PURDUE UNIVERSITY

CAPSTONE EXPERIENCE 2014

Agricultural & Biological ENGINEERING

SMALL SCALE GREEK YOGURT PRODUCTION

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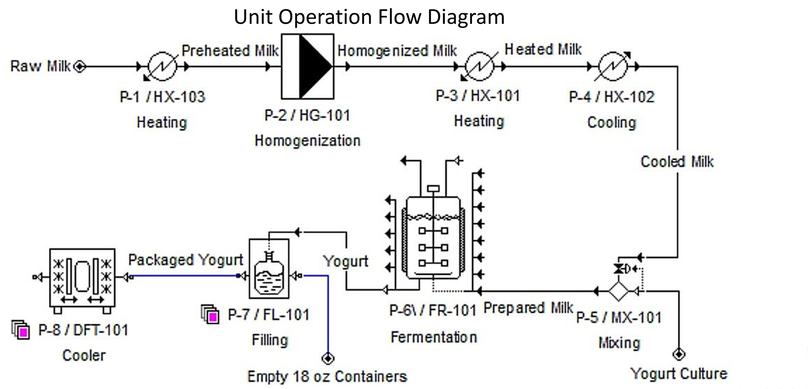
INTRODUCTION

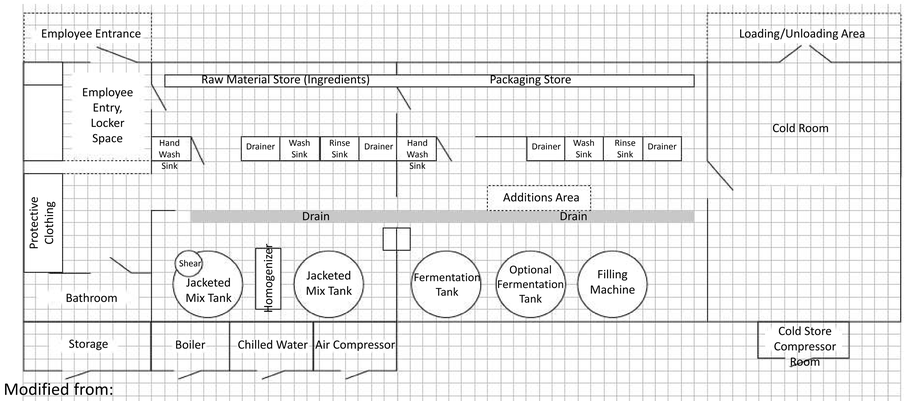
- Greek yogurt market has grown to $2 billion per year industry in recent years, and market growth is expected to continue to rise
- No standard identity of "Greek" yogurt by FDA
  - No mandatory straining step
  - Whey toxic byproduct is sustainability issue
  - Milk protein concentrates often used in industrial production
- Sustainability will become growing concern in yogurt industry

OBJECTIVES

- Create a process to expand production of Lafayette-based *Parthenon* Greek Restaurant
- Goal is to sell packaged yogurt in local grocery stores; e.g. Marsh and Payless
- Perform small-scale experimental procedure to measure: pH, viscosity, lactic acid, and rheology
- Perform scale-up optimal design of plant and economic analysis to give highest rate of return
  - Alternative design options
  - Optimal design/Equipment sizing
  - Economic Analysis

PLANT DESIGN



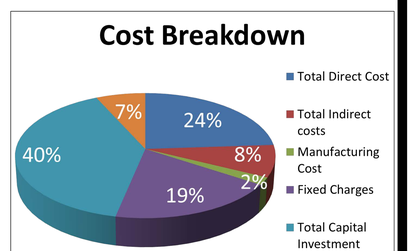


Modified from:
DairyCo. (2008). Yogurt/Ice Cream/Pasteurized Milk - A beginner's guide to processing. Society of Dairy Technology. Retrieved from www.dairyco.org.uk/non_umbraco/download.aspx?media=1667

ECONOMIC ANALYSIS

Economics Summary	Cost
Equipment Purchase Cost	$ 97,440.00
Total Capital Investment	$ 570,600.00
Total Product Cost	$ 55,570,000.00
Total Revenue	$ 1,046,000,000.00
Total Profit	$ 49,030,000.00
ROI	9032.00%

Equipment Purchase Cost	Cost
Homogenizer	$17,290.00
Jacketed Vessel	$3,500.00
Fermentation Tank	$3,500.00
Packing and Filling machine	$49,000.00
Cooler	$6,148.00
Holding Tank	$8,000.00
Total Equipment Purchase Cost	**$87,440.00**



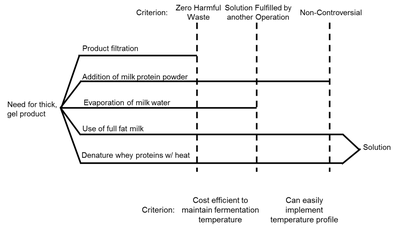
EXPERIMENTAL DESIGN

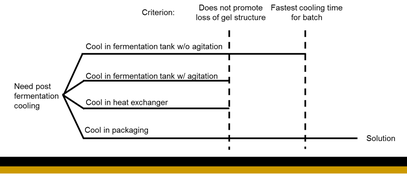
- Model non-constant temperature fermentation:
  - Ferment yogurt at four temperatures: 90°F, 100°F, 110°F, 120°F
  - Record pH hourly for 8 hours
- Analyze rheology of products from fermentation experiment:
  - Flow sweep: 25°C, 0.01 to 20 1/s
  - Strain sweep: 25°C, 1.0 Hz, logarithmic sweep, strain percent 0.5% to 10.0%
  - Frequency sweep: 25°C, 0.02 to 35 Hz

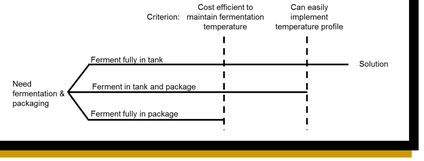
ALTERNATIVE DESIGNS

Cases examined to optimize economics

- Case 1: Heat exchanger, fermenter, packaging
- Case 2: Jacketed vessel, fermenter, packaging
- Case 3: Heat exchanger, packaging
- Case 4: Batch vessel for all operations







IMPACT & SUSTAINABILITY

- Design process eliminates whey waste because of lack of straining step
- Product adds to already huge national Greek yogurt market
- Product fits with trend to buy local food, and adds to local economy
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- $2 billion per year in national Greek yogurt market
- Greek yogurt was19% of yogurt market in 2011, growing from 2% of market in 2008
- Few full fat Greek yogurt producers
  - Less competition in market
  - Less available market

Acknowledgements: Dr. Okos & Jim from the Parthenon

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