IPRO 321

Introduction to Zymurgy

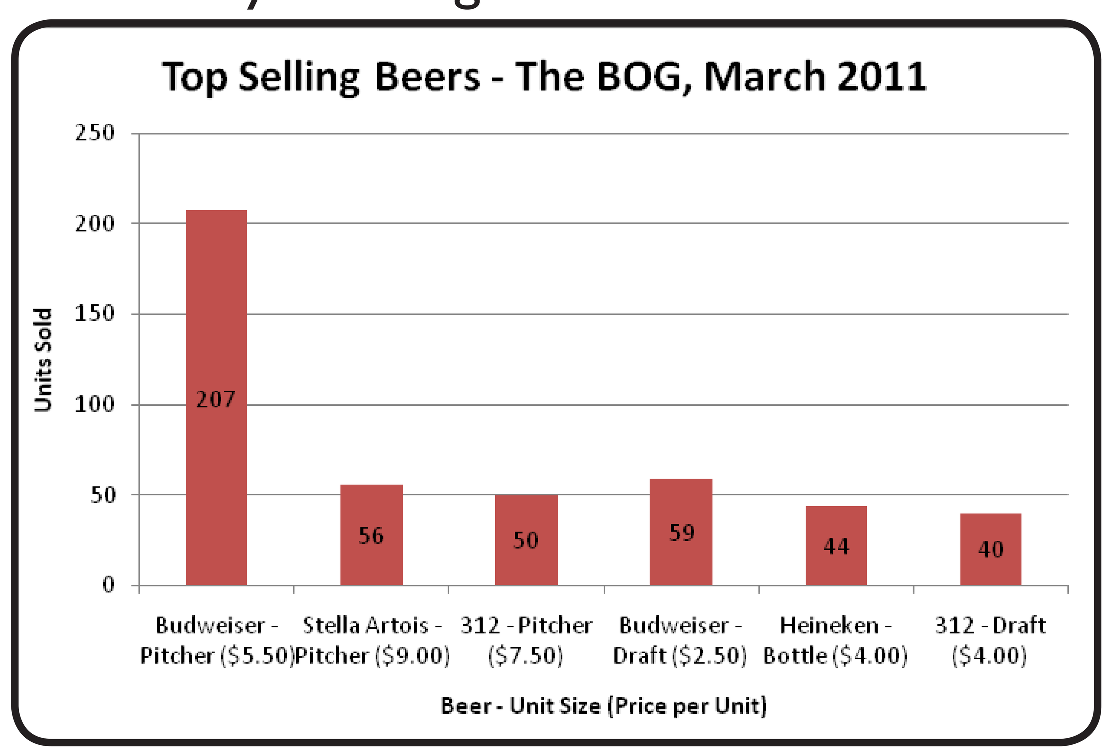
Know iit Ales

IPRO It takes a team! INTERPROFESSIONAL PROJECTS PROGRAM

ILLINOIS INSTITUTE OF TECHNOLOGY

Business Plan

Know IIT Ales strives to provide students with better choices for their money. The approach is to micro-brew beer at the university and then offer the product at The BOG through an agreement with campus food service. By brewing small batches on campus, the Know IIT Ales will be able to provide beer in a timely fashion as needed and also adapt to the preferences of students by brewing a wide selection of beers.



IPRO BG 321

Recipes

Altbier was produced in three batches. The first batch had yeast that required fermentation at 50 °F. The second batch had more hops than the former and used as a control fermenting at room temperature. This was to observe how much faster the fermentation process would be along with comparing taste and alcohol content. The third batch also consisted of the same recipe but with a few minor changes, including using different yeast that fermented at room temperature. This was used to analyze how yeast and temperature changes the taste and quality of the beer.

