

THAPAR INSTITUTE OF ENGINEERING & TECHNOLOGY, PATIALA
Department of Chemical Engineering
End Semester Examination ≡ Process Equipment Design – I (CH-033)

111

Semester – I, 2006-07

December 14, 2006

Max. Marks: 50

Thursday

Answer all parts of the question in a sequence

14.00 – 17.00 Hrs

Assume suitable data, if required

Faculty: Dr. D. Gangacharyulu

Evaluated answer sheets will be shown at 4.00 P.M. on December 18, 2006.

1.	a). The piston rod of a hydraulic cylinder exerts an operating force of 10 kN. The friction due to piston packings and stuffing box is equivalent to 10% of operating force. The pressure in the cylinder is 10 MPa. The cylinder is made of cast iron ultimate tensile strength of 200 N/mm ² and a factor of safety is 5. Determine the diameter and thickness of the cylinder. To calculate the thickness, one can use Lamé's equation given in the page 2.	2.5																																	
	b). It is required to design a square key for fixing a gear on a shaft of 25 mm diameter. The power of 15 kW at 720 r.p.m. is transmitted from the shaft to the gear. The key is made of steel 50C4 ($S_{yt} = S_{yc} = 460 \text{ N/mm}^2$) and the factor of safety is 3. Determine the dimensions of the key.	2.5																																	
	c). What are the types of headers and closures are being used to close the cylindrical process vessels before being operated? Explain them with the help of neat sketches, nomenclature and design equations?	5																																	
2.	a). What are the various types of nozzles based on the method of forming and attachment? Explain the design methodology of reinforcement of nozzles?	5																																	
	b). A fractionating tower is 4.0 m in diameter by 6.0 m in length from tangent to tangent line of closures. The tower contains removable trays on a 1.0 m tray spacing and is to operate under vacuum of 0.1 MN/m ² and 400 °C. The material of construction is IS: 2002-1962 Gr. I, plain carbon steel. The modulus of elasticity for this material at 400 °C is $1.67 \times 10^5 \text{ MN/m}^2$. The allowable compressive stress = 70 MN/m ² . Determine the required thickness of the shell without stiffeners? (Take, $K = 0.52$ and $m = 2.49$).	5																																	
3.	a). Analyze the saddle support for horizontal vessel made of low carbon steel for the following data and confirm design feasibility.	5																																	
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P.T.O.

3.	b). Explain the detailed design procedure of lug/bracket support with the help of neat sketch along with base plate, gusset plate and column?	5																		
4.	a). What are the advantages to use the variable volume storage tanks with the floating roofs to store the fluids?	5																		
	b). Explain the pressure tests and dye penetration test carried out under non destructive testing methods?	5																		
5.	a). A thick walled vessel is to be designed to withstand an internal pressure of 200 MN/m^2 . An internal diameter of 350 mm is specified. Calculate the wall thickness required by the various theories of elastic failure with a factor of safety 1.5.	5																		
	b). A low pressure steam pipe line from utility plant to evaporator section of the chemical plant is to be installed. Verify from the following data whether the wall thickness and the expansion loop radius are properly designed.	5																		
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The average torque transmitted by the shaft, T_{ave} :

$$T_{ave} = \frac{\text{Horse power} \times 75 \times 60}{2 \pi \times \text{r.p.m.}}$$

Lame's equation, $t = \frac{D_i}{2} \left[\sqrt{\frac{f_t + p_i}{f_t - p_i}} - 1 \right]$

The inside depth of the closure, h_i :

$$h_i = R_i - \sqrt{\left(\left(R_i - \frac{D_i}{2} \right) \times \left(R_i + \frac{D_i}{2} - 2 r_i \right) \right)}$$

The pressure, p :

$$p = 2 f \left(\frac{t}{D_o} \right) \frac{1}{1.5 U \left(1 - 0.2 \frac{D_o}{L} \right) + \frac{100 \left(\frac{t}{D_o} \right)}{1}}$$