PURDUE UNIVERSITY

CAPSTONE/SENIOR DESIGN EXPERIENCE 2017

Malt Roasting

Agricultural & Biological ENGINEERING

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Problem Statement

There are limited options in the malt industry for malt roasting equipment. The sponsor for this project is Sugar Creek Malt Co., malting company located in Lebanon, Indiana. They currently produce and process base and smoked malts for breweries around the Midwest. The company has asked for a roasting system that is capable of processing and producing roasted malts. The solution had to meet the following objectives:

1. 7-10 bushel batch capacity
2. Temperature control of 150-600ºF
3. Moisture and airflow control
4. Minimize economic investment
5. Roast uniformity with a good mixing design.

Background

Roasted malts are called “Specialty Malts”. These kinds of malts have a big impact on a beer’s flavor, mouthfeel and color. There are many different types of specialty malts with different color and flavor characteristics that influenced by time, temperature, moisture and airflow while being roasted. The roaster also has the purpose of stopping further germination from the malting process, give a better shelf life of the product and ease of handling.

Global/Societal Impact

There are currently very few companies that provide specialty malts to a large number of breweries in the U.S. Specialty malts require a big economic investment on equipment in order to produce these products. Having more accessible machinery to do so will allow many other competitors to offer these highly demanded products.

Malting Process

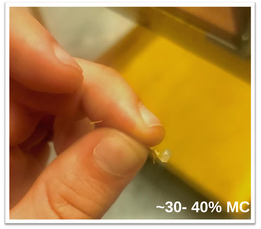
Roasting Process

Steeping

Water is added to steeping tanks to completely soak the grain and a rotation of water submersion and drained air rest begins.

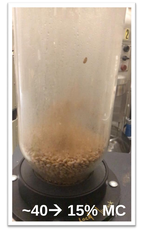
Germination

The purpose of germinating is to activate the grain. This will develop enzymes to break down starch.



Conversion

Once inside the roasting chamber, maintaining the temperature and humidity, the enzymes turn starch into simple sugars.



Dehydration

All vents are opened in order to take out moisture.

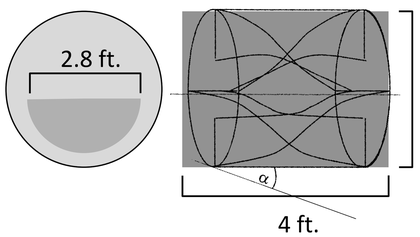
Maillard Reaction & Cool Down

When the grain reaches 15% moisture, it will start changing color. Depending on the desired color the roaster will determine the degree of roast and begin cooling down to avoid further reaction.

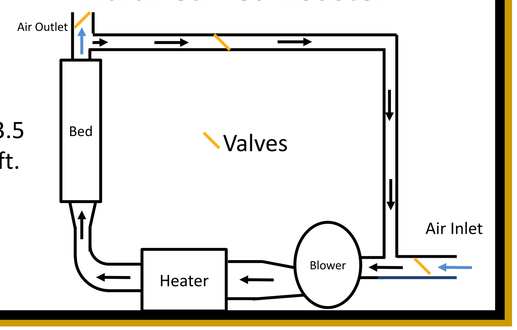
Alternative Solutions

The drum roaster was the initial solution. Further involvement with the solution, the drum’s size, complexity and cost meant it was not a viable solution. With fluidized beds satisfied all of the constraints. This system has many advantages for example, low cost on manufacturing, perfect mixing, more energy and time efficiencies and a higher quality end product.

Drum Roaster



Fluidized Bed Roaster



Economic Analysis.

The table shows a bill of quantities from a project in Nigeria with the objective of building a drying unit for farmers with limited resources. This example shows that the simplicity and flexibility of a fluidized bed can result in having a low cost building a unit.

Materials	Quantity	Rate (Naira)	Rate $	Cost (Naira)	Niara to $
Mild steel	4	4000	$13.13	16000	$52.50
Mild steel	2	3750	$12.31	7000	$22.97
Hacco pipe	1	5000	$16.41	5000	$16.41
Brim plate	1	2000	$6.56	2000	$6.56
Valves	2	600	$1.97	1200	$3.94
Electrode	2	1200	$3.94	2400	$7.88
Electric motor	1	8000	$26.25	8000	$26.25
Bolts and nuts	20	30	$0.10	600	$1.97
Electrode	100	10	$0.03	1000	$3.28
Paints	1	1850	$6.07	1850	$6.07
Miscellaneous				5000	$16.41
Total				50,550.00	**$165.87**

Oluleye, A. E., and A. A. Ogungbemi. *Design and Fabrication of a Low Cost Fluidized Bed Reactor.*

Design Assessment & Conclusions

A lot of the project’s time was invested in research and experimental trials with a lab sized fluidized bed dryer. The objective of the experiments was to prove that the FB concept is applicable to roasting malt. This machine had to be modified to recirculate the air to retain humidity for the “conversion” step for crystal malts. The results were satisfactory, and proved that it is possible to activate enzymes to convert the starch into simple sugars. There are some aspects of functionality still in question that were not able to prove. For example, right out of the germination stage the malt still has a web of roots that do not allow the seeds to freely flow in the chamber. Further experimentation is necessary to fully say that fluidized beds are practical for malt roasting.

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