Drying

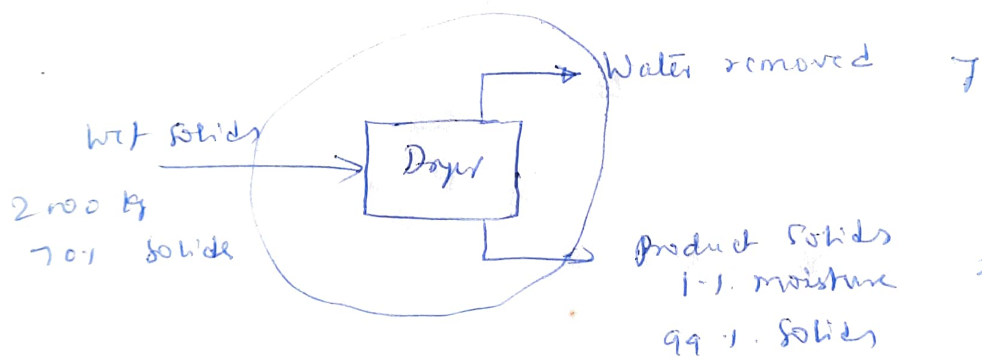
2000 ~~kg/hr~~ kg of wet solids containing 70% solids by weight are fed to tray drier where it is ~~twisted~~ dried by hot air. The product finally obtained is found to contain 1% moisture by weight. Calculate

(a) kg of water removed from wet solids

(b) kg of product obtained.

Soln Here wet solids to dryer is the input while product solids and water/moisture removed are the output streams from dryer. It is given that dryer is charged with 2000 kg of wet solids (basis is defined) so take 2000 kg of wet solids as a basis of calculation.

Basis. 2000 kg of wet solids fed to dryer



Let x be the kg of product obtained and y be the kg of water removed.

Overall material balance

$$2000 = x + y \quad \text{——} \quad (1)$$

Material balance of solids

$$2000 \times 0.7 = x \times 0.99 + y(0)$$

$$0.99x = 1400$$

$$x = \frac{1400}{0.99} = 1414.14 \text{ kg}$$

and

$$2000 = x + y$$

$$2000 = 1414.14 + y$$

$$y = 2000 - 1414.14$$

Material balance of water.

$$2000 \times 0.3 = 585.85 + 1414.14 \times 0.01$$

$$600 = 585.85 + 14.1414$$

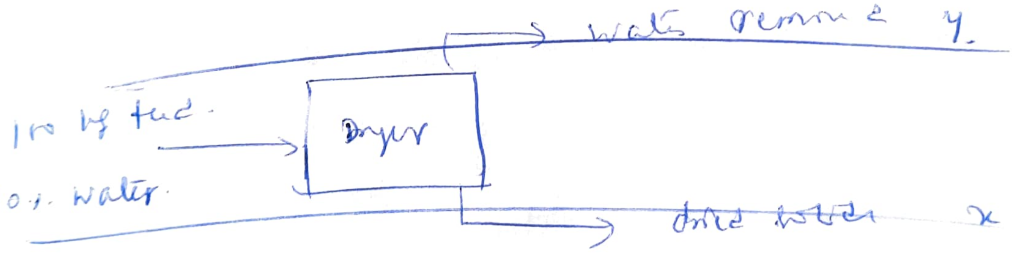
$$600 = 600$$

(3.20) Wet solids containing 20% water is sent through a dryer in which 80% of the water is removed. Based on 100 kg of feed calculate

(a) The mass fraction of dry solids in wet solids that leaves dryer.

(b) The weight ratio of water removed to wet solids leaving the dryer; and

(c) At 1000 kg per day of wet solids are fed to the dryer. Find the additional water to be removed to dry the solids completely.



Let x be the kg of product obtained and y be the kg of water removed.

~~100 × 0.2 =~~

Overall material balance

$$100 = x + y \quad \text{---} \quad (1)$$

Material balance for solids

~~100 × 0.8~~

$$100 \times 0.8 = x \times$$

Solids in feed = $100 \times 0.8 = 80$ kg

Water in feed = $100 \times 0.2 = 20$ kg

Water removed = $20 \times 0.8 = 16$ kg

Water in solids leaving dryer = $20 - 16$ kg
$= 4$ kg

∴ Wet solids leaving dryer = $80 + 4 = 84$ kg

∴ Max fraction of dry solids in wet solids leaving dryer

(a) $\frac{80}{84} = 0.9523$

Weight ratio of water removed to wet solids leaving the dryer $= \frac{16}{84} = 0.19 : 1$

Additional water to be removed to dry 100 kg wet solids completely = 4 kg

∴ Water to dry completely 1000 kg/day wet solids

$= \frac{4}{100} \times 1000$

$= 40$ kg.

(Q.43) A multiple effect evaporator system has a capacity of processing one tonne of solids caustic soda when it concentrates weak liquor from 4 to 25%. (wt basis). When the plant is fed with 5% weak liquor and it is concentrated to 50% find the capacity of the plant in terms of solid caustic soda, assuming the ~~water~~ water evaporating capacity to be same in both cases.

Solution :

Basis : One day operation.

Case-I

Quantity of solid NaOH produced = 1000 kg.

Let 'x' ~~and 'y'~~ be the kg of feed solution (weak liquor), y be the kg of ~~and~~ thick liquor ~~containing 4% and 25% by weight caustic soda.~~ Let z be the kg of water evaporated.

Overall material balance

$x = y + z$ ——— (1)

Quantity of solid caustic soda in 'x' and 'y' will be same and is equal to 1000 kg

Amount of feed = (weak liquor) = $\frac{1000}{0.04}$

$x = 25000$ kg

Material balance of caustic soda

$0.04x = 0.25y$

$0.04 \times 25000 = 0.25y$

$y = 4000$ kg

Amount of water evaporate in the first case = 25000 - 4000 = 21000 kg.

Case II

Water evaporating capacity in second case (5% to 50% caustic soda) is equal that in first case

Water evaporated in second case = 21000 kg

Let x_1 and y_1 be the kg of weak liquor and thick liquor in second case

Overall material balance

~~$x_1 = y_1$~~ $x_1 = y_1 + 21000$

Material balance of caustic soda

$0.05\, x_1 = 0.5\, y_1$

Solving we get,

$x_1 = 23333.3$ kg

Caustic soda in weak liquor $= 0.05 \times 23333.3$

$= 1167$ kg

$\therefore$ capacity of plant in terms of caustic soda $= 1167$ kg / day

$= 1.167$ tonnes per day