Design of a Kill Step for an Enzyme Production Process

Lauren Capoziello, McKenna Crummey, Samuel Doak, Emily Watts
Mentors: Dr. Justin Galloway and Emily Hon

1. Project Scope

Novozymes North America produces industrial grade enzymes for the food and feed industries. The goal of this project was to research and design a more sustainable and cost-effective solution to improve Novozymes' liquid preservation via a microbial reduction ("kill") step. Five technologies were researched, but Pasteurization and Ultraviolet Light Radiation (UV) were chosen for testing

2. UV

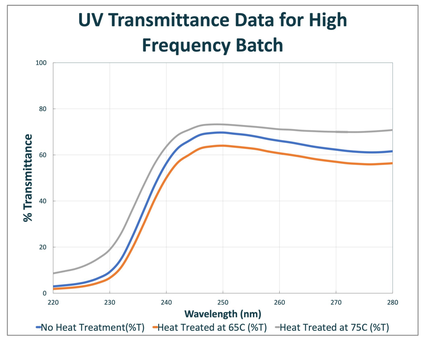


Figure 1: UV transmittance for high frequency batch before and after heat treatment at 65 and 75C for 30s

- UV transmittance analysis of the heat treated and untreated samples (targeting 20%)
- Denmark site has conducted UV radiation experiments. The above results prove that Franklinton batches are comparable

3. Pasteurization

Species	Thermal Reduction Temperature (°C)
B.cereus	>48°C
Salmonella	>60°C

- High Temperature Short Time (HTST) heat treatment
- Heat to 62-68°C for 15-36s
- Measuring total viable count (TVC) before and after heat treatment

4a. Microbial Results

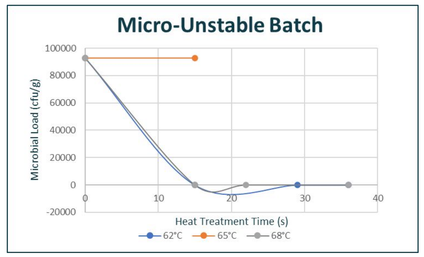


Figure 2: Microbial count for micro-unstable batch heat-treated at 62°C, 65°C, and 68°C for 15-36s

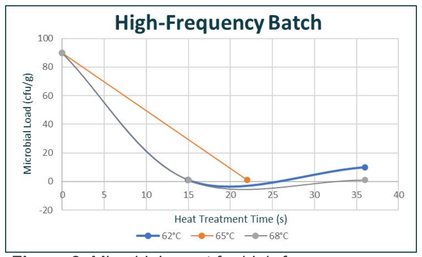


Figure 3: Microbial count for high-frequency batch heat-treated at 62°C, 65°C, and 68°C for 15-36s

4b. Activity Results

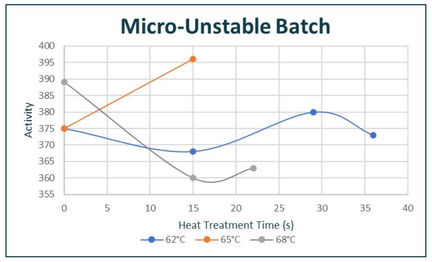


Figure 4: Total enzyme activity in micro-unstable batch heat-treated at 62°C, 65°C, and 68°C for 15-36s

