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### Third Semester M.Tech. Degree Examination, Dec.2014/Jan.2015
## Design of Heat Transfer Equipments for Thermal Power Station

Time: 3 hrs.                                                                 Max. Marks:100

Note: *1. Answer any TWO full questions from Part-A*
*and any ONE full question from Part-B.*
*2. Use of design data handbook is permitted.*
*3. Missing data, if any, may be suitably assumed.*

## PART – A

1 It is desired to heat 4454.35 kg/hr (9820 lb/hr) of cold benzene from 26.67°C (80°F) to 48.88°C (120°F) using toluene which is cooled from 71.11°C (180°F) to 37.78°C (100°F). The specific gravities at 20°C (68°F) are 0.88 and 0.87 respectively. A fouling factor of 0.001 should be provided for each stream and allowable pressure drop of each stream is 0.702 bar (10 psi). A number of 5.095 m (20 ft) hairpins of 50.8mm (2 inch) by 31.75 mm (1.25 inch) IP are available. How many hair pins are required?                            (25 Marks)

2 175000 lb/hr of distilled water enters an exchanger at 93°F leaves at 85°F. The heat will be transferred to 280000 lb/hr of raw water coming from supply at 75° F and leaving the exchanger at 80°F. A 10 psi pressure drop may be expected on both streams while providing a fouling factor of 0.0005 for distilled water and 0.0015 for raw water when the tube velocity exceeds 6 fps.                                                                 (25 Marks)

3 a. Partial pressure of water in flue gases of a boiler burning 3% sulphur coal at 25% excess air is 10%. Estimate sulphuric acid dew point.                            (04 Marks)

 b. There are 25 assemblies in a superheater, each having four elements. The table below gives the arrangement history:

| 1 | | 2 | | 3 | | 4 | |
|---|---|---|---|---|---|---|---|
| $L_e$ (ft) | $D_i$ (in) | $L_e$ (ft) | $D_i$ (in) | $L_e$ (ft) | $D_i$ (in) | $L_e$ (ft) | $D_i$ (in) |
| 60 | 1.686 | 70 | 1.686 | 70 | 1.686 | 65 | 1.686 |
| 125 | 1.436 | 120 | 1.436 | 115 | 1.436 | 100 | 1.40 |

If the total steam flow is 500000 lb/hr at 1500 psi, 800°F average. Estimate flow in each element.                                                                 (09 Marks)

 c. A coal fired boiler furnace operates at the following parameters:
 $A_p$ = 9200 ft$^2$ ; $t_{air}$ = hot air temperature = 600°F ; $W_f$ = 6900 lb/hr ; Excess air = 25% ; LHV = 9500 Btu/lb ; HHV = 10,000 Btu/lb ; Ash = 20% ; Furnace volume = 48310 ft$^3$ ; Medium speed mills are used. Make quick estimate of $t_e$.                            (12 Marks)

## PART – B

4 A quantity of 2,20,000 lb/hr of steam at 1.5 inch-Hg has to be condensed using cooling water at 60°F 90/10 cupronical tubes of 1″ OD and 3/4″ OD thickness 14, 18, 20 BWG are available. It is desirable to limit exit cooling water temperature to 75°F from cooling tower performance considerations. A value of 950 Btu/lb may be used as latent heat. Study the alternatives and suggest the optimum choice.                                                                 (50 Marks)

5 Design a fuel oil suction heater for typical 210 MW boiler for the following data:
 Quantity oil fired = 48 TPH ;          Inlet temperature of oil = 25°C ;
 Outlet temperature of oil = 50°C ;      Specific gravity of oil = 0.89
 Viscosity of oil at 38°C (100°F) = 3500 sec and Redwood No. 1 pressure drop limited to 0.103 bar (1.5 psi)tube of 19.05 mm (3/4 in OD) 16 BWG and 25.4 mm (1 in square pitch) are available for service.                                                                 (50 Marks)

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