Assignment No. 5  
CEE 546: Air Quality Control  
Due Friday, May 5, 2017, noon, in Rood’s mailbox or by e-mail

Solve the following problems and show how you were able to arrive at the solutions. Describe and justify the assumptions that were made to solve the problems, if all of the information is not provided in the problem statement. You are welcome to work in groups but your final solutions and interpretation of your results are to be prepared individually. Provide a brief interpretation of your results for problem 1 (5 pt per problem).

1. (100 pt) A counter-current packed absorption tower will be used to remove SO2 from the flue gas stream described in assignment no. 2, problem no. 2 of this year for CEE 546. The combustion chamber is operated at an equivalence ratio of 0.85. Actual conditions of the flue gas stream is 90 ºC and 1 atm as the gas stream enters the absorption tower. The tower is to remove 90% of the SO2 from the gas stream. Pure liquid water (H2O(l)) is used as the solvent and is added to the top of the column without the use of re-circulation. Henry’s Law constant for this system is 42.7 mole fraction of SO2 in the gas per mole fraction of SO2 in liquid (ySO2 = 42.7 xSO2). The design liquid water flow rate is 40% greater than the minimum liquid water flow rate. The packing material is 5.08 cm (2 in) ceramic Intalox saddles. The tower will operate at 75% of the flood point. Use \( \alpha = 3.8 \), \( \beta = 0.41 \), and \( \gamma = 0.45 \) for the constants describing this packing material that are presented in Table 6-3 for other packing materials. Use a Schmidt Number for SO2 as a gas \( (Sc_g) = 0.94 \) and as a liquid \( (Sc_l) = 570 \) that are described for other reagents in Table 6-4. Use \( \Phi = 0.0125 \) and \( \eta = 0.22 \) for the constants describing this packing material that are presented in Table 6-5 for other packing materials. See attached text from Air Pollution: It’s Origin and Control for additional information about absorption and the tables referenced above.

Determine:

a) (20 pt) Design liquid water flow rate in units of kg/hour.
b) (20 pt) Required tower diameter, in unit of meter.
c) (20 pt) Tower pressure drop, in unit of mm Hg.
d) (15 pt) Number of transfer units.
e) (20 pt) Required height of packing material in the tower, in unit of meter.

2. (100 pt) Provide a critical, yet constructive, review of the attached manuscript. An example review of another manuscript is provided after this manuscript as a guide and example. Your review should be no more than 2 pages, 12 point font, single line spacing, and 1” margins.

3. (50 pt) Prepare a thoughtful thank you letter to be signed by all of us and then sent to the facility contact person that you worked you for us to go on your tour. We can all sign the letter and then I will U.S. mail the letters. An example letter is provided below. Feel free
to modify the letter provided below, including the contact information and signature block to reflect your information. Other members of the class can sign the letter after you have submitted the letter to me. **Please bring your letter to class during Wednesday, 03 May 2017 so that we can sign it and I will then have the letters mailed.**
May X, 2017

Ms. Vicki Howell
R. R. Donnelley & Sons Co
U.S. Route 45 N
Mattoon, IL 61938
(217) 235-0561

Dear Ms. Howell,

RE: Thank you for hosting CEE546: Air Quality Control class at R. R. Donnelley & Sons

Thank you for arranging and providing a tour of R. R. Donnelley & Sons Co. for our air quality engineering class. It was very valuable for the class to learn your perspective about air quality and to see how Donnelley prints a wide range of materials, collects the paper waste with the use of cyclones, collects and recycles the toluene from the gravure printing operations, and collects the solvents from the offset printing operations and combusts the vapors using recuperative thermal oxidizers. Touring R. R. Donnelley & Sons Co. is a valuable component of our class to relate concepts discussed during lectures to what occurs in practice. A very valuable experience.

Sincerely,

Mark J. Rood, Ph.D.
Ivan Racheff Professor of Environmental Engineering