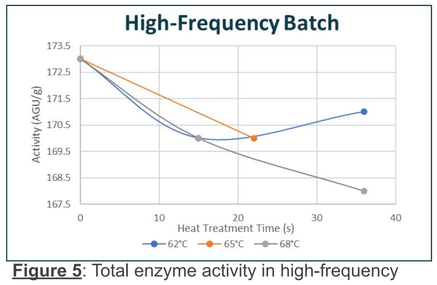
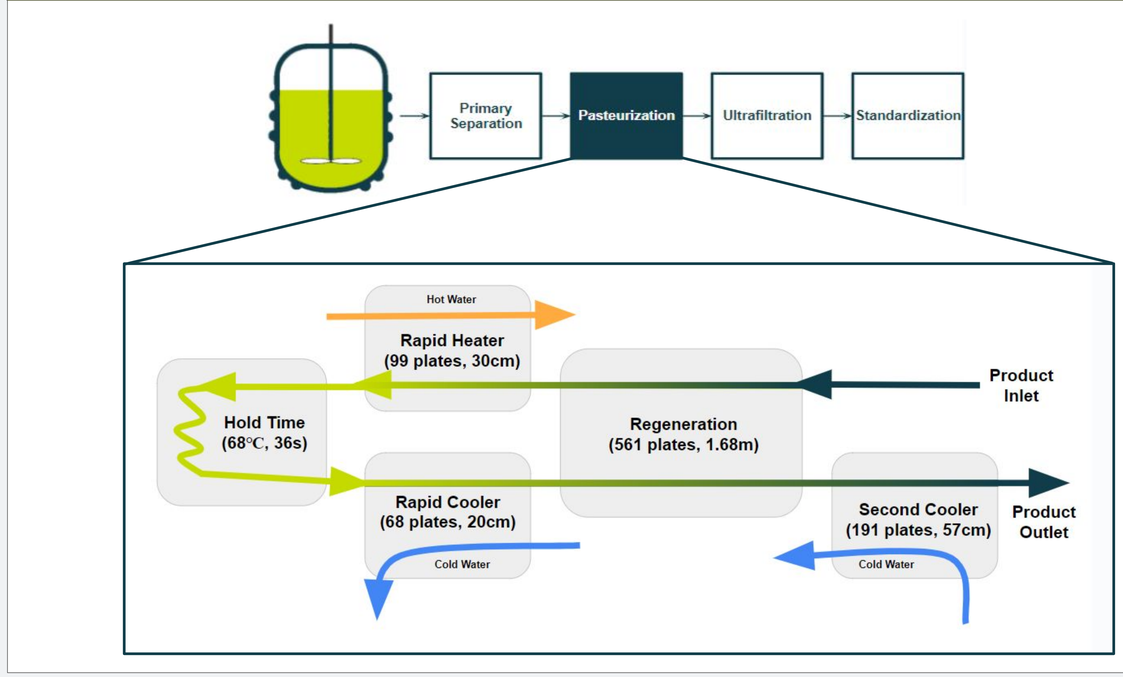


Figure 5: Total enzyme activity in high-frequency batch heat-treated at 62°C, 65°C, and 68°C for 15, 29, and 36s

5. Pasteurization Diagram



6. Sizing

	Regeneration	Rapid Heater	Rapid Cooler	Second Cooler
LMTD (°C)	4.48	33.38	53.53	15.64
Area (m^2)	389.1	68.6	46.8	132.4
# of Plates	561	99	68	191
Length (m)	1.68	0.30	0.20	0.57

- Pasteurizer modeled as four heat exchangers in series
- Using an Alfa Laval© plate-and-frame heat exchanger

7. Costing

Qty	Mechanical Charter Items	Unit Cost	Installed Cost
1	Pasteurizer	$300,000	$480,00
200 (ft)	2" SS Piping	$121	$41,140
10	4" Valve LKB	$950	$18,050
2	Control Valves	$3,500	$13,300
3	Hot Water Valves	$1,200	$6,840
200 (ft)	2" Tubing to Steam	$100	$38,000

- Total cost for 1 pasteurizer came out to be $1.1 million
- 4 pasteurizers will need to be purchased

8. Conclusion

- The UV results are comparable to that of the Denmark site
- Pasteurization is a good fit for the Franklinton, NC site
- The cost of installing 4 pasteurizers is feasible ~$4.4 million
- On site sizing will need to be done to ensure that 4 pasteurizers can fit

9. Acknowledgements

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