



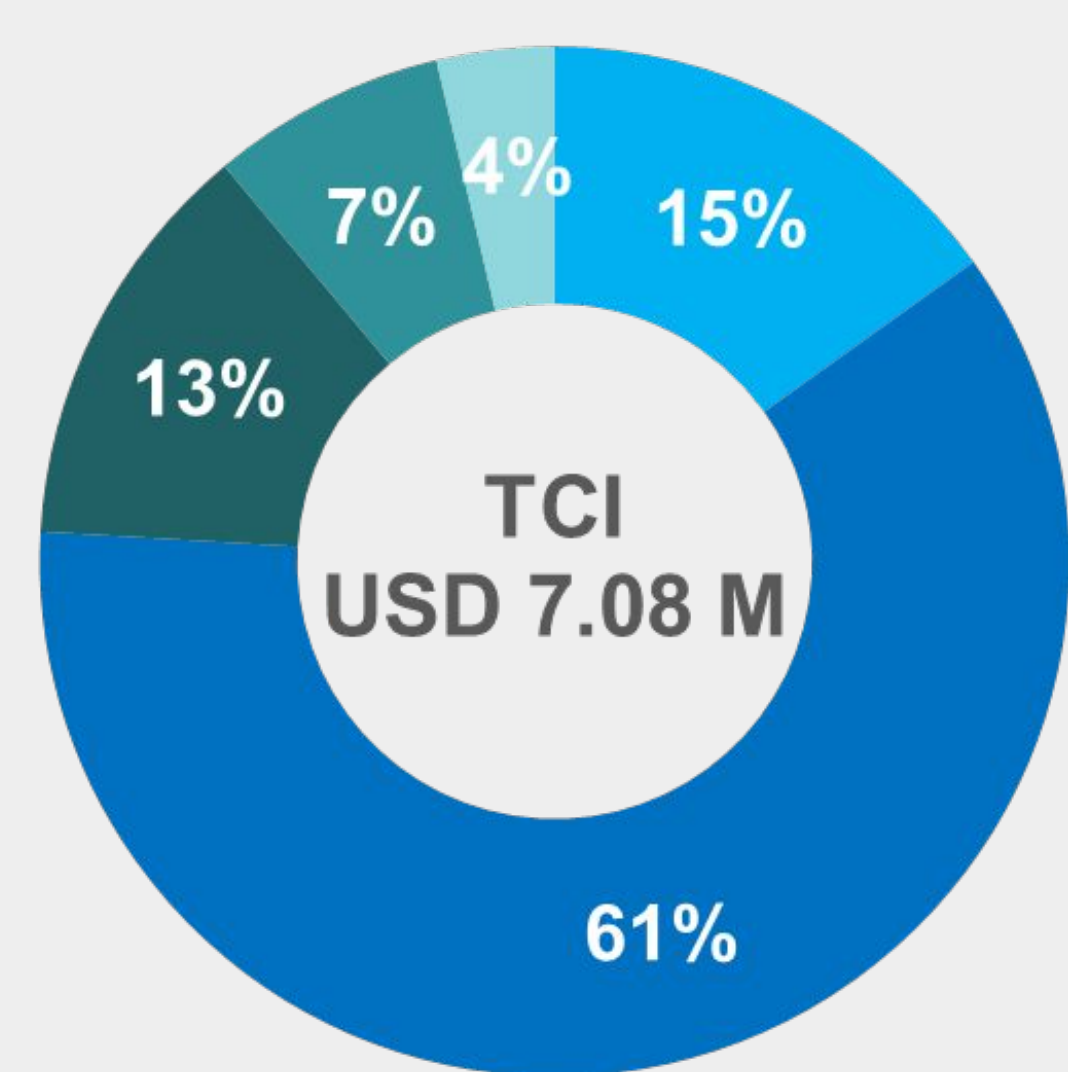
Background

- Sodium alginate ($C_6H_7NaO_6$) is present in cell walls of brown algae
- Vast applications in biomedical, food, textile, cosmetics, and **bioplastic** industry
- Produce sodium alginate from a recombinant strain of *Azotobacter vinelandii*
- Pros: adjustable M/G ratio and suitable for production in inland areas
- Aim for 120 tonnes annual production as a 10% solution

