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Roll No .....

CM-6001-CBGS

B.E. VI Semester

Examination, June 2020

Choice Based Grading System (CBGS)

Process Equipment Design - I

Time : Three Hours

Maximum Marks : 70

Note: i) Attempt any **four** questions.

ii) All questions carry equal marks.

iii) Draw neat sketch and assume suitable data wherever you required.

1. a) What is a shell? What are the advantages and disadvantages of shell structure?

   b) Explain the longitudinal and circumferential stress.

2. a) A cylindrical vessel 14 ft. ID and 0.3125 inch has ring stiffeners located at 40 in spacing and it is subjected to an external pressure of 15 psi at a temperature of 700 °F. The MOC is carbon steel with yield stress of 30,000-38,000 psi. Modulus elasticity of carbon steel is 170×10^3 N/mm^2.

   i) Is t_s = 0.3125 inch adequate for a design with factor of safety of 4?

   ii) What is the allowable external pressure for a factor of safety of 3?

   iii) What is the thickness for same ID vessel based on a factor of safety 3?

   iv) Determine the stiffener ring requirements for the vessel in (C)

b) A tower having 4.5m inside diameter and 8m length from tangent line to tangent line of the end closers. Tower is operated under vacuum. Tower shell is constructed from SA283 grade-B carbon steel plate, which has yield strength of 1898.4 kgf/cm^2. Determine the required thickness of shell without stiffeners. Assume 8 mm thick plate.

3. a) Explain in brief about classification of unfired vessel as per IS-2825.

b) Determine the shell thickness at different height of a storage tank of the given data: Storage capacity of the tank = 100 m^3, Density ρ Fluid = 950 kg/m^3, joint efficiency J = 0.8, f = 980 kg/cm^2, C.A. = 2, Type of welding joint = double welded full fillet lap joint, height of each course = 1, Available plate = 2m × 2m, 3m × 2m. Also calculate the total no. of plate required to fabricate the vessel.

4. a) Discuss the design steps for column supported conical roof.

b) Examine the data given below to evaluate the requirement of reinforcement pad for the nozzle opening in cylindrical shell. OD of shell = 2m, maximum working pressure within shell = 3.5 MN/m^2, thickness of shell = 0.05m, corrosion allowance = 3mm, joint efficiency of nozzle and shell = 1, MOC = IS 2002, Allowable stress = 96 MN/m^2, Density = 7800 kg/m^3, OD of nozzle = 0.25m, Nozzle wall thickness = 0.016m, length of nozzle = 100mm.

5. a) Compare head thickness for torrispherical, elliptical and hemispherical heads using following data: Operating pressure = 15Atm; Crown radius = 1000mm, Knuckle radius = 100mm; MOC - CS (f = 142 N/mm^2, CA = 2 mm); J = 0.85; Shell D = 1000mm; Inside depth of the elliptical dish = 200mm.

b) Find the thickness of a straight cylindrical skirt support for distillation column based on following data. Diameter of column = 2500mm. Height of distillation column = 40m Max. wt of vessel, its attachment and contents = 300000 kg Diameter of skirt = 2500mm Height of skirt = 5m Wind pressure at the top of column = 128.5 kgf/m^2 Material used for skirt support = IS 800 structural steel Max. allowable tensile stress = 1400 kgf/cm^2 Max. allowable compressive stress = 666 kgf/cm^2 Max. allowable bending stress = 1575 kgf/cm^2 Seismic coefficient = 0.08 Minimum wt of empty vessel = 250000 kg.

6. a) Discuss the design of trays and tray supports for a tray tower.

b) Determine the shell thickness for the entire tower height based on the following data:
Shell diameter = 3500 mm
Working pressure = 2 N/mm^2
Design temperature = 200^{o}C
Base chamber height = 3200 mm
Top chamber height = 2000 mm
Feed chamber height = 800 mm
Sp. Gr. of the material = 7.7
Permissible tensile stress = 95 N/mm^2
Insulation density = 7700 N/m^3
Corrosion allowance = 3 mm
Poisson's ratio = 0.3
Density of MOC = 1.93×10^3 kg/m^3
Insulation thickness = 148 mm
Weight of head = 2800 N
Weight of attachments (pipes, ladders, platforms) = 1600 N/m
Weight of column = 3×10^6 N
Weight of tray and liquid = 900 N/m^2
Wind pressure = 1600 N/mm^2
Neglect the seismic load and eccentricity Number of trays = 60 Tray spacing = 0.7m Joint efficiency is 85%.

7. a) What is flange? State advantages and disadvantages of flange joint and explain any two in detail.

   b) Design a ring flange based on given data Internal design pressure = 10 kgf/cm^2 Design temperature = 150^{o}C Shell O.D = 900mm Basic gasket seating width = 10mm Shell thickness = 10mm Maximum allowable stress of flange material at atmospheric temperature = 1257.9 kg/cm^2 Maximum allowable stress of bolting material at design temperature = 816.5 kg/cm^2 Maximum allowable stress of bolting material at atmospheric temperature = 1020.7 kg/cm^2 Bolt size = 3/4" Root mean area of bolt = 0.302 in 2 Gasket factor = 2.75 Gasket seating stress = 257.77 kg/cm^2. Calculate gasket and flange dimensions with no. of bolts and every factor of flange design.

8. Write short notes on :
   a) Poisson's ratio
   b) Autofrettage
   c) Conical Heads and Reducers

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