Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A Constituent Institution of MAHE, Manipal)

VII SEMESTER B.TECH. (CHEMICAL ENGINEERING)

MAKEUP EXAMINATIONS, DEC 2018

SUBJECT: DESIGN AND DRAWING OF CHEMICAL EQUIPMENTS [CHE 4102]

REVISED CREDIT SYSTEM
27/12/2018

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed.
- Heat and Mass transfer data book, Design and Drawing of Chemical Equipment's data book are permitted.

1. Design oil cooler finned tube double pipe heat exchanger with oil cooler and sea water

Length of the hairpin = 4.5m, Annulus nominal diameter = 2inch schedule 40

Diameter of inner tube = ¾ inch schedule 40, Fin length H_f = 0.0127 m, Fin thickness = 0.9mm, Number of fins per tube = 30, Thermal conductivity = 52 W/m.k (Carbon steel)

Number of tubes inside the annulus Nt = 1.

Select proper fouling factors, calculate surface area of heat exchanger and number of hairpins.(use constant wall temperature co-relation for annular side)

Fluid	Annulus fluid (Engine oil)	Tube side fluid(Sea water)
Flow rate kg/s	3	-
Inlet temperature ^oC	65	20
Outlet temperature ^oC	55	30
Density kg/m^3	885.27	1013..4
Specific heat kJ/kg.k	1.902	4.004
Viscosity kg/m.s	0.075	9.64×10^{-4}
Thermal conductivity W/m.k	0.1442	0.639
Prandtl number Pr	1050	6.29

10

2.	Find the thickness of a. Unfired vessel b. Flanged flat cover c. Conical head (apex angle 60^o) d. Tori-spherical(100-10), e. 2:1 ellipsoidal (no –uncompensated openings), f. 2:1 ellipsoidal (uncompensated openings) what is the maximum diameter opening will be permissible **Given data:** Maximum operating pressure: 400 $kN/m^{2,}$ Nominal diameter of vessel: 1m, Material of construction: IS: 2002-1962 Grade -2A allowable stress: 96.05 MN/m^2, Corrosion allowance: 2 mm, Joint efficiency: 0.85, Straight flange: 40mm, Factor depending on attachment to shell (assuming butt welded) = 0.45	**10**
3.	A heat exchanger is to be designed to heat raw water by the use of condensed water at 67°C and 0.2 bar, which will flow in the shell side with a mass flow rate of 50,000 kg/hr. The heat will be transferred to 30,000 kg/hr of city water coming from a supply at 17°C (*Cp* = 4184 J/kg.K). A single shell and a single tube pass is preferable. A fouling resistance of 0.000176 m^2K/W is suggested and the surface over design should not be over 35%. A maximum coolant velocity of 1.5 m/s is suggested to prevent erosion. A maximum tube length of 5 m is required because of space limitations. The tube material is carbon steel (*k* = 60 W/m.K). Raw water will flow inside of 3/4in. straight tubes (19 mm OD with 16 mm ID). Tubes are laid out on a square pitch with a pitch ratio of 1.25. The baffle spacing is approximated by 0.6 of shell diameter, and the baffle cut is set to 25%. The permissible maximum pressure drop on the shell side is 5.0 psi. The water outlet temperature should not be less than 40°C.Perform the preliminary analysis. (Assume the shell-side heat transfer coefficient and the tube-side heat transfer coefficient as 5000 W/m^2.K and 4000 $W/m^2 \cdot K$, respectively for preliminary analysis). Using preliminary analysis data (As per TEMA) calculate length of the heat exchanger.	**10**
4.	The vessel is made of stainless steel for which flange may be selected from IS-4868, minimum shell thickness of 6mm, the particulars of flange and bolts are as follows: Shell out side diameter – 1200 mm, Design pressure – 1.5 $MN/m^{2,}$ Design Temperature – 150°C, loose type flange, Bolt circle diameter - 1270mm, Number of bolts - 48, Nominal diameter bolt – 18mm (M18), bolt material 1% Cr Mo steel, allowable stress for flange material – 138 MN/m^2, Gasket material – asbestos composition (1.6mm thick), outside diameter of flange – 1327 mm, calculate the a) Diameter at a location of gasket load reaction. b) Estimate the bolt loads c) Minimum bolt area and actual bolt area required for a given data. d) Thickness of flange	**10**
5.	A 5% aqueous solution of a high molecular weight solute has to be concentrated to 40% in a forward-feed double effect evaporator at the rate of 8000 $kg.h^{-1}$. The feed temperature is 40°C. Saturated steam at 3.5 $kg.cm^{-2}$ is available for heating. A vacuum of 600 mm Hg is maintained in the second effect. Calculate the area requirements, if calandria of equal area are used. The overall heat transfer coefficients are 550 and 370 $kcal.h^{-1}m^{-2}\ °C^{-1}$ in the first and the last effect respectively. The specific heat of the concentrated liquor is 0.87 $kcal.kg^{-1}°C^{-1}$.	**10**