CHBE 344 Homework Assignment #4

Due: 16 November 2018 at 4pm

Problem 1 (10 points):

a) Describe the fundamental, physical principles upon which separation is accomplished using chromatography in 100 words or less. Count your words and clearly list the number at the end of your answer.

b) Name three *specific* industrial or consumer products that utilize chromatography in the production process. List your sources in an easy-to-read format with enough detail to allow someone else to look it up.

Problem 2 (20 points):

Two new proteins have been identified as potential cures for every form of cancer ever known and are being characterized for purification by chromatography. Adsorption data have been collected for the most promising packing material from early trials and need to be fit to an isotherm model for numerical simulations to optimize the process.

a) For the data provided in the csv file, find the best fit parameters for the following isotherms:

   i) Linear isotherm
   ii) Langmuir isotherm
   iii) Freundlich isotherm

b) Which model would you recommend be used in the numerical simulations of the chromatographic separations process and why?

Problem 3 (20 points):

A single effect evaporator is to be used to concentrate 5890 kg/hr of a 2.01 wt% solution of NaOH to a final concentration of 50.0 wt% NaOH. The steam used in the evaporator is at 821 kPa (171.5C) and the heat transfer coefficient is 1232 $W/m^2/K$. The pressure in the head space above the boiling liquid is maintained at 6.89 kPa and the feed is entering the evaporator at 22C. You may estimate the boiling temperatures by assuming Raoult's law holds for all concentrations and interpolating the following data taken from a saturated steam table:

Pressure [kPa]	5.0	6.0	7.0	8.0	9.0	10.0	12.0	14.0	16.0	18.0	20.0
Temperature [C]	32.90	36.18	39.03	41.54	43.79	45.83	49.45	52.58	55.34	57.83	60.09

a) Calculate the following quantities assuming negligible enthalpy of mixing and adiabatic tanks:

   i) mass flow rate of steam needed for this process
   ii) surface area of the evaporator
   iii) economy of the evaporator

b) Plot the mass flow rate of steam needed (y-axis) to adjust the concentration from 2.01 wt% to 60.0 wt% under the same assumptions.

c) Will the required mass flow rate increase or decrease if enthalpy of mixing and heat loss from the tanks are not neglected? Briefly explain your answer.