BATCH 1 & 2

Recipes: St. Udleys Beer

Ingredients:

- 6-lbs plain dark malt (15)
- 1-lbs German vienna grain
- 1-lbs Belgian caramunich (cara 45) grain
- 1-lbs caramel 40 L grain
- 1oz perle (90)
- 0.5oz perle (40)
- 0.5 oz perle (15)
- wyeast 2565 kolsch yeast
- Irish mach (1-lb)

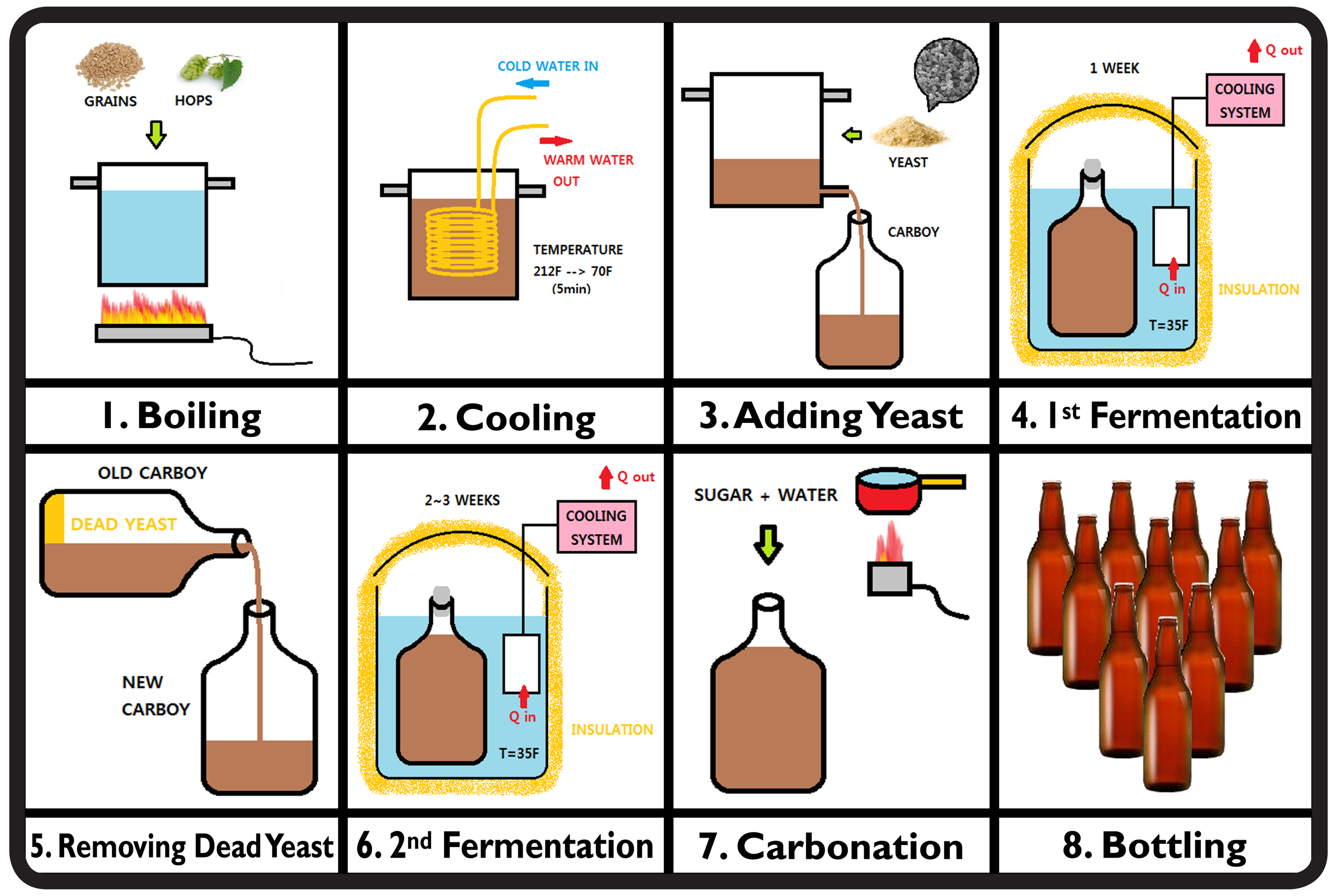
BATCH 3

Recipes: St. Udleys Beer

Ingredients:

- 6 Lbs. Munton's Plain dark molt extract color EBC 60
- 1 Lb German Vienna grain
- 1 Lbs Carmel 40 grain
- 2 Lbs Belgian cara 45 grain
- 1 oz Tentnag hop
- 1 oz perle (90) hops
- 0.5 oz perle (45) hops
- 6 Lbs dark malt
- 1 tbsp Irish moss
- Wyeast American Ale XL yeast

