concentrated AFP liquid solution that:
- Is safe for infrastructure, pets, and environment.
- Is presented as a stable protein emulsion.
- Completely inhibits ice growth up to -7.1°C (~19.2°F) when -62.5 mL/m² of 1 mg/mL AFP solution is applied to the roads.

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Thermal Hysteresis Modelling
- A Langmuir isotherm model relates fractional coverage ($\theta$) to AFP protein concentration.
- An extended Langmuir adsorption model predicts the thermal hysteresis activity of the dimerized protein.

$$\theta = \frac{1}{2K_s C} + \frac{1}{2K_f} + 1 - \sqrt{\left(\frac{1}{2K_s C} + \frac{1}{2K_f}\right)^2 + \frac{1}{K_s K_f C}}$$

Cost:

K_i = k_u/k_f

Manufacturing Equipment
Bioreactor
- 5000L Bioreactor
- DI Water System
- Autoclaves
- High Pressure Homogenizer
- 2000L/H Membrane Purification
  - IMAC Column
  - SEC Column
  - Centrifuge

Lyse and Membrane Separation
- Lyse E. coli cells, separate out proteins and small molecules

Nickel-Affinity Resin Chromatography
- Bind 6xHis sequence, elute the larger protein containing RiAFP

Size Exclusion Chromatography
- Cleave and separate RiAFP from larger protein

Concentration
- From 125 g/hr of RiAFP/L of cell feed, concentrate to 1 mg/mL.

Financial Analysis

Product Timeline
- 1st year: Lab-scale research, patent filing
- 2nd-3rd year: 2nd-3rd year
- 4th year: Hit the market
- 9th year: Break even

References