BITS Pilani K K Birla Goa Campus

Mid Term Test (Open Book) - CHE F314: Process Design Principles - I

First Semester 2019-20 | Marks 30, Duration: 90 mins | Date: 30.11.2019

Note: Write all the answers clearly with appropriate units.

1. Flue gas desulphurization is a common pollution control technique used in power plants and major industrial units. Lime slurry is used as an absorbent, which reacts with the SO_2 in the flue gas and generates calcium sulphite. The calcium sulphite is settled and the water is recycled. Make-up water is added to account for losses in absorber. A certain factory currently pays a penalty for not complying with environmental standards. In order to comply with the environmental standards, the factory wants to setup a desulphurization unit. Calculate the potential economic benefit of setting up of the unit. (10)

   The required data is given as follows-

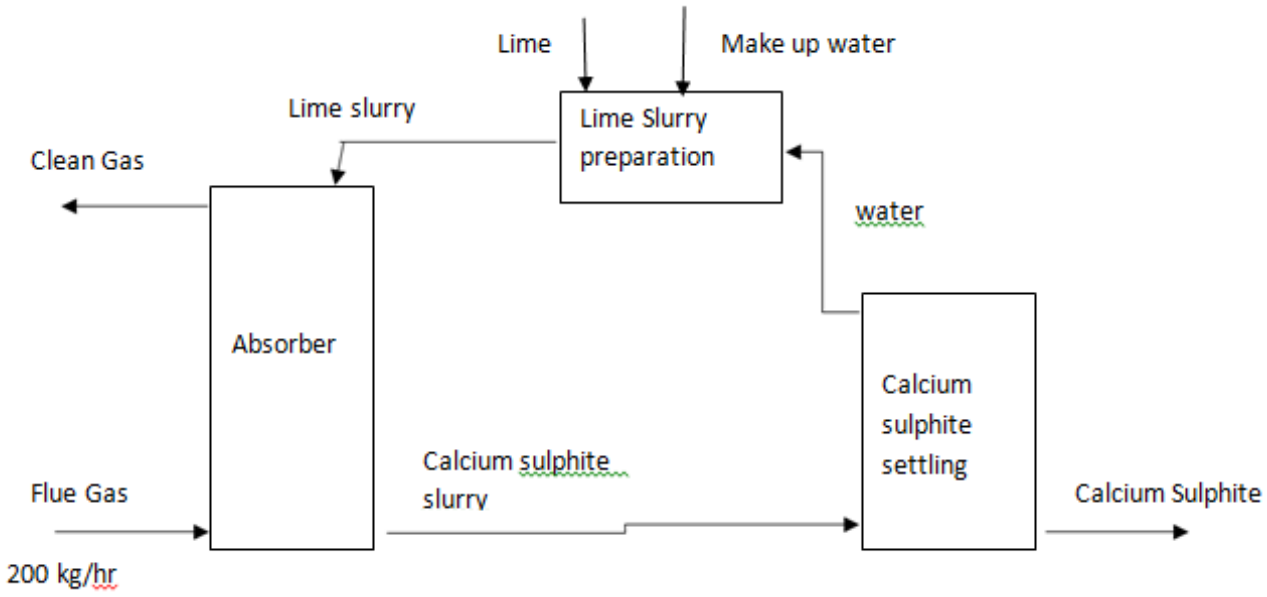
   Flue gas SO_2 conc = 400 ppm; Allowed SO_2 conc =20 ppm

   SO2 removal efficiency = 1-e^(-L/G) ; L is the slurry flowrate; G is the flue gas flow rate

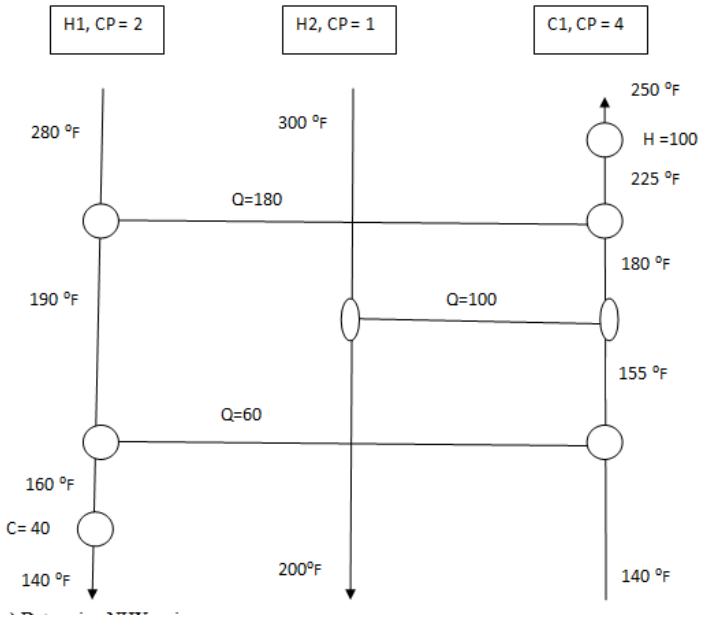
   Flue gas to be treated = 200 kg/hr; Concentration of lime in Slurry = 3% (by weight)

   Water lost in absorber = 1% of Flue Gas flow rate; Price of lime = Rs 5000/ton

   Cost of calcium sulphite slurry treatment = 0.01 Rs/kg; Price of water = Rs 0.05/kg; Penalty = Rs 25 lakh per annum, if the factory doesn't comply with environmental standards. Assume 100% settling of calcium sulphite in settling tank.



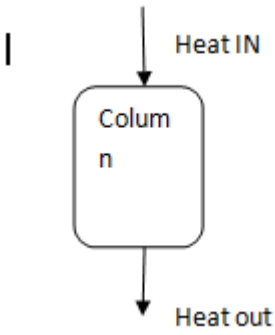
2. Consider the minimum energy network of heat exchanger in following figure. The heat capacity flow rate values are in Btu/hr. ºF and hear loads are in Btu/hr. All temperatures are in ºF. (12)



a) Determine minimum no of exchangers required
b) Identify and show the loops by way of drawing the loop
c) Break the loops using ΔT_{min} = 10 ºF. If there is ΔT_{min} violation, restore the ΔT_{min} . For the revised network, prepare the revised diagram, showing all temperatures and heat duties.
d) Provide number of exchangers, heating and cooling requirements for revised network

3. Consider a condensation process for recovering acetone from an air stream. (4)
   a) Draw a flowsheet for a condensation process for the recovery of acetone problem
   b) Material balances and energy balances (can be discussed qualitatively)
   c) Design variables, d) Describe the economic tradeoffs involved in the design of a condensation process

4. Consider the heat input and heat output diagram for distillation column shown in below figure



How will you Integrate distillation column with heat exchanger network. Will you place across the pinch, above pinch or below pinch? Explain with the diagrams. (4)