EX/PG/ME/T/113D/24/2017

M.M.E 1st. Year (1st. Semester), 2017

Steam Generators

Full Marks =100

Time = Three Hours.

Answer any ***four*** questions. All questions carry equal marks. Use of steam tables is permitted.

1. a) List the factors that influence the average density in riser tubes.

b) What is meant by structural and thermal non-homogeneity of water-wall in a boiler furnace? Explain with the help of appropriate sketches.

c) Explain, with the help of appropriate sketches, the reasons for the possible appearance of steam in the down-comers of a natural circulation-based boiler.

(4+8+13)

2. a) Sketch the general hydraulic characteristics of a riser tube when it is a part of a i) low pressure boiler and ii) high pressure boiler. No description is needed.

b) Explain briefly, with the help of appropriate sketches, the methods for determining the steady state operating point in a natural circulation-based boiler comprising of, say three riser tubes fed by a single down-comer tube.

c) Carefully prepare the hydraulic characteristic of the following elements in an once-through boiler for i) Ascending motion in a vertical tube ii) Descending motion in a vertical tube iii) Motion in a π-section and iv) Motion in a U-section.

(5+6+14)

3. a) A natural circulation based boiler operates at 160 bar. Water from the drum, sub-cooled by 7.3^0C, flows down the down-comer at the rate of 1250 Kg/sec. The down-comers and risers are all 15 m high. The average density of steam- water mixture in the risers may be assumed to be equal to 350 Kg/m^3. The pressure loss in the down-comer and the risers is 0.52 bar. Calculate the power needed to drive a forced circulation pump of 70 % efficiency. Assume that the sub-cooling is due to the presence of a non-boiling economizer; the effect of the height of the down-comer on sub-cooling is ignored.

b) Critically comment on the methods for determination of frictional pressure drop in a tube by (i) Owen's method and (ii) Thom's method

c) Explain the different methods to the tackle the problem of ambiguity in the tube segment of a forced circulation boiler. (10+6+9)

4. a) Sketch the possible flow patterns in the riser elements of a natural circulation boiler and label the different regimes of flow structure. (12)

b) Consider a vertical tube that is heated uniformly over its length. The tube has an inside diameter of 10.16mm and its length is 3.66m. Temperature of water at the inlet of the tube is 203^0C and the pressure at the exit section of the tube is 68.9 bar. The total power applied to the tube is 200kW. Mass flow rate of water is 0.432 Kg/Sec. Heat transfer co-efficient on the inside surface of the tube is $47.8KW/m^2.^0C$. Calculate a) the length of the tube required to preheat water to the saturation temperature and 2) the length of the tube at which the tube metal temperature attains the saturation temperature. (13)

5. a) Show that as the capacity of a boiler increases, the ratio of heat transfer surface to its furnace volume decreases. Assumptions, if any, need to be stated.

b) Consider a wall fired furnace. How are firing arrangements modified for enhancing turbulence? Explain with the help of suitable sketches.

c) What is a design firing circle in a tangentially fired furnace? Do the actual jets conform to these circles? Explain with the help of suitable sketches.

d) Sketch the representative velocity distributions in a tangentially fired furnace.

e) Sketch the representative temperature distributions (along the height) in a tangentially fired furnace. 5+ 8+ 3+ 5+4 =25