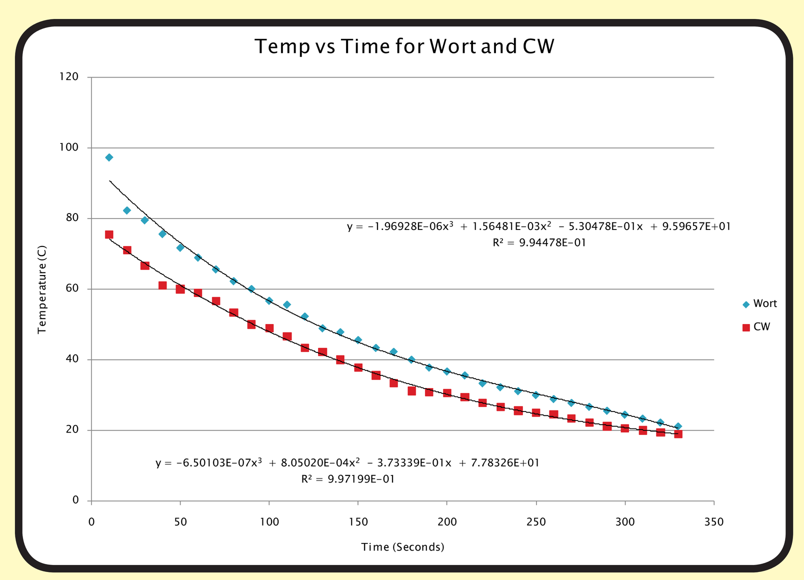
Brewing



Heat Transfer

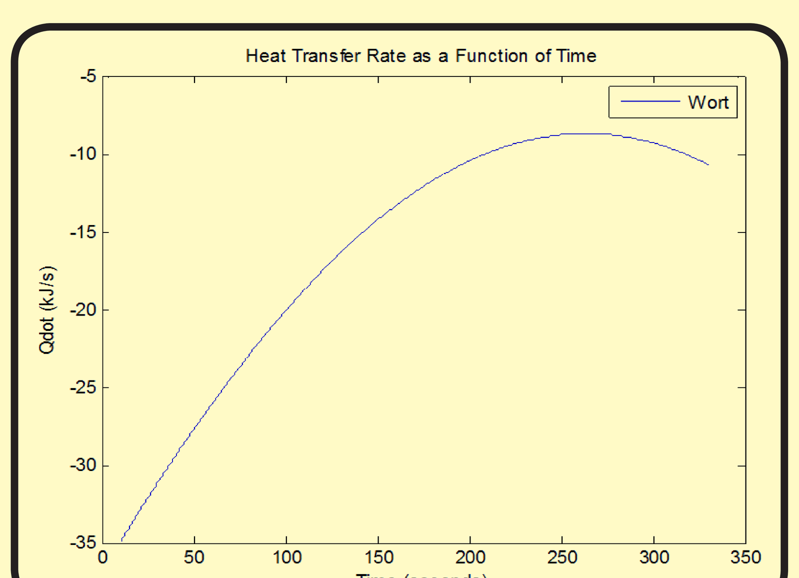
Intro: Heated wort was cooled via a copper cooling coil that circulated cold water (CW).

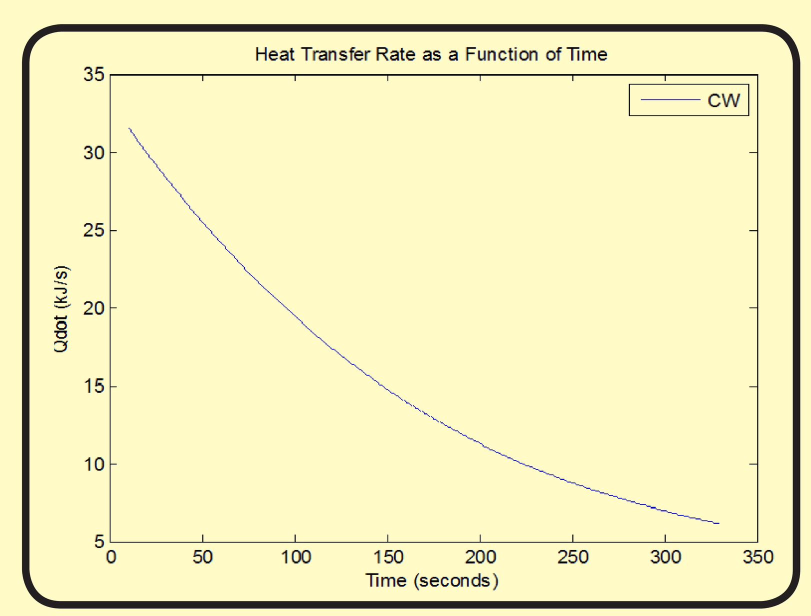
Goal: Find total energy absorbed via CW and total energy removed from wort.



