Continuous Solidification of an Organic Intermediate

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Motivation and Goals

Reshore production of a subcooling organic intermediate back to the US

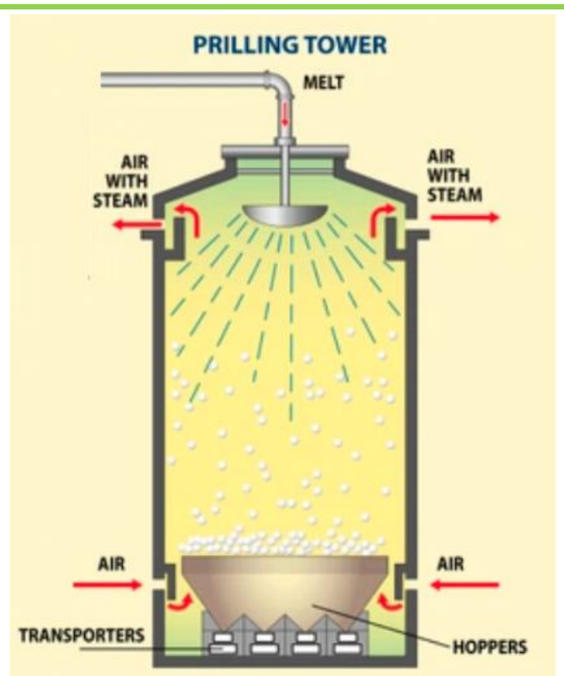
- Design a continuous solidification process
- Create an economically viable design
- Perform a HAZOP safety analysis

Solid allows for better storage and transport

Opportunity for Nation Ford to be one of the first to enter the domestic market

Technical Background

- Organic intermediate is subcooler
- Prilling decided as the best option → transforms melts into spherical prills
- Small energy consumption, simple process, scalability potential, and product uniformity

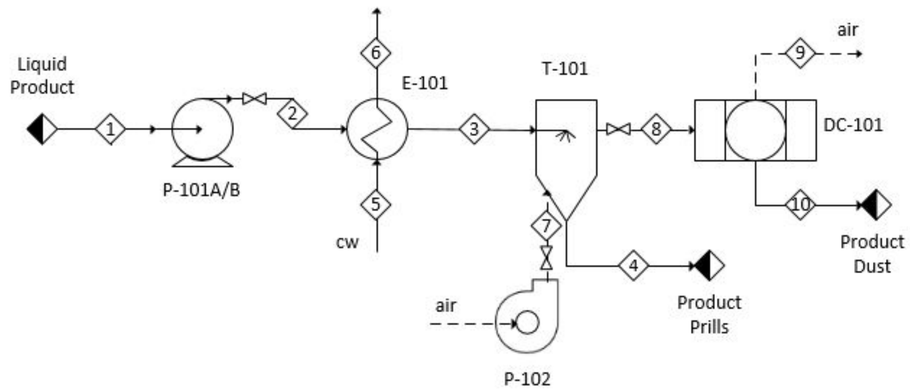


https://www.shutterstock.com/search/prilling-tower

Process Design

Process Flow Diagram

P-101A/B Liquid Product Feed Pump
E-101 Liquid Product Feed Cooler
T-101 Prilling Tower
P-102 Centrifugal Draft Fan
DC-101 Solid Product Dry Filter



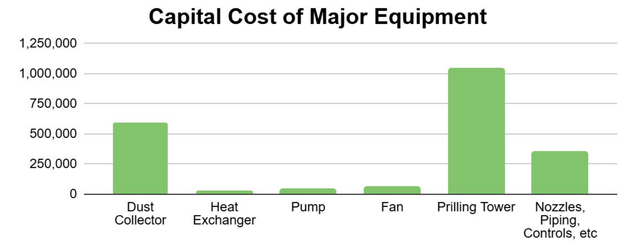
Equipment Summary

Equipment Name	Type	Important Specifications	MOC
Pump	Centrifugal	Shaft Power: 0.94 kW Efficiency: 0.68	CS
Heat Exchanger	Shell and Tube	Heat transfer area: 8 ft^2 Cooling Water Temp: 10°C or 32°C	CS
Tower	Prilling Tower	Height: 76 ft Diameter: 9.66 ft	CS
Fan	Centrifugal	Diameter: 5 ft Width: 2.6 ft	CS
Dust Collector	Baghouse	Filtration Area: 1242 ft^2 Number of bags: 156	CS
Valves	Pressure Relief/Safety	Relief Valves: Liquid Streams Safety Valves: Gas Streams	CS

Stream Table

Stream	1	2	3	4	8	10
Temperature (°C)	95	95.135	90	65	50	50.001
Pressure (psi)	14.696	44.088	44.088	14.696	14.696	13.971
Flowrate (gal/min)	50	50.004	49.848	49.84	164474	0.0083
Product Phase	Liquid	Liquid	Liquid	Solid Prills	Air/Solid Dust	Solid Dust
MOC	CS	CS	CS	CS	CS	CS
Pipe Diameter (in)	3	3	3	3	48	0.125
Schedule	40	40	40	40	40	40

Economic Analysis



Net Present Value (MM)	2.97
Disc. Cash Flow ROR (%)	25.31
Disc. Payback Period (years)	2.4
Cumulative Cash Position (MM)	17.03

Total Module Cost:

$2.1 million

Safety and Hazards

- Components: pump, heat exchanger, prilling tower, centrifugal fan, baghouse collector
- Parameters of interest: flow rate, temperature, pressure, and prill size
- Deviations: more, less, no
- Major concerns: overpressurization, clogging, solidification of organic intermediate in the pipes, prill inconsistency, explosion
- Actions: pressure relief valves, indicators, controllers, heat traced insulated pipes

Conclusions and Recommendations

- Process shown to be economically viable as a long-term investment;
- Benefits of prilling can increase market demand
- Further research needed on the physical properties organic intermediate

Acknowledgements

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References