ENCH 445 — Separation Processes — Problem Set #6

1. Do problem D.11 from chapter 12 of the 4th edition of your textbook.

2. Do problem D.22 from chapter 12 of the 4th edition of your textbook.

3. A stripping column is used to remove hydrogen sulfide that is present in trace amounts from a water stream. The column uses air at 60.8 kPa absolute pressure as the stripping gas, and the overhead gases are drawn at that pressure into a vacuum system. The column must remove 98% of the hydrogen sulfide that is originally present in the water stream. The tower is isothermal at 27 °C. If the tower provides three equilibrium stages, find the necessary air rate, expressed as moles air per mole water. The equilibrium data is on the attached figure.

4. Design of a solvent extraction process for wastewater treatment

A solvent extraction process uses n-butyl acetate as a solvent to remove pyrocatechol (o-dihydroxybenzene) from a wastewater stream where it is present at an average concentration of 800 ppm (w/w) (0.08 wt-%). It is known that the equilibrium distribution coefficient K_D [= (weight fraction in solvent phase/weight fraction in aqueous phase)] is 13.2 for this system at 298 K. If the regenerated butyl acetate used as a solvent in the process contains 100 ppm (mass/mass) pyrocatechol, propose a design for the extraction process for the case where 97% of the pyrocatechol that is originally present is to be removed from the wastewater stream.

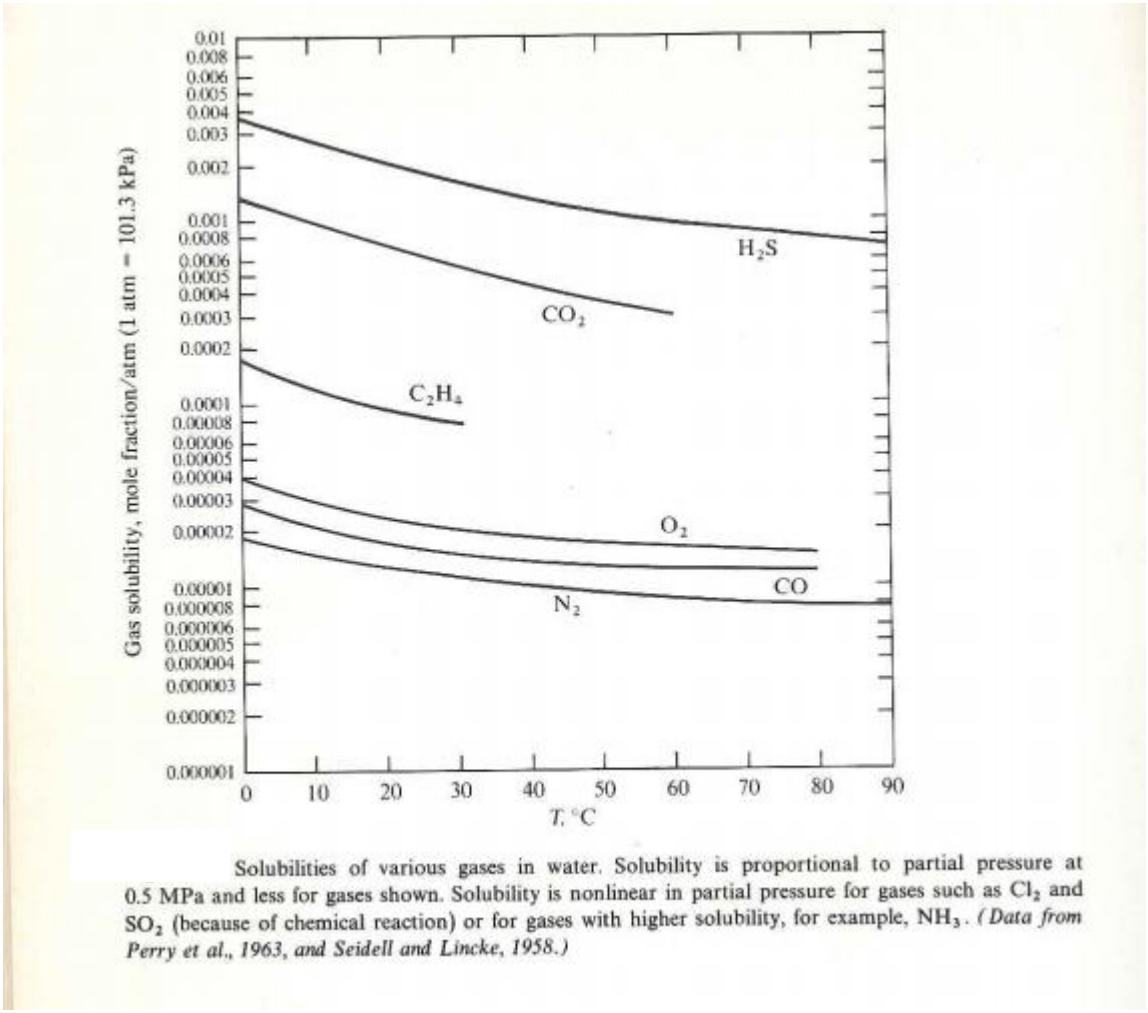
5. Simulation of a solvent extraction process for acetic acid recovery

