BioBoba: Designing a Mycoprotein Production System for Food

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Introduction

Mycoprotein is one of the potential future foods to meet the demand of the large population growth. Mycoprotein has wide spectrum of nutrient, particularly it is very rich in protein and low in carbohydrates. Its fiber and texture property also grant the food possibility to produce in various forms as other food substitutes but healthier.

BioBoba is a food made from this microbial-based protein. The food pellets BioBoba is produced under controlled culture conditions.

Goals and Objectives

The **goal** of this project is to design a mycoprotein production system at pilot scale to manufacture an *Aspergillus awamori* based mycoprotein food product.

Objectives:

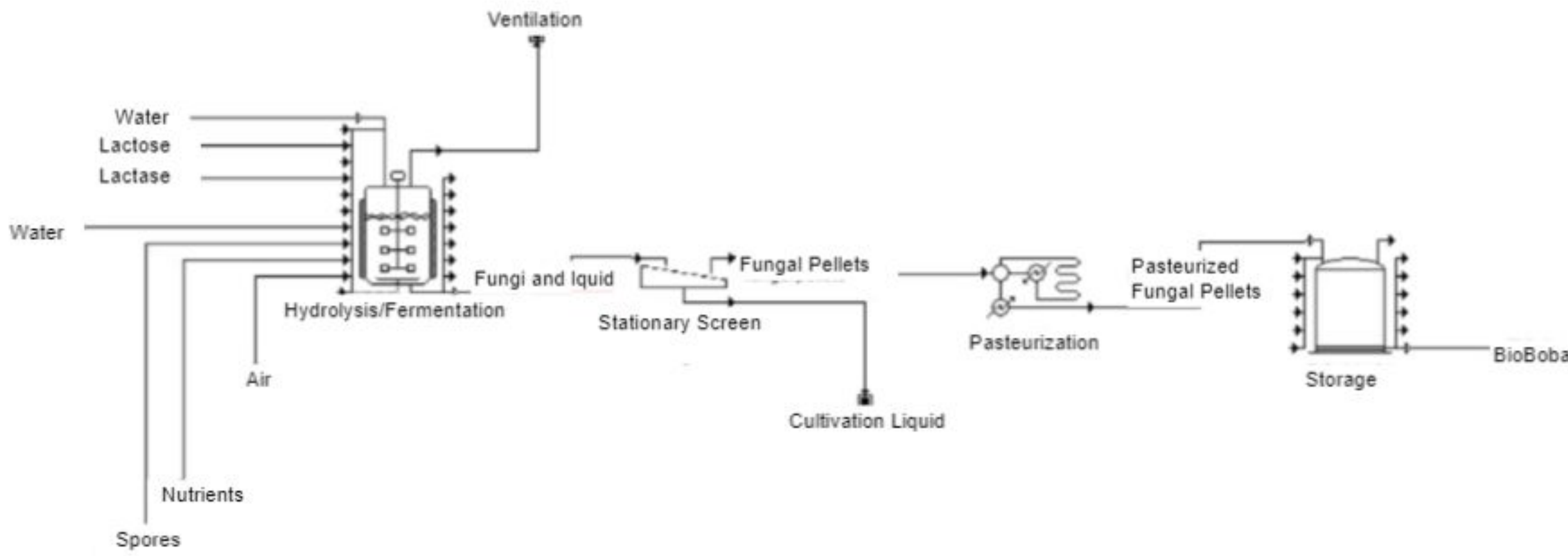
1. Design the upscale production system for mycoprotein pellets
2. Select equipment and estimate cost of the pilot production system

Design Criteria and Constraints

Criteria	Food Safety	Food Product meet the requirements from FDA
	Process Capability	Avg. 18 kg(dm) mycoprotein per day 360 kg(wt) mycoprotein per day
	Service Life	>5 years
	Construction of the system	All operators are built with stainless steel
	Layout	The equipment can fit in room
	Cleaning	Clean in place capability
	Fermentor	Working volume at 150 gallon
		Temperature at 30℃
		The thermo-model meets the requirement of heat removal
		Air flow rate and pressure controllable
		pH monitoring and handling at pH of 4~5
	Separator	Separate pellets from the liquid phase
		Keep the pellets unbroken
		Collect the food pellets fast enough
Constraints	System Capacity	18 kg(dm) of bioboba per batch (5days/batch) >18 kg(dm) production per week
	Budget	As low cost as possible
	Food Property	Mycoprotein as a fungal food needs stabilization
		Food could clot and fill the transportation

