CHE407: Separation Processes

Tutorial#1 Due: Wed: 01/06/1440

1. ***Prediction of Effect of Process Variables on Drying Rate.*** Using the conditions in Example 9.6-3 for the constant-rate drying period, do as follows.
   (a) Predict the effect on R_C if the air velocity is only 3.05 m/s.
   (b) Predict the effect if the gas temperature is raised to 76.7°C and H remains the same.
   (c) Predict the effect on the time t for drying between moisture contents X_1 to X_2 if the thickness of material dried is 38.1 mm instead of 25.4 mm and the drying is still in the constant-rate period.

2. ***Prediction in Constant-Rate Drying Region.*** A granular insoluble solid material wet with water is being dried in the constant-rate period in a pan 0.61 m × 0.61 m and the depth of material is 25.4 mm. The sides and bottom are insulated. Air flows parallel to the top drying surface at a velocity of 3.05 m/s and has a dry bulb temperature of 60°C and wet bulb temperature of 29.4°C. The pan contains 11.34 kg of dry solid having a free moisture content of 0.35 kg H_2O/kg dry solid and the material is to be dried in the constant-rate period to 0.22 kg H_2O/kg dry solid.
   (a) Predict the drying rate and the time in hours needed.
   (b) Predict the time needed if the depth of material is increased to 44.5 mm.

3. ***Graphical Integration for Drying in Falling-Rate Region.*** A wet solid is to be dried in a tray dryer under steady-state conditions from a free moisture content of $X_1 = 0.40$ kg H_2O/kg dry solid to $X_2 = 0.02$ kg H_2O/kg dry solid. The dry solid weight is 99.8 kg dry solid and the top surface area for drying is 4.645 m^2. The drying-rate curve can be represented by Fig. 9.5-1b.
   (a) Calculate the time for drying using graphical integration in the falling-rate period.
   (b) Repeat but use a straight line through the origin for the drying rate in the falling-rate period.

   Ans. (a) t(constant rate) = 2.91 h, t(falling rate) = 6.36 h, t(total) = 9.27 h

4. ***Drying Tests with a Foodstuff.*** In order to test the feasibility of drying a certain foodstuff, drying data were obtained in a tray dryer with air flow over the top exposed surface having an area of 0.186 m^2. The bone-dry sample weight was 3.765 kg dry solid. At equilibrium after a long period, the wet sample weight was 3.955 kg H_2O + solid. Hence, 3.955 − 3.765, or 0.190, kg of equilibrium moisture was present. The following sample weights versus time were obtained in the drying test.

Time (h)	*Weight (kg)*	*Time (h)*	*Weight (kg)*	*Time (h)*	*Weight (kg)*
0	4.944	2.2	4.554	7.0	4.019
0.4	4.885	3.0	4.404	9.0	3.978
0.8	4.808	4.2	4.241	12.0	3.955
1.4	4.699	5.0	4.150		

   (a) Calculate the free moisture content X kg H_2O/kg dry solid for each data point and plot X versus time. (*Hint*: For 0 h, 4.944 − 0.190 − 3.765 = 0.989 kg free moisture in 3.765 kg dry solid. Hence, X = 0.989/3.765.)
   (b) Measure the slopes, calculate the drying rates R in kg H_2O/h · m^2, and plot R versus X.
   (c) Using this drying-rate curve, predict the total time to dry the sample from $X = 0.20$ to $X = 0.04$. Use graphical integration for the falling-rate period. What is the drying rate R_C in the constant-rate period and X_C?