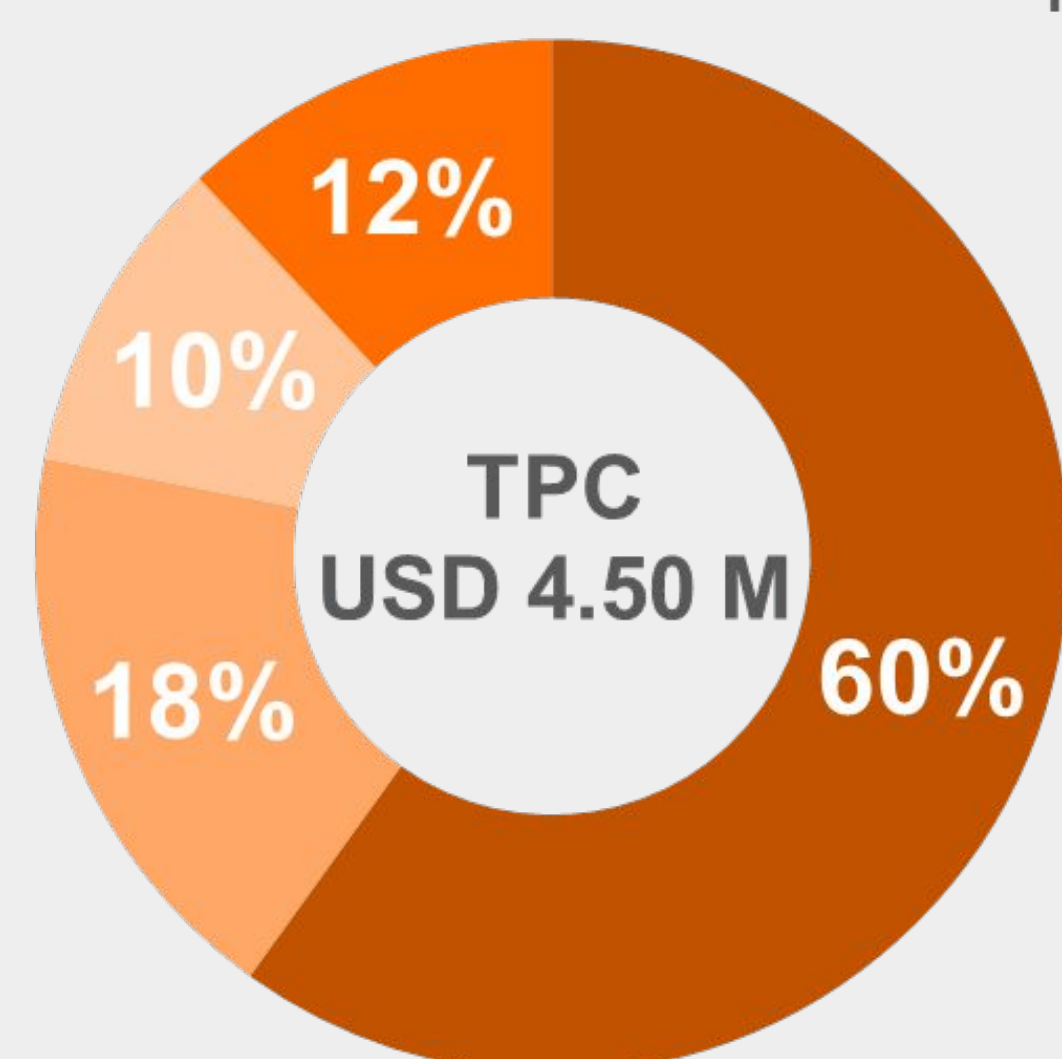


Economic Assessment

Plant Lifetime	Annual interest rate	Break-even Price
10 years	5%	\$44.14/kg



■ Direct Production Cost ■ Fixed Charges
■ Plant Overhead Costs ■ General Expense



■ Working Capital ■ Direct Plant Costs
■ Indirect Plant Cost ■ Contingency
■ Contractors Fee

Environmental Analysis

Solid waste: cell debris sent to anaerobic digestion

Liquid waste: sent to a wastewater treatment plant

Component	Flow rate in waste stream (kg/hr)
Sodium carbonate	19.0
Sodium alginate	15.7
Ethanol	6.3
Sucrose	4.1

Process Description

Media & Substrate Sterilization

Sterilization

Sterilize with 175°C steam in heat exchangers



14000 kg/ hr
2% Sucrose + medium



Bioreactor Fermentation

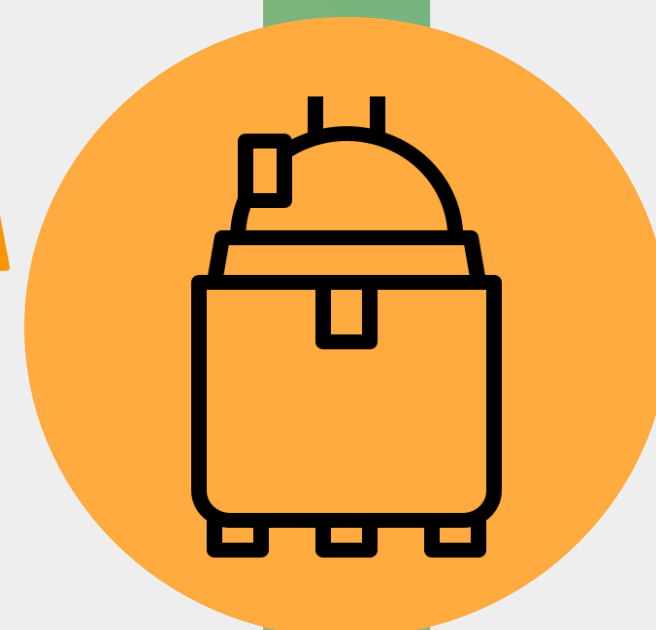
Three 24m³ bioreactors work in parallel under two-stage fermentation