$$\dot{Q}_{wort} = mC_v\frac{dT(t)}{dt}$$

$$\dot{Q}_{CW} = \dot{m}C_p(T_{out}(t) - T_{in})$$





$$integrate \int_{10}^{330} \dot{Q}_{wort}\,dt = total\ energy\ removed\ from\ wort = -5108.5\ kJ$$

$$integrate \int_{10}^{330} \dot{Q}_{CW}\,dt = total\ energy\ absorbed\ via\ CW = +4847.4\ kJ$$

$$|Q_{wort}| - |Q_{CW}| = |Q_{loss}|_{to\ surroundings}$$

$$5108.5\ kJ - 4847.4\ kJ = 261.1\ kJ$$

Cell Kinetics

The kinetics of the yeast cells were modeled from experimental data. Concentrations of alcohol and sugar content were recorded for 12 days. The graphs generated below illustrate experimental data plotted along with the designed model output to compare level of agreement between actual and predicted results.

EQUATIONS:

$$r_g = \mu C_c \text{ ....(1)}$$

$$\mu = \mu_{max}\frac{C_S}{K_S + C_S} \text{ ....(2)}$$

$$C_C = (1 - \frac{C_P}{C_P^*})^n \text{ ....(3)}$$

Using equations 2 and 3, equation 1 becomes:

$$r_g = (1 - \frac{C_P}{C_P^*})^n * \mu_{max}\frac{C_S}{K_S + C_S} \text{ ....(4)}$$

$$r_d = k_d C_c \text{ ....(5)}$$

$$\frac{dC_C}{dt} = r_g - r_d \text{ ....(6)}$$

$$\frac{dC_S}{dt} = -Y_{S/C} * r_g - mC_C \text{ ....(7)}$$

$$\frac{dC_P}{dt} = Y_{P/C} * r_g \text{ ....(8)}$$

Using equations 4 and 5, equation 6 becomes:

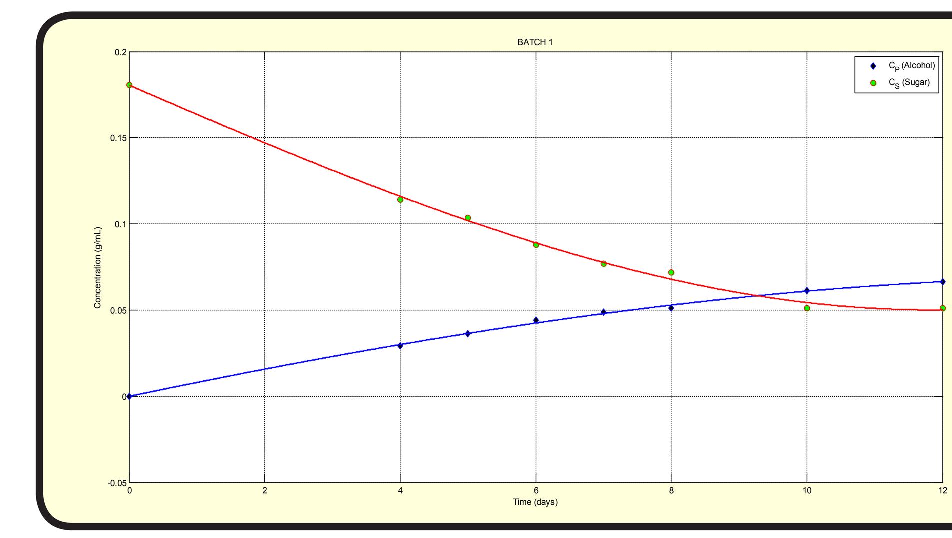
$$\frac{dC_C}{dt} = (1 - \frac{C_P}{C_P^*})^n * \mu_{max}\frac{C_S}{K_S + C_S} - k_d C_c \text{ ....(9)}$$

