CAPSTONE EXPERIENCE 2012

Enzymatic Beer

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Introduction

Global and Societal Importance

Beer

•Most popular alcoholic beverage in the United States
•Generates $61 billion in retail sales per year
•Expected to grow 19% to 73 billion from 2010-2015

Microbreweries

•Mass-produced domestic beer is becoming less popular.
•Over the past 5 years, microbreweries have been a growing industry.

Traditional Beer Process

Milling: Cracking the grain.
Mashing: Grains, hot water, and malt* are combined to produce starchy solution called wort. Starches in wort are converted to fermentable sugars.
Straining: Solids are filtered
Brewing: Hops are added mostly for flavor. Solution is boiled for an hour to destroy microbes.
Cooling: The hops are filtered from the wort and solution cooled.
Fermentation: The yeast is added, and the solution mixed for aeration. The fermentable sugars are converted to alcohol and CO_2.
* Our process replaces the enzymatic activity of malt with fungal enzymes.

Problem and Impact

Our objective is to eliminate the malting process in brewing by replacing the malt with fungal enzymes and non-germinated grains. This is beneficial for energy reduction, process time reduction, and cost.

Lab Experiment

Objective

The goal of the lab experiments were to test if fungal enzymes would act as a viable substitution for malt in the beer making process. The enzymes we used were alpha-amylase and gluco-amylase.

large amylose —*alpha-amylase*→ small amylose and disaccharides

small amylose and disaccharides —*gluco-amylase*→ glucose

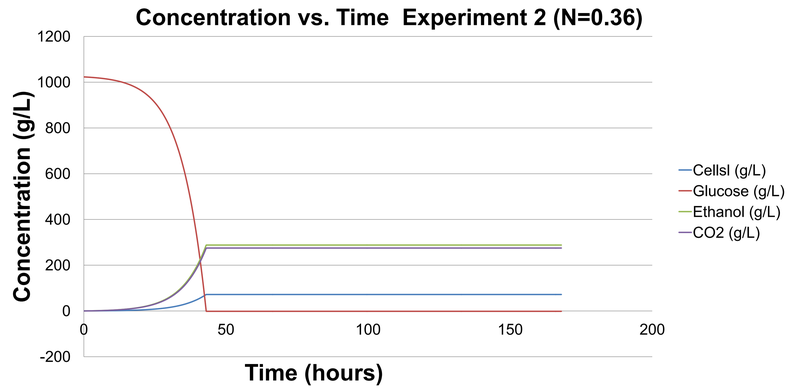
Procedure for Saccharification

1. Heat water to 155 °F.
2. Add oats and stir for 30 minutes.
3. Filter the mixture.
4. Add varying amounts of enzyme to each pot.
5. Stir and maintain a temperature of 145 to 155 °F for 60 minutes to allow the enzymes to convert the starch to glucose.
6. Cool and measure the specific gravity.
7. Calculate the glucose content of the solution based on the specific gravity.

Results

Experiment	Alpha-Amylase (g)	Gluco-Amylase (g)	Specific Gravity	Specific Gravity (adjusted)	ABV (%)	ABW (%)
1	0.136	0.136	1.018	1.021	2.063	1.635
2	0.068	0.068	1.018	1.023	2.260	1.790
3	0.034	0.034	1.017	1.020	1.965	1.558

The amylases prove to be effective in converting the starch into glucose in our beer process.

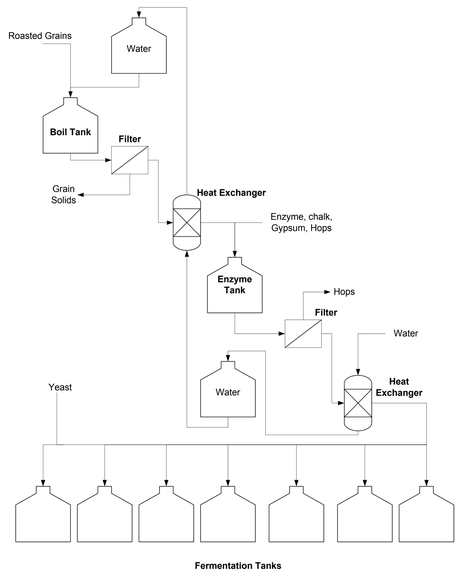


Plant Design

Economic Evaluation and Constraints

Our plant design was constrained by energy use. Our goal was to design a process that reduces energy input while producing affordable beer.

Beer Process



Economics

Equipment cost ($): 773,000
Energy cost ($/yr): 557,000
Raw Material cost ($/yr): 393,000
Product Output (gal/yr): 630,000
Optimized price ($/kg): 2.66

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