Puu-23.3000 Chemical Engineering in Pulp and Paper Processes

Exam:
Calculation part 30.10.2006:

1. The dimensions of softwood chips are as follows: length 25 mm, width 15 mm and thickness 6 mm. The moisture content of the chips is 45 w-%. The Basic Density of the pine wood is 400 kg/m^3. The chips are steamed by means of saturated steam of 110 °C.

   Estimate how long it takes to increase the temperature of the chips from 20 °C to 108 °C. You can use the enclosed diagram in the calculations and assume that the chip particle is a sphere having the same volume as the above mentioned real chip particles.

2. A suspension of groundwood pulp having the consistency of 4,5 % is agitated in an intermediate tank. The production rate of the pulping line is 500 BDT/d and the retention time in the agitated tank 4 min. The required intensity of agitation (power demand/ volume of the pulp suspension in the tank) is 2 kW/m^3. The diameter of the agitator is 900 mm.

   a. Calculate the power demand of agitation-.
   b. Calculate the rotational speed of the agitator

3. The production of a pulp mill is 1500 ADT/d. The dry matter amount to be evaporated in the black liquor evaporation is 1,8 tons/ADT pulp. The evaporation plant has 6 effects, the dry matter concentration of the feed liquor is 20 % and the dry matter concentration of the evaporated strong liquor is 70 %. The temperature of the heating steam is 135 °C and the temperature of the saturated steam leaving the last effect is 60 °C.
   Calculate:
   a. The evaporated water amount/evaporation effect. It can be assumed that the evaporated water amount is the same in each effect.
   b. Estimate the total Boiling Point Rise (the sum of individual boiling point rises of each effect) and the effective temperature difference of the evaporation plant.

4. An adiabatic drying section of a paper machine uses the drying air flow of 8 kg dry air/s. The temperature of the drying air is 90 °C and relative humidity 1 %. The paper machine is operated at the production rate of 2 kg dry paper/s. The inlet moisture content to of paper into the drying section is 0,6 kg H_2O/kg dry paper and the outlet moisture content 0,1 kg H_2O/kg dry paper. What is the temperature and the relative humidity of the air leaving the drying section?