Team 19: JAGS Soap

James Lee, Anna Grace DeYoung, Gregory Dobson, & Shawn Sackey
Calvin University, Grand Rapids, Michigan

Calvin UNIVERSITY 1876

Introduction

Team 19, JAGS Soap, is composed of four senior chemical engineers. The team designed and optimized a soap production plant. The project was prompted by the increased global demand for sanitary products, instigated specifically by the COVID-19 pandemic.

Traditional soap making methods utilize a chemical reaction called saponification, which is the hydrolysis of glyceride when reacted with a base (NaOH). It takes a fatty acid from a triglyceride and reacts it with a strong base in the presence of water to produce glycerin and a carboxylic salt soap base. Our process will be utilizing a blend of three fatty acids (15% lauric acid, 25% palmitic acid, and 60% oleic acid), for the triglyceride, to produce solid bar soap with desired properties set forth in industrial literature.

The project goals are to exemplify caring, trust, and cultural appropriateness in our design, by offering a reliable, trustworthy, and relatively inexpensive soap option to the average family.

Objectives

- Design to produce roughly 1,000 $\frac{kg\ of\ soap}{hr}$
- Design of process equipment
  - Continuously stirred-tank reactor (CSTR)
  - Tank sizing
  - Pump and equipment energy estimation
- Design a high-quality soap in terms of:
  - Hardness
  - Cleansing
  - Conditioning
  - Bubbly lather
  - Creamy lather
- Meeting all requirements and regulations
  - Government requirements
  - Environmental requirements
  - Performance requirements
- Safety
  - Environmental
  - Process
  - Consumer

Chemistry

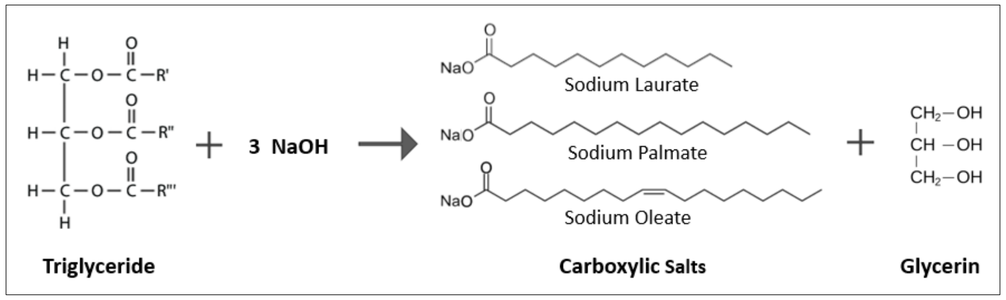


Figure 1: Saponification Reaction

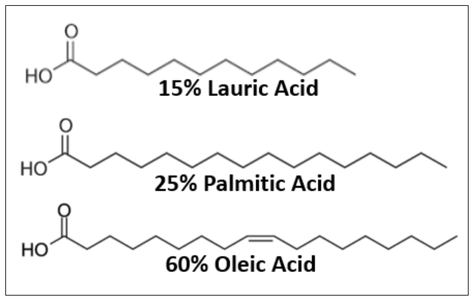


Figure 2: Fatty Acids for Triglyceride

Process Overview

- A composition of glycerin and fatty acids enter the conversion reactor (Reactor 1) to form JAGS triglyceride.
- NaOH in water, along with JAGS triglyceride, enter the CSTR reactor (Reactor 2).
- A liquid solution exits the CSTR reactor and enters a separator, separating the liquid carboxylic salts (soap base) and glycerin. This glycerin is recycled back into the system.
- Carboxylic salts, with water, are mixed with scented enzymes to give the product a fragrance.
- Liquid soap is then cooled to a solid soap to be cut into bars.

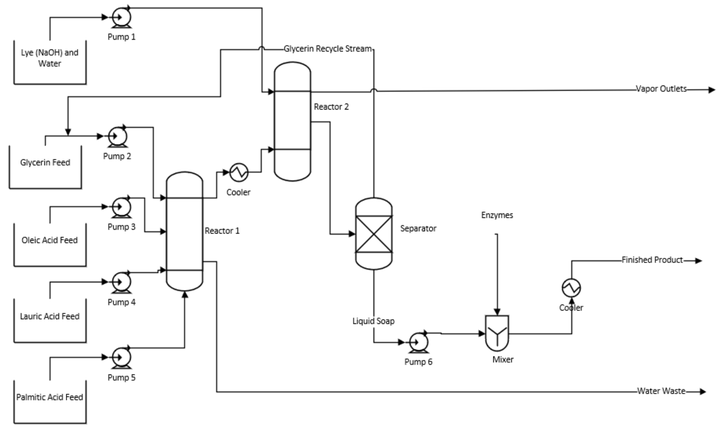
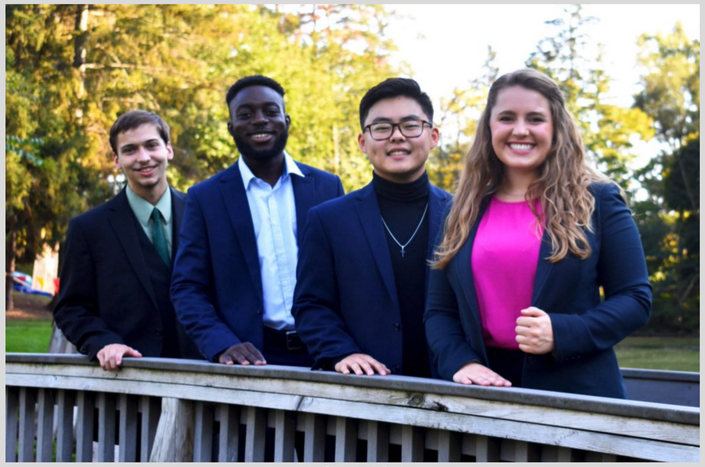


Figure 3: Process Flow Diagram for JAGS Soap Production



(Left to Right)
Gregory Dobson, Shawn Sackey, James Lee, Anna Grace DeYoung

Conclusions

- The process was successfully designed and modeled using Excel and UniSim software.
- The soap mixture developed fell within industrial literature recommendations for all qualities.
- The plant construction, operation, and product are in accordance with local and federal regulations.
- The business model's viability is demonstrated in a 5-year return on investment.
- JAGS Soap met all objectives and requirements for their personal project scope, Engr340, and the industry.

Acknowledgements

To our **professors:**
- Dr. Andrew Wilson
- Dr. Wayne Wentzheimer
- Dr. Kumar Sinniah
- Dr. Chad Tatko
- Dr. Eric Arnoys

Industrial reference:
- Mrs. Dana Roa, American Plant and Equipment
- Mr. Victor Lebron, American Plant and Equipment

Senior design consultant:
- Mr. Steven Pohler, Process Engineer, Vertellus

We cannot express enough of our thanks for your steady support and encouragement throughout this project.