Cell Washing

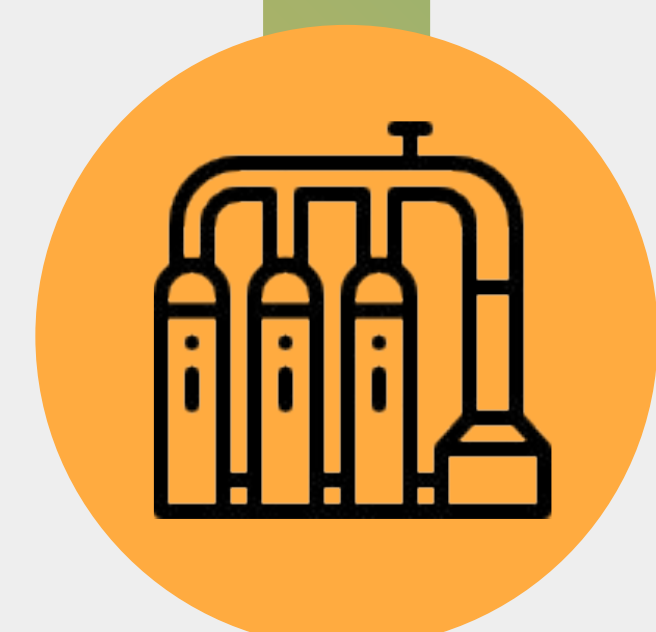
Separate cells from excess media in a rotary vacuum drum

2300 kg/hr
2.6% NaCO₃



Alkaline Treatment

Lyse cells and convert alginic acid to sodium alginate by Na₂CO₃ treatment in a heater at 90°C



Cell Debris Removal

Separate sodium alginate from cell debris in a set of hydrocyclones

1600 kg/hr
96% Ethanol



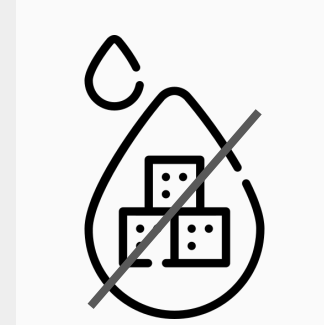
Ethanol Treatment

Separate sodium alginate by ethanol treatment in a liquid-liquid separator & recover ethanol in a flash drum

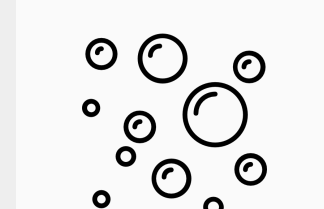
Important Units

Two-staged Fermentation

Batch:



No additional sucrose



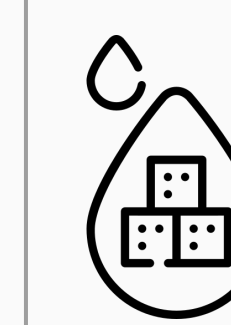
High O₂ requirements



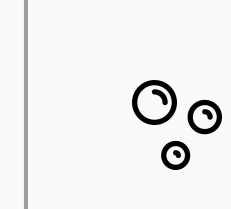
24 hours

Result: High **cell** yield

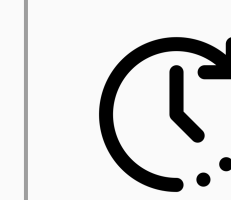
Fed Batch:



Sucrose fed to bioreactor



Low O₂ requirements



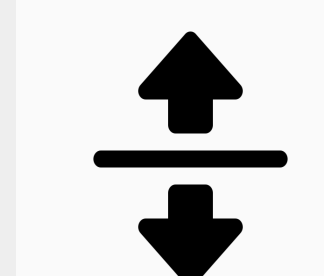
36 hours

Result: High **product** yield

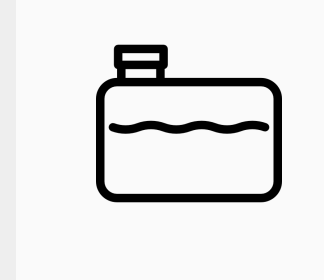
Ethanol Treatment



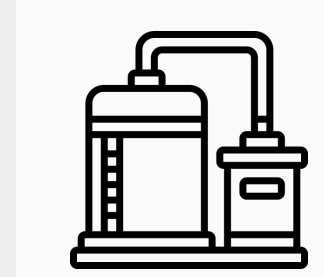
Ethanol is mixed with crude Na(Alg) solution in a mixing tank



Na(Alg) separates out while impurities and excess water remain entrained in the light phase



Mixture separates in a liquid/liquid separator and our desired product is obtained from the bottom



Used ethanol is sent to a flash drum to be recovered and reused

Site Considerations

- Brown field plant in Burnaby, BC
- 700 m³ indoor warehouse
- Corridors for fire escape and equipment transport
- Hazardous units placed far away from control rooms

Acknowledgement

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