Project HZ2-1

Distillation

We wish to distill IPA from a feed which is 35 vol% IPA and water using our lab's distillation column. Our tops product, however, may be required to contain a range of IPA concentration from 80 to 90 vol% of the azeotrope, and this concentration may need to be altered quickly. Your task will be to investigate the use of adjusting the reflux ratio to alter the tops IPA concentration.

Use appropriate theory and/or a software package such as *Aspen* to evaluate your strategies, predict your outcomes, and to compare your results to theory. Characterize the system's response to a step change in the reflux ratio and use the system's response to make recommendations about operating the column in the desired range by manipulating the reflux ratio.

When operating our distillation column there are several factors that you may adjust to achieve desired results: reboiler power, condenser temperature, feet point, and more. Use your judgment and relevant theory in order to determine conditions necessary to operate the distillation column in the most efficient manner.

Be prepared in your oral quiz to address the following:
a) Safety issues with this experiment
b) Equipment operation
c) Data sheets
d) Other germane points with respect to this experiment

Please include this assignment in your report as an appendix but do not cite it in the body of your report.

Project HZ2-2

Bioreactor

Your company is interested in culturing baker's yeast. Your task is to characterize the new bioreactor in the lab. Dissolve oxygen is essential for cell growth in a bioreactor. Due to the low solubility of oxygen in water, chemical engineers often need to design a bioreactor with maximized oxygen transport. Your objective is to determine the specific growth rate of the yeast, the specific oxygen uptake rate of the yeast, and the oxygen mass transfer coefficient k_La at the presence of the yeast.

Be prepared in your oral quiz to address the following:

a) Safety issues with this experiment

b) Equipment operation

c) Data sheets

d) Other germane points with respect to this experiment

Please include this assignment in your report as an appendix but do not cite it in the body of your report.

Project: HZ2-3

Differential Scanning Calorimetry (DSC)

Your company produces commodity plastics. Unfortunately. The data center has lost the material property information of our products. Your task is using DSC to characterize the materials properties of the four missing product. We are primarily interested in glass transition temperature, crystallinity temperature, and melting temperature. The warehouse record also showed one of the products is Nylon 66. Please identify which product is closely to Nylon 6/6

Be prepared in your oral quiz to address the following:

a) Safety issues with this experiment

b) Equipment operation

c) Data sheets

d) Other germane points with respect to this experiment

Please include this assignment in your report as an appendix but do not cite it in the body of your report.

Project HZ2-4

Liquid Flow Bench

Flow through packed beds are essential for many unit operations including trickle bed reactors used for biological clean-up of phenol from process waters in a Salt Lake City refinery. Phenol at concentrations above 10 ppm is toxic to bacteria in waste water treatment facilities and must be removed before refinery waste water is discharged to the sewer. As a result, waste water is caused to flow through a packed bed bioreactor made of porous sand impregnated and bound with an enzyme from unique strain of bacteria that considers phenol food. The enzyme in the acid form catalyzes the oxidation of phenol rendering it non-toxic. The kinetics of this oxidation reaction follows the Michaelis Menton kinetic relation

$$-\text{Rate} = V_{max}\, S/(K_m+S)$$

where S is the concentration of the substrate, phenol, and V_{max} =1 x10^{-6} mole/(cm^2 hr) and K_m= 12 ppm measured for the enzyme impregnated sand particles. Your job is to determine from the properties of the flow of water in the laboratory sand bed (i.e. friction factor vs Reynolds number) so that this sand bed can be used in an appropriate waste water treatment plant to treat 50 gal/hr of water loaded with 500 ppm phenol so that it can be rendered safe to send to the Salt Lake City sewer. Size (diameter and height) the sand bed reactor needed for this application.

Be prepared in your oral quiz to address the following:

a) Safety issues with this experiment

b) Equipment operation

c) Data sheets

d) Other germane points with respect to this experiment

Please include this assignment in your report as an appendix but do not cite it in the body of your report.

Project HZ2-5

Fluidized Bed

Using the steel grit – SG 80 with the properties given on the ERVIN Industries web site (www.ervinindustries.com) with bulk density 3.44 gm/cc, tap density 3.99 gm/cc and steel density of 7.86 gm/cc determine the bed height with different superficial velocities ranging from 0 to 2.5 ft/s. This website gives information about the particle size distribution that is to be used in determining an average particle size for determination of fluidization characteristics using theory. Above the minimum fluidization velocity the bed will become a bubbling fluidized bed which will give difficulty in measuring the bed height such that determining the min and max height is a more realistic way of measuring the bed height than trying to determine the average bed height. In addition to the bed height, please determine the min/max pressure drop over the bed. Be sure to remove the pressure drop associated with the distributor plate so that only the pressure drop in the bed is given in your data. In your report please develop graphs of the min/max bed height and min/max pressure drop over the bed. Compare these graphs to those developed using theory associated with fluidized bed operation for this distribution of particle sizes.

Be prepared in your oral quiz to address the following:

a) Safety issues with this experiment

b) Equipment operation

c) Data sheets

d) Other germane points with respect to this experiment

Please include this assignment in your report as an appendix but do not cite it in the body of your report.

Project: HZ2-6

Ebulliometer

You are working at a chemical processing plant in Salt Lake City, UT. Your plant is interested in distilling an isopropanol/water mixture. Your task is construct a Txy diagram for isopropanol/water mixture by using an Ebulliometer. Please compare the experimental results with the theoretical result and discuss the discrepancy between the results.

Note: There are many methods to measure the composite of the isopropanol in our lab, including the gas chromatograph, densitometer, refractometer, and infra-red spectroscopy. Please choose the proper method for your experiments.

Be prepared in your oral quiz to address the following:
a) Safety issues with this experiment
b) Equipment operation
c) Data sheets
d) Other germane points with respect to this experiment

Please include this assignment in your report as an appendix but do not cite it in the body of your report.

Project HZ3-7

Ultrafiltration

Your team is a part of the downstream processing team for a pharmaceutical company. Your company has developed a protein-based therapeutic for Alzheimer's patients. The current formulation has a high concentration of glucose, which is not suitable for diabetic patients. Your team is asked to develop a crossflow ultrafiltration process for removing the glucose in the current formulation.

The current formation has 5% glucose (w/v) and 1mg/ml of proteins in water. The target glucose concentration in the final product is 0.5% (w/v) and 1mg/ml of proteins. Determine the operating parameters to achieve the final product specificity.

Note: the protein therapeutic in our product is similar to bovine serum albumin (BSA). You can use BSA for your experiments to reduce the cost.

Be prepared in your oral quiz to address the following:

a) Safety issues with this experiment

b) Equipment operation

c) Data sheets

d) Other germane points with respect to this experiment

Please include this assignment in your report as an appendix but do not cite it in the body of your report.

Project HZ2-8

Double Pipe Heat Exchange

The goal of this project is to evaluate its performance in using steam to heat cold water by at least 10 ^{0}C. Please run the heat exchanger at a variety of steam pressures and cold side flow rates. For each case, calculate the amount of heat lost by the steam using measurements on the steam only. For each case, calculate the amount of heat gained by the water using measurements on the water only. Are these two quantities equal in magnitude? Also, determine the overall heat transfer coefficient at each operating condition.

Be prepared in your oral quiz to address the following:

a) Safety issues with this experiment

b) Equipment operation

c) Data sheets

d) Other germane points with respect to this experiment

Please include this assignment in your report as an appendix but do not cite it in the body of your report.