Bioethanol Production

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Problem Definition

MuPor industries has designed and patented a novel rapid fermentation bead system that needs to be tested and proven for industrial applications. These beads have shown to be effective for bench-top scale fermentation and microbrewery purposes, but their full potential will likely require a specially designed fermenter tailored to the design of the beads.

Project Goal

To have a fully functional 150-300 gallon ethanol fermenter tailored specifically for the use of the BioEx beads and being capable of operating industrially.

Major Parameters

- Temperature
- Sugar concentration
- Mass of beads per sugar solution
- Alcohol content
- Time

Current Design Specifications

Liquid Volume	**150-300 gallons**
Process	**Batch or continuous flow reactor**
Operating Temperature	**70-100° F Optimal (95°)**
Fermentation Time	**2 hours**
Initial Sugar Concentration	**16% (yields 9.4% ethanol by volume)**
Bead Loading	**300 grams (Dry) Per Liter**
Average Size	**4mm**
Composition Type	**Encapsulated Matrix**
Expansion	**5.23 x dehydrated volume 33% expansion when actively fermenting**

Gay-Lussac Equation

$6(C_2H_2O)$	--->	$2(C_2H_5OH)$	+	$2CO_2$	+	heat
1kg		511 g		489 g		147Kcal
(sugar)		(ethanol)		(carbon dioxide)		(energy)

- Universal equation used to easily calculate byproducts from fermentation.
- Specifically we used it to calculated CO_2 evolved

Calculations: Determination of Theoretical CO2

Per 18 gallons of 16% sugar solution (wt)

24.0336 lbs sugar x (453.592 grams/1lbs) = 10901.4 g sugar or 10.9014 kg sugar

Using stoichiometric relationship of reaction:

(.489 kg CO2/1kg sugar) x (10.9014 kg sugar) = 5.33078 kg CO2 produced

Converting to moles:

(5.33078 kg CO2) x (1000 g/1 kg) x (1 mol/44.01 g) = 121.127 mol CO2

Calculations cont.

Using ideal gas law Pv= nRT

P = 1 atm
V = ?
R = .0821 L x atm/ mol K
T = 273 K

Solving for volume:

V= (121.127 mol x .0821 L atm/mol K x 273 K)/ 1 atm

<u>V = 2714.86 liters</u>

Experiment 1

- Beads migrated across the layers
- Head space (1.2 gallon loss)
- Loading and unloading overly complicated
- Reaction is exothermic ~ 6400 btu of heat per barrel reaction
- Dead zone at the bottom of the reaction vessel ~10 degree temperature change
- Had some initial problems with the set up of our reactor and were not able to get sufficient data collected