VII SEMESTER B.TECH. (CHEMICAL ENGINEERING)

END SEMESTER EXAMINATIONS, NOV 2017

SUBJECT: DESIGN AND DRAWING OF CHEMICAL EQUIPMENTS

[CHE 4102]

REVISED CREDIT SYSTEM
(21/11/2017)

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitable assumed.

1.	The mechanical design of a standard (calendria) vertical short tube evaporator with the help of the following data: Evaporator drum : operating under vacuum Amount of water evaporated : 2500kg/hr Heat transfer area : 220m^2 Steam pressure : 0.15 N/mm^2 Density of liquid : 1000kg/m^3 Material of construction (MOC) : Evaporator : carbon steel IS-2062 Tubes : brass Permissible stress for carbon steel : 98N/mm^2 Modulus of elasticity : Carbon steel : 19.0 x 104 N/mm^2 Brass : 9.5 x 104 N/mm^2 Conical head bottom : cone angle 120^0 Torispherical head at top : (100-10) Poisons ration : 0.3 Length of drum – 4000mm Operating temperature – 120^oC Top head connected with drum : Flange (IS-2004-1962 Class -2) **Calendria with vertical tubes** **Tubes and tube lay out :** Tube diameter (outside) : 100mm Tube thickness : 1.5mm Tube length : 1220mm The effective tube length : 1165mm Tube lay out : triangular pitch : 125mm **Bottom flange of the calendria** Flange material – IS-2004-1962 Class -2 Bolting material : 5% Cr Mo Steel Gasket material : asbestos composition (1.6mm thickness) Out side diameter : 3894mm Pitch circle diameter : 3825mm Number of bolts : 112 Flange joint : Lap joint	**10M**

2. It is desired to cool 35000 kg / hr of flue gas (Assume the properties of air) from 150°C to 60°C using cold butanol available at 30°C in a STHE. The outlet temperature of butanol is 50°C. Design the heat exchanger (Pressure drop calculation need not be carried out). **DATA:** **10M**

	AIR	BUTANOL
Temp (°C)	100	40
Density (kg/m^3)	2.42	810
Viscosity (cP)	0.023	0.85
Thermal Conductivity (W/mK)	0.032	0.178
Sp. Heat (KJ/kgK)	1	2.8

3. Design shell and tube heat exchanger (2 pass STHE) with the help of following data **10M**

Shell side
MOC: carbon steel
Number of shell : 1
Number of passes : 1
Fluid : liquid
Working pressure : 0.33 N/mm^2
Design pressure : 0.50 N/mm^2
Temperature inlet : 30°C
Temperature outlet : 50°C
Segmental baffles (25% cut) with tie rods spacers
Head
Crown radius : 400mm
Knuckle radius : 40mm
Shell flange : female facing
Gasket : flat metal – jacketed asbestos filled
Bolts – steel
Nozzles – inlet and outlet – 75mm
Vent - 25mm
Drain – 25mm
Opening for relief valve – 50mm
Permissible stress for carbon steel – 95 N/mm^2
Permissible stress for bolt material– 140.6N/mm^2

Tube side
Tube and tube sheet material : stainless steel (SS 304)
Number of tubes – 54
Outside diameter – 18mm
Length (maximum U) – 12m
Pitch (square) – 25mm
Fluid – gas
Working pressure – 19 N/mm^2
Design pressure – 21.5 N/mm^2
Inlet temperature – 150°C
Outlet temperature – 55°C
Permissible stress – 100.6 N/mm^2

Channel and channel cover
Material – carbon steel (IS-2062)
Joint with tube sheet – ring facing
Gasket – steel jacked asbestos
Nozzle – inlet and outlet dia. – 75mm
Permissible stress – 95 N/mm^2

4A. A plant needs to take care of its emissions by employing a sieve plate tower (for absorption). Initial design calculations have been conducted to obtain certain data (given below). You are tasked with the job to check whether weeping occurs or not. Check if the design values need any corrections. **5M**

DATA: $A_h = 0.048$ m^2, $A_a = 0.61$ m^2, $t_R = 3$ mm, $t_S = 400$ mm, $d_h = 5$ mm, $\rho_g = 1.41$ kg/m^3, $G = 0.824$ m^3/s, $L = 0.014$ m^3/s, $L_w = 80$ cm, $\rho_L = 1000$ kg/m^3, $\sigma = 59.1$ dynes/cm, $h_w = 50$ mm.

4B. Explain in detail mechanical design of tall vertical vessel. **5M**

5. Check if down-comer flooding occurs in the previous design (Q. 4A) of sieve plate tower. Employ the same data along with the values obtained from your calculations undertaken to check weeping. **10M**