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14MTP41

Fourth Semester M.Tech. Degree Examination, June/July 2016
Design of Heat Transfer Equipments for Thermal Power Plant

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer any TWO full questions from part A and ONE question from Part B.***
2. ***Use of design data hand book, steam table charts permitted.***

Part A

1 It is desired to heat 4454.35kg/hr (9820ℓb/hr) of cold benzene from 26.67°C (80°F) to 48.880°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 (10psi). A number of 5.095m (20ft) hairpins of 50.8mm (2inch) by 31.75mm(1.25 inch) IP are available. How many hairpins are required? **(25 Marks)**

2 55188kg/s (43800ℓb/hr) of a 42API kerosene leaves the bottom of a distilling column at 198.7°C (390°F) and will be cooled to 93.3°C (200F) by 18774kg/s (149000/b/hr) of 34API midcontinent crude coming from storage at 39.8°C (100°F) and heated to 76.6°C (170°F). A 0.702bar (10psi) pressure drop is permissible on both streams and a combined dirt factor of 0.003 should be provided. Available for this service is a 53.98cm (21 ¼ in) ID exchanger having 158, 2.58cm (1 in) OD, 13BWG tubes 487.7cm (16') long and laid out on 3.18cm (1 ¼ in) square pitch. The bundles is arranged for four passes and baffler are spaced 12.7cm (5in) apart. Will the exchanger be suitable, that is, what is the dirt factor? **(25 Marks)**

3 a. A quantity of 63kg/s (500000ℓb/hr) of fuel gas from a boiler is cooled from 371.11°C' (700°F) while 50.4kg/s.(400000 ℓb/hr) of air at 26.66°C (80°F) is heated upto 204.44°C (400°F). Design suitable tubular air heater 5.08cm (2inch) OD × 0.221cm(0.087 inch) thick carbon steel tubes are available. Assume $\frac{ST}{d}=1.5$ and $\frac{SL}{d}=1.27$ having inline arrangement. **(15 Marks)**

b. Determine the approximate furnace exit gas temperature of a boiler when net input is about 586.152×10^{6}W (2000×10^{6}Btu/hr) of which 512.883×10^{6}W (1750×10^{6}Btu/hr) is due to fuel and rest is due to air. HHV and LHV of coal are respectively 23260kJ/kg (10,000 Btu/ℓb) and 20934kJ/kg (9000Btu/ℓb) and a furnace heat release rate of 252416 W/m^2 (80,000 Btu/ft^{2}hr) (projected area basis) has been used. The values of ϵ_w and ϵ_f may be taken as 0.6 and 0.5 respectively 25% excess air is used. Water wall outer temperature is 315.55°C (600°F). Ash content in coal in 10%. **(10 Marks)**

Part B

4 Design a fuel oil function heater for a typical 210MW oil fired boiler for following data.
Quality of oil fired at 100% BMCR = 48TPH
Inlet temperature of oil = 25°C
Outlet temperature of oil = 50°C
Specific gravity = 0.89
Auxillary steam available at 16bar is at 230°C
Viscosity of oil at 38°C = 3500 Redwood sec no 1
Pressure drop is limited to 1.5 psi
Tube of 19.05mm (0.75 inch) OD, 16BWG and 25.4mm
(1inch) square pitch are available for service. **(50 Marks)**

5 a. Explain the influence of following process condition on the design of cooling tower:
i) Un-saturation of the inlet air
ii) Close approach
iii) Stagging
iv) Changing operating pressure. **(20 Marks)**

b. A coaling tower 9.143m×9.143m (30ft×30ft) was designed to deliver 1433 ton/hr (1300gpm) of water from 40.65°C(105°F) to 29.45°C (85°F) when 5% wet bulb was 26.67°C (80°F). Fans are capable of delivering 6792m^3/min (240,000ft^3/min) of air. In an actual test at full loading when wet bulb was 21.11°C (70°F) the water range was from 25°C (77°F) to 36.63°C (98°F). Was the tower fulfilling the guarante conditions? **(30 Marks)**

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