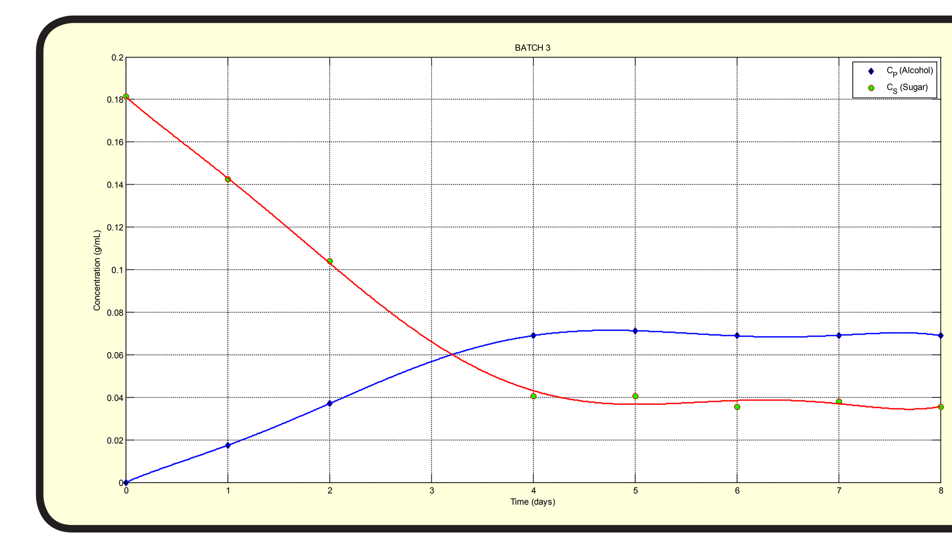
Using equation 4, equation 7 becomes:

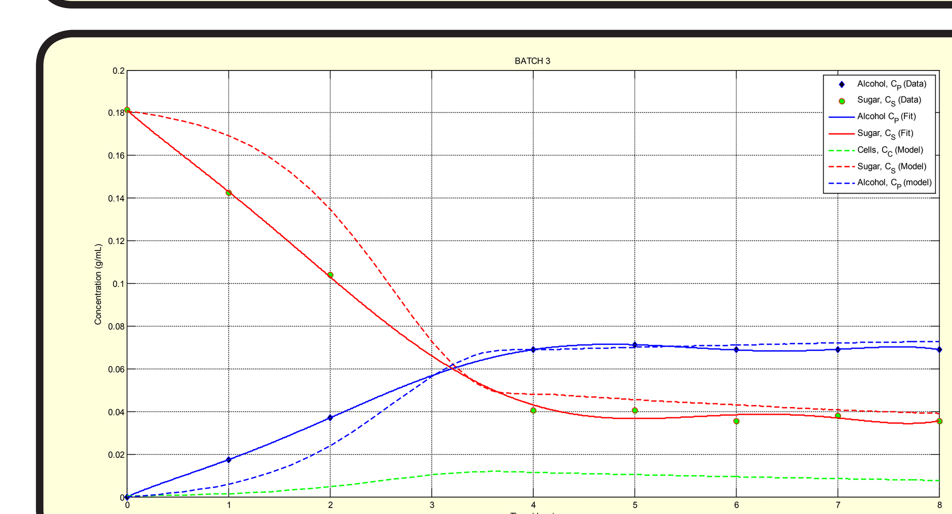
$$\frac{dC_S}{dt} = -Y_{S/C} * (1 - \frac{C_P}{C_P^*})^n * \mu_{max}\frac{C_S}{K_S + C_S} - mC_C \text{ ....(10)}$$

Using equation 4, equation 8 becomes:

$$\frac{dC_P}{dt} = Y_{P/C} * (1 - \frac{C_P}{C_P^*})^n * \mu_{max}\frac{C_S}{K_S + C_S} \text{ ....(11)}$$







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