BioBoba Product

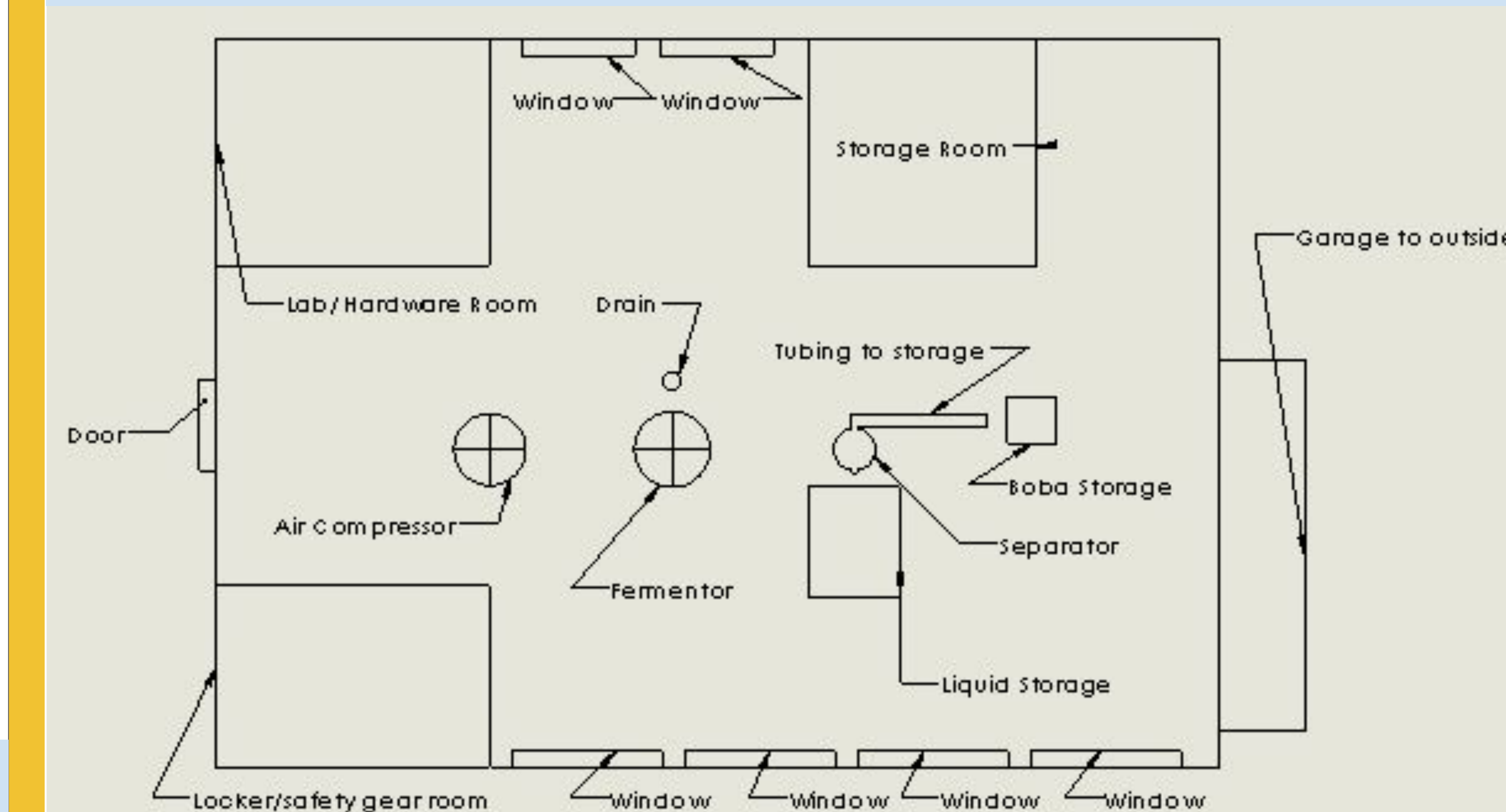
Mycoprotein Production System



Unit operations for Mycoprotein Production System

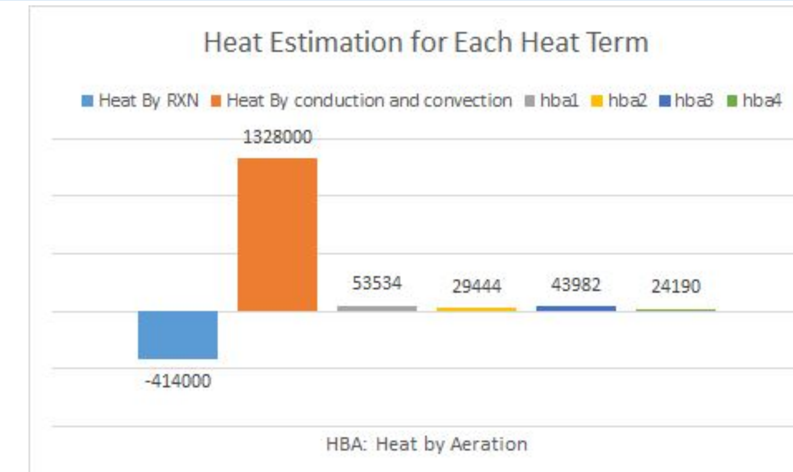
1. **Hydrolysis & Fermentation** to create a sugar liquid solution from lactose, pasteurizing it and then adding nutrients and spores to the fermenter to cultivate the fungi in a 150 gal fermenter for 5 days.
2. **Separation** to separate the fungal pellets from nutrient solution
3. **Pasteurization** of the fungal pellets at 55 deg C for 3 hours to ensure they are food safe
4. **Storage** of the fungal pellets under refrigeration conditions until they are used in a final food product

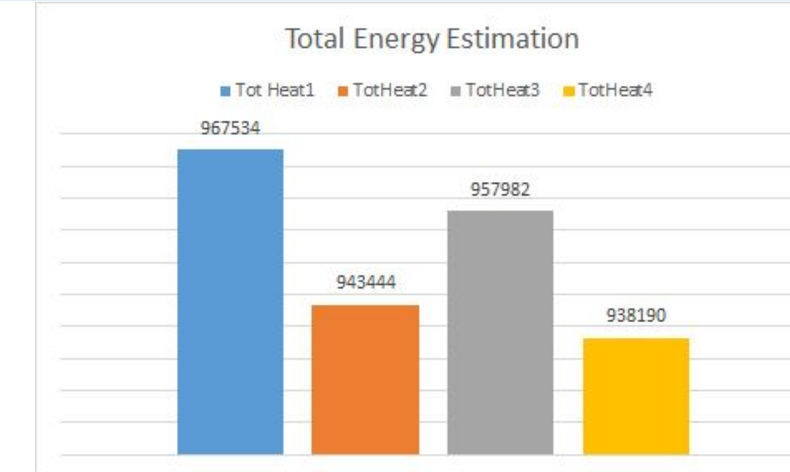
Pilot Plant Layout



The pilot plant is layout reveles around the central fermentor. There is an air compression tank attached to the fermentor. A drain was placed right by the fermentor to catch any liquid run off. We have a room for equipment management and a locker room for lab gear. The storage room has two refrigerators. To ensure we can move the equipment into the plant and transport our products in we installed a garage on the rear side. The separator is placed 2 meters away from the fermenter to catch all of the boba pellets then it is transferred to storage.

Thermal Modeling





Thermal modeling for the cultivation process are based on heat released by the reaction, heat transfer via conduction, convection, and aeration. The conduction and convection heat transfer dominate the heat transfer term.

At room temperature of 20~22℃, and the relative humidity at range of 40%~50%, 93MJ to 100MJ of energy must be removed per batch. The variation of the energy is due to the construction equipment, geometry of the fermenter, and air flow rate.

Equipment

- Fermentor
- Separator
- Pasteurizer
- Air Supply
- BioBoba Storage
- Liquid Storage

Economic Analysis

Annual BioBoba Production	19,080 kg of fungal pellets
Capital Investment	$2,901,738
Annual Operating Costs	$597,513

Conclusion

The 150 gallon, pilot scale mycoprotein production system designed can produce 19,080 kg of BioBoba annually. A SuperPro model including all the unit operations has been created. Heat and aeration calculations were completed in order to select the appropriate equipment. The team designed a separator for BioBoba using SolidWorks since no comercial separators fit the criteria.The cultivation requires heat removal of 186,000 to 196,000 kJ per day and an airflow rate of 4.51 to 8.2 CFM. The pilot plant requires a room size of 8 x 11 m, a capital investment of $2.9M and an annual operating cost of $600K.

Future Recommendations

Following our accomplishments so far on the project, the future steps are finalizing the equipment for the fermentation and separation processes based on the aeration and heat calculations, and as well as how Bioboba can be further utilized to produce variety products.

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