

AGRICULTURAL AND FOOD ENGINEERING DEPARTMENT

INDIAN INSTITUTE OF TECHNOLOGY KHARAGPUR

Date: 24.02.11 (AN)

Full Marks: 30

Time: 2 Hrs.

Mid Spring Semester Examination 2010-11 1st year M. Tech. (FPE), IVth Year B. Tech. (Hons.) and Vth Year DD; Subject No. AG60096 Subject Name: Food Plant and Equipment Design No. of Students: 26

INSTRUCTIONS: Answer ALL questions. Make reasonable assumptions with justification, wherever necessary.

<p>1. (a) Draw a neat sketch of bucket type steam trap and explain its working principle. 5 (b) For a thick wall pressure vessel prove:</p> $\sigma_t = \frac{(p_i - p_o) r_i^2 r_o^2}{r^2 (r_o^2 - r_i^2)} + \sigma_a$ <p>r = radial distance on the wall, m; r_i = inner radius, m, r_o = outer radius, m</p> <p>2. A fire tube boiler is rated to produce 5000 kg h⁻¹ steam at 10 bar pressure. If Bituminous coal with lower calorific value of 30000 kJ kg⁻¹ has 81% carbon and 8% oxygen then obtain the length of 30 fire tubes if flue gas enters at 600 °C and leaves at 450 °C. The tubes are of 5 cm and 5.8 cm ID and OD respectively. Assume the feedwater to come to the boiler at 25 °C with air supply for burning of fuel as twice that of the minimum required. Mean specific heat capacity of water is 4.25 kJ kg⁻¹ K⁻¹. Viscosity, thermal conductivity and specific heat capacity of flue gas are 2.63 x 10⁻² mPa s, 1.1 kJ kg⁻¹ K⁻¹ and 0.039 W m⁻¹ K⁻¹ respectively. Also assume $\epsilon_1 = 1$ and $\epsilon_2 = 0.5$ with $\Delta x_1 = 1$ mm and $\Delta x_2 = 5$ mm. Boiling heat transfer coefficient is 8000 W m⁻² K⁻¹. $k_m = 15 \text{ W m}^{-1} \text{ K}^{-1}$ 12</p> <p>3. Superheated steam at 3 bar pressure and 165 °C is compressed to 7 bar pressure and 0.85 dryness fraction. How much heat is lost? How does this compare with entropy change times the absolute temperature? 8</p>	<p>where σ_a = axial stress, MPa σ_t = tangential stress, MPa p_i = inside pressure, MPa p_o = outside pressure, MPa</p>
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Dr. A. K. Datta



Name of the Paper Setter

Signature of the Paper Setter