Department of Chemical Engg.

ASSIGNMENT-3, Mass Transfer I

Question (1): A certain material was dried under constant drying conditions and it was found that 2hrs are required to reduce the free moisture concentration from 20% to 10%.How much longer would it required to reduce the free moisture to 7%.Assume that no constant rate period is encountered

Question (2): A filter cake is dried for 5 hrs from an initial moisture content of 30% to 10% (wet basis).Calculate the time required to dry the filter cake from 30% to 6% (wet basis).

Equilibrium moisture content=4% on dry basis

Critical Moisture content=14% on dry basis

Assume that the rate of drying in the falling rate period is directly proportional to the free moisture content

Question (3):1000kg dry weight of non-porous solid is dried under constant drying conditions with an air velocity of 0.75m/s , so that the surface area of drying is 55 m^2.The critical moisture content of the material may be taken as 0.125 kg water/kg dry solid?

(i)If the initial rate of drying is 0.3 g/m^2.s.How long will it take to dry the material from 0.15 to 0.025 kg water/kg dry solid?

(ii)If the air velocity is increased to 4.0m/s, what would be the anticipated saving in time if surface evaporation is controlling.

Question (4):A plant wishes to dry a certain type of fibreboard. To determine drying characteristics, a sample of 0.3 x 0.3 m size with edges sealed was suspended from a balance and exposed to a current of hot dry air. Initial moisture content was 75%. The sheet lost weight at the rate of 1 x 10^{-4} kg/s until the moisture content fell to 60%. It was established that the equilibrium moisture content was 10%. The dry mass of the sample was 0.90 kg. All moisture contents were on wet basis. Determine the time for drying the sheets from 75% to 20% moisture under the same drying conditions.

Question (5): A commercial drier needed 7 hours to dry a moist material from 33% moisture content to 9% on bone dry basis. The critical and equilibrium moisture content were 16% and 5% on bone dry basis respectively. Determine the time needed to dry the material from a moisture content of 37% to 7% on bone dry basis if the drying conditions remain unchanged.

Question (6): A slab of paper pulp 1.5 m x 1.5 m x 5 mm, thick is to be dried under constant drying conditions from 15% to 8.5% moisture (dry basis). The equilibrium moisture is 2.5% (dry basis) and the critical moisture is 0.46 kg free water/ kg dry pulp. The drying rate at the critical point has been estimated to be 1.40 kg/(m²)(hr). Density of dry pulp is 0.22 g/cm^3. Assuming drying to take place from the two large faces only, calculate the drying time to be provided.

Question (7): A wet solid is dried from 35% to 8% moisture in 5 hrs under constant drying condition. The critical moisture content is 15% and equilibrium moisture content is 5%. All the moisture contents are reported as percentage on wet basis. Calculate how much longer it would take place under the similar drying conditions to dry from 8% to 6% moisture on wet basis.

Question (8): Sheet material, measuring 1m^2 and 5 cm thick, is to be dried from 50% to 2% moisture under constant drying conditions. The dry density of the material is 400 kg/m^3 and its equilibrium moisture content is negligible. The available drying surface is 1 m^2. Experiments showed that the rate of drying was constant at 4.8 kg/(hr)(m^2) between moisture contents of 50% and 25% and thereafter the rate decreased linearly. Calculate the total time required to dry the material from 50% to 2%. All moisture contents are on wet basis.

Question (9): Calculate the critical moisture content and the drying rate during the constant rate period for drying a wet slab of size 20 cm × 75 cm × 5 cm, whose dry weight is 16 kg. Both the sides are used for drying. The steam used was at 3 atm. pressure and was consumed at the rate of 0.135 g/s. cm2 of the contact surface. The following drying data is available for the sample. Assume equilibrium moisture content is negligible.

Drying Time(hrs)	0	0.25	1.0	1.5	2.0	2.5	3.0	4.0	6.0	8.0	10.0	12.0
Sample weight(kg)	19.9	19.7	19.2	18.9	18.6	18.3	18.1	17.65	16.92	16.4	16.15	16.05

Question (10): The following data are available for drying a substance. Estimate the drying time needed to dry a similar sample under similar drying conditions from 40% to 12% moisture content, on wet basis. The drying surface is 1 m^2/4 kg of dry weight and the initial weight of the wet sample is 80 kg.

X(dry basis)	0.35	0.25	0.2	0.18	0.16	0.14	0.10	0.08	0.065
N(kg/hr.m^2)	0.3	0.3	0.3	0.266	0.24	0.21	0.15	0.07	0.05

Question (11):175 kg of wet material with 25% moisture is to be dried to 10% moisture. Air enters at 65°C DBT and a WBT of 25°C. The velocity of air is 150 cm/s. Drying area equals 1 m^2/40 kg dry weight.

X(dry basis)	0.26	0.22	0.20	0.18	0.16	0.14	0.12	0.10	0.08
N(kg/hr.m^2)	1.5	1.5	1.5	1.3	1.2	1.04	0.9	0.75	0.6

Question (12): Data on drying rate curve of a particular solid is given below. The weight of the dry material in the solid is 48.0 kg/m^2. Calculate the time required to dry the material from 25% to 8% moisture (dry basis).where X is the moisture content in kg water/kg dry solid and N is the drying rate in kg/ (hr)(m^2)

X	0.30	0.20	0.18	0.15	0.14	0.11	0.07	0.05
N	1.22	1.22	1.14	0.90	0.80	0.56	0.22	0.05

Question (13):A wet slab of material weighing 5 kg originally contains 50 percent moisture on wet basis. The slab is 1 mx 0.6 m x 7.5 cm thick. The equilibrium moisture is 5% on wet basis. When in contact with air, the drying rate is given in the table below. Drying takes place from one face only

   (i)   Plot the drying rate curve and find the critical moisture content.
   (ii)   How long will it take to dry the wet slab to 15% moisture content on wet basis

Wet slab wt (kg)	5.0	4.0	3.6	3.5	3.4	3.06	2.85
Drying rate(kg/hr.m^2)	5.0	5.0	4.5	4.0	3.5	2.00	1.00
X, Dry basis	1.00	0.6	0.44	0.4	0.36	0.224	0.14