Processes for recovering acetic acid from a aqueous stream are widely used in the chemical process industry. A solvent extraction column that provides 4 equilibrium stages is to be used for this purpose to recover acetic acid from an aqueous feed stream using ethyl acetate as a solvent. The composition of the feed steam and the solvent (which contains residual water) for the extraction process is as follows:

	Flows (kg/hr)		
	Acetic acid	Water	Ethyl Acetate
Feed	666	2,360	0
Solvent	0	250	6,860

Use the UNIFAC model to predict the liquid-liquid phase equilibrium behavior for this system.

The extraction is to take place at 1 atm pressure and 30°C. Determine the amount of acetic acid that is extracted from the feed into the solvent for the conditions stated above. Also make a plot of the total flow rates of the aqueous and organic streams inside the column as a function of the plate number. You may use either ChemSep or Aspen for your calculations.



Solubilities of various gases in water. Solubility is proportional to partial pressure at 0.5 MPa and less for gases shown. Solubility is nonlinear in partial pressure for gases such as Cl_2 and SO_2 (because of chemical reaction) or for gases with higher solubility, for example, NH_3. *(Data from Perry et al., 1963, and Seidell and Lincke, 1958.)*

Figure 1. Phase equilibrium data for problem 3.

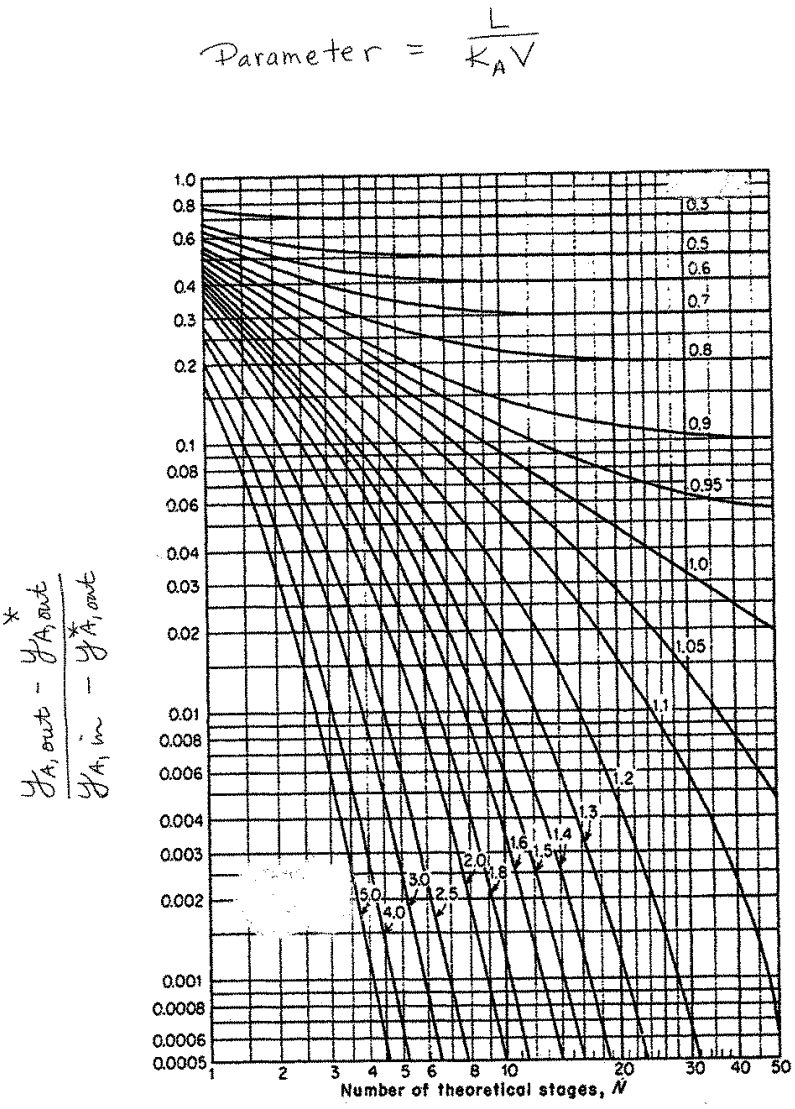


Fig. 2. Absorber form of KSB equation.