T.E. sem-VI (CBSGS) chemical - HTO -II 7/12/16
Heat Transfer operations-II

QP Code:574301

(Revised Course)

(3 Hours) **[Total Marks :80**

N.B. : (1) Question No.1 is **compulsory.**
(2) Use of "Heat Exchanger Databook" is permitted.
(3) Attempt any Three out of remaining questions.
(4) Assume any suitable data if necessary and indicate it clearly.
(5) Draw neat sketches wherever required.
(6) Answer to the sub-questions of an individual question should be grouped and written together i.e. one below the other.

1. (a) Explain briefly tube count, tube pitch, and baffles. **5**
(b) Write comparison between horizontal and vertical condensers. **5**
(c) List out the methods for calculating heat absorption in furnace radiant sections **5**
(d) Write briefly about forced circulation reboiler. **5**

2. (a) Explain with diagram the concept of critical heat flux. **10**
(b) Estimate the heat transfer coefficient for the pool boiling of water at 2.1 bar from a surface at 125°C. Check that the critical flux is not exceeded. **10**

Data physical properties:

saturation temperature, °C	121.80	ρ_L, kg/m³	1180.0
μ_L, cP	0.23	Cp_L, kJ/kg-K	4.25
k_L, W /m-K	0.687	σ, N/m	0.055
λ, kJ /kg	2198.0	P_{sat} at 125°C, kPa	232.10

Use the Foster-zuber correlation.

3. (a) Explain horizontal condenser with diagram. **10**
(b) Estimate the heat transfer coefficient for steam condensing outside and inside of a 25 mm OD, 21 mm ID, vertical tube, 3.66 m long. The steam condensation rate is 0.015 kg/s per tube and condensation takes place at 3 bar. The steam flows down the tube. Physical properties: **10**

k_L, W/m-K	0.688	ρ_L, kg/m³	0.931
μ_L, cP	0.21	Pr	1.27
saturation temperature, °C	133.5		

use Boyko - Kruzhillin correlations.

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4. (a) Give classification of Different furnaces and write briefly about the characteristics of an efficient furnace. **10**

(b) Explain construction and working of barometric condenser. **10**

5. Design a shell and tube exchanger for the following duty. **20**

20,00kg/hr of kerosene (42^0 API) leaves the base of a kerosene side-stripping column at 200^{0}C and is to be cooled to 90^{0}C by exchange with 70,000 kg/hr light crude oil (34^0 API) coming from storage at 40^{0}C .The kerosene enters the exchanger at a pressure of 5 bar and the crude oil at 6.5 bar. A pressure drop of 0.8 bar is permissible on both streams. Allowance should be made for fouling by including a fouling factor of 0.0003 m^2-K/W on the crude stream and 0.0002 m^2-K/W on the kerosene stream.

Physical Properties:

	Inlet	Mean	Outlet
Kerosene:			
Temperature, ^{0}C	200	145	90
Specific heat, kJ /kg^{0}C	2.72	2.47	2.26
Thermal conductivity, W/m^{0}C	0.13	0.132	0.135
Density, kg/m^3	690	730	770
viscosity, cP	0.22	0.43	0.80
Crude Oil:			
Temperature, ^{0}C	78	59	40
Specific heat, kJ /kg^{0}C	2.09	2.05	2.01
Thermal conductivity, W /m^{0}C	0.133	0.134	0.135
Density, kg/m^3	800	820	840
viscosity, cP	2.4	3.2	4.3

Find out heat transfer area, number of tubes, bundle and shell diameter, tube side heat transfer coefficient, shell side heat transfer coefficient, overall heat transfer coefficient, tube side pressure drop, exchanger type, tube size and layout.

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A fluid whose properties are essentially those of o-dichhlobenzene is vaporised in the tubes of a forced convection reboiler. Estimate the local heat transfer coefficient at a point where 5% of the liquid has been vaporised. The liquid velocity at the tube inlet is 2m/s and the operating pressure is 0.3 bar. The tube side diameter is 16mm and the local wall temperature is estimated to be 120°C. **20**

Data physical properties:

Boiling point, °C	136.0	Pc bar	41.0
μ_L, cP	0.45	ρ_L kg/m³	1170.0
μ_v, cP	0.01	ρ_v 1 kg/m³	1.31
Cp_L, kJ/kg°C	1.25		