ABE 558 Sp19. RO design problem.

Due 21 Jan 18 11:59pm Do you own work

X = each student’s alphabetical class listing

1. Design a RO membrane system to concentrate 1000+10X gallons/hr of 1+0.01X% glucose solution to 10+0.1X% by wt. Determine equipment and operating costs. The RO system is comprised of 1.5 mm diameter 4+0.1X meter long tubes grouped in parallel. To help minimize concentration polarization, the retentate velocity is maintained by placing the membranes in series in a tapered cascade design. A pump is used to boost the pressure for each group of membrane tubes in series. Pressures up to 50-0.1X atm. are used across the membrane. At a given velocity, a pressure drop will occur across the membrane due friction. The velocity in a tube will decrease due to water permeation and the concentration of glucose will increase. The osmotic pressure because of concentration polarization and glucose rejection will be effected by the water permeation flux. The membrane pure water permeability constant AW = 4.01X10^ -4 kg water/ (s m2 atm) and the glucose permeability constant is 1+0.1X x 10^ -7m/s.
2. Hints:

Set initial velocity per each tube per CJG table 2.10-3

Estimate glucose diffusivity with CJG Eq 6.4-1

Estimate kc’ using correlation for Sherwood Number CJG Eq 7.3-25

Estimate fanning friction factor ‘f’ using equations 12.4 and 12.5 of PTW or using Chilton-Colburn analogy CJG Eq 7.3-13

Using literature data, develop an equation to determine viscosity, density and diffusivity of glucose as a function of concentration.

Membrane equipment cost (yr 2002): 10 M^2 is $400/M^2 n=0.8 range 5 M^2 to 200 M^2.

To determine pump costs see PTW (Figures 12-20 to 12-24) and energy costs Table B-1.

1. Determine the number of membrane tubes in series, the membrane area, number of tubes required and pump hp required for each group.’

2: develop a detailed algorithm of the design solutions.

3. Provide a report of the design in an organized manner: summary of design, show plot of outlet glucose concentration and pressure drop, present process diagram of flows, concentrations, hp, and tube number for each stage. Capital and operating costs. Provide reference for all equations, units. Submit all code and/or calculations in an organized manner as a runnable .m file