CAPSTONE EXPERIENCE 2012

Soy Flour by Extrusion

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Objective:

To design a process to create a soy flour that is low fat and a gluten-free alternative.

Problem Statement:

To determine which variables affect how much oil is removed

•Variables to consider:

Inlet Moisture Content (Temperature of Extruder)

Number of Extrusions (Oil Removal)

Market Analysis:

With the increase in awareness of Celiac Disease, more and more individuals are living a gluten-free lifestyle. Approximately twenty-five percent of consumers desire more gluten-free foods in the market. With an increasing market, our company will produce 1% of the total market which is approximately 10,165,200 pounds of soy flour per year.

Overview of Process:

Raw soybeans are dried in a rotary dryer from 13% moisture to 8% moisture. The dried feed is then fed into the first extruder. Once extruded, the meal is then re-hydrated to 8% in a mixer and then fed into the second extruder. The product is then milled. The extruders are extruding into a slight vacuum. The overall flow diagram is shown below and was modeled using SuperPro.

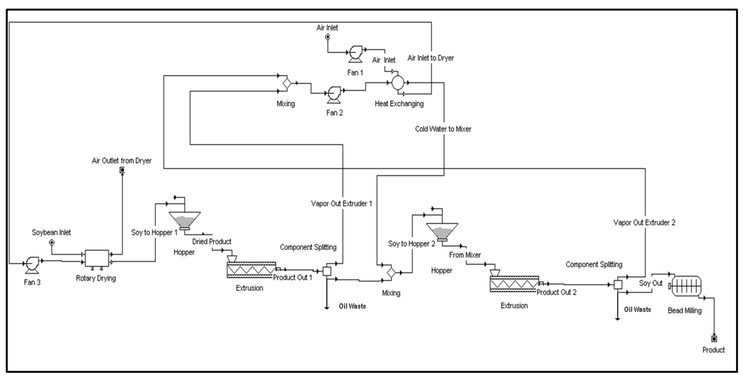

Figure 1: Diagram showing the overall process of making soy flour from raw materials

This is the extruder that was used for experiments.

Results:

It was experimentally determined that at lower soybean moisture contents the temperature of the extruder would increase. Higher extruder temperatures correlate to increased oil and water removal from the soybeans. It was also determined that soybeans could be extruded twice, with no negative effects in running the extruder. Thus, the process was created to extrude the soybeans twice, which results in about 40% of the total oil being removed. Given actual equipment sizes, it is best to produce the flour using one equipment line. The total capital investment was determined to be $1,848,000 and the yearly net profit would be $4,598,000.

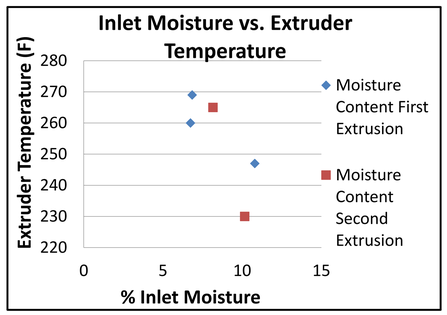

Figure 2: Graph of Temperature vs. Moisture

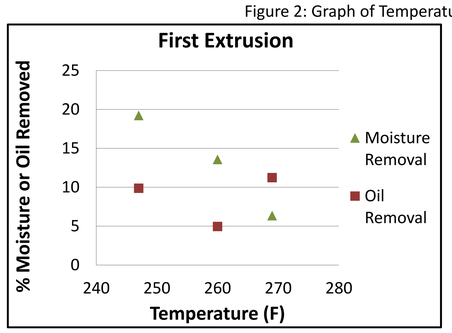

Figure 3: Oil and Moisture Removal for First Extruder

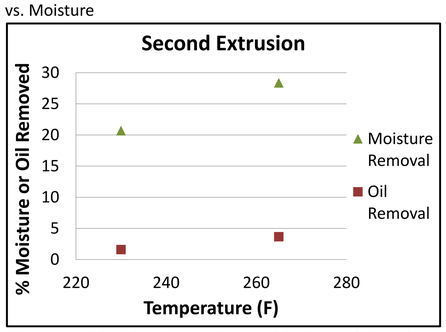

Figure 4: Oil and Moisture Removal for Second Extruder

Budget Information:

Fixed Capital Investment	
Purchased Equipment, delivered	$348,676
Purchased Equipment Installation	$125,523
Instrumentation and Controls	$90,656
Piping	$174,338
Electrical Systems	$34,868
Buildings (Including Services)	$101,116
Yard Improvements	$34,868
Service Facilities	$191,772
Engineering and Supervision	$111,576
Construction Expenses	$174,338
Legal Expenses	$13,947
Contractor's Fee	$55,788
Contingency	$129,010
Working Capital	$261,507
Total	**$1,847,982**

Economic Summary	
Fixed Capital Investment	$1,847,982
Annual Production Costs	$5,571,694
Annual Production (lbs)	10,170,000
Price per pound	$1.00
Annual Revenue	$10,170,000
Annual Net Profit	$4,598,306
Return on Investment	82.53%
Payback Period (years)	0.40

Annual Production Cost	
Raw Materials	$2,933,868
Labor	$2,012,500
Utilities	$87,520
Facility	$390,211
Fixed Charges	$47,594
General Expenses	$100,000
Total	**$5,571,694**

Alternative Solutions:

- Multiple extruders in series could be used to remove a higher percentage of the total oil for use in low fat products.
- Use Hexane or similar chemical to extract oil from the soybeans and then mill the remains to create a flour (current processing being used).

Global/Societal Impact:

- Extrusion is a potential method to process soybeans and other grains in third world countries; it is a low energy processing method.
- Extrusion is also more environmentally friendly when compared to the current processing method. The soybean industry uses hexane to remove the oil, which is derived from crude oil.

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