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Food Processing Engineering 1

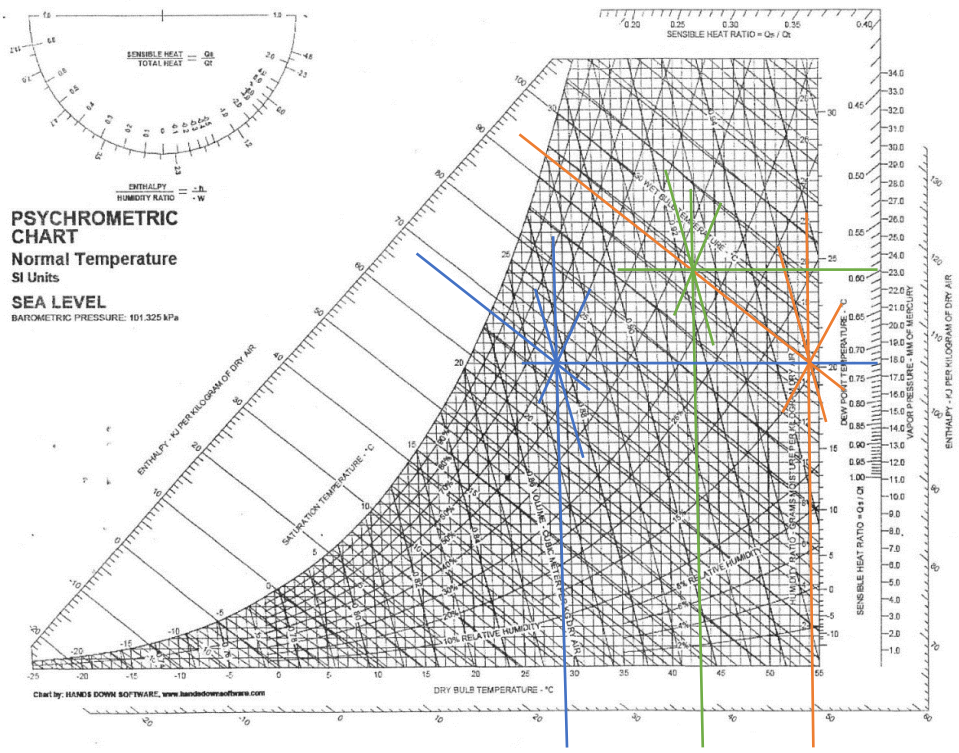
Food Processing Engineering Quis (Substitute for college).

1. Complete the table below using a psychrometric graph, the graph is attached

No		Unit	Beginning	Warming	Drying
1	Dry bulb temperature	^oC	27	49	39
2	Wet bulb temperature	^oC			
3	Relative humidity	%	75		
4	Humidity ratio	gr water/kg uk			
5	Enthalpy	kJ/kg uk			
6	Specific volume	m3/kg uk			

Settlement:

1. Psychometrics



No		Unit	Beginning	Warming	Drying
1	Dry bulb temperature	oC	27	49	39
2	Wet bulb temperature	oC	23.5	28.8	28.8
3	Relative humidity	%	75	23	47
4	Humidity ratio	gr water/kg uk	17	17	21.1
5	Enthalpy	kJ/kg uk	71	94	94
6	Specific volume	m3/kg uk	0.874	0.938	0.914

2. A tub-type dryer was used to dry 2.5 tons of grain from an initial moisture content of 42.85714 %bk to a final moisture content of 14 %bb. Outdoor air temperature 27 ^{oC} with Humidity Ratio (H) = 17 gH20/kg uk. The air temperature of the dryer is 49 oC, and the air temperature out of the dryer is 39 ^{o}C.
   a. Calculate the air rate required for drying to complete within 12 hours
   b. Calculate the required energy rate

Settlement:

Known: Material initial weight = 2.5 tons = 2500 Kg
Initial moisture content = 42.85714 % bk
Final moisture content = 14 % bb
Tbk = 27
Humidity rate = 17 gramsH2O/kguk
Dryer air temperature = 39
Temperature of air out of drying = 49

No	Name	Unit	Beginning	Warming	Drying
1	Dry bulb temperature	^{o}C	27	49	39
2	Wet bulb temperature	^{o}C	23,3	29	29
3	Relative humidity	%	75	22	49
4	Humidity Ratio	gr water/Kg uk	17	17	23
5	Enthalpy	Kj/Kg uk	71	94	94
6	Volume Specific	m^3/Kg uk	0,87	0,93	0,91

Settlement:

a = 57,14286 % $\times$ 2500 Kg $= 1428{,}57\ Kg$

P= 2500 Kg $- 1428{,}57\ Kg$ $= 1071\ Kg$

$$KA\ bb = \frac{X}{X + p} \times 100\ \%$$

$14 = \frac{X}{X+1071} \times 100\ \%$
X= $174{,}3\ Kg$

Evaporation Rate = 104.5 Kg H= $\frac{a-X}{1} = \frac{1428{,}57-174{,}3}{12\ jam}$ 2O/h

A. Air rate for drying

$$LU = \frac{LP\left(\frac{KgH2O}{Jam}\right)\times\left(\frac{m^3}{Kg\ uk}\right)}{(H_3-H_2)\left(\frac{gram\ H2O}{Kg\ uk}\right)\times\left(\frac{KgH2O}{1000\ gram\ H2O}\right)} = m^3/Jam$$

$$LU = \frac{104{,}5\left(\frac{KgH2O}{Jam}\right)\times 0{,}91\left(\frac{m^3}{Kg\ uk}\right)}{(23-13)\left(\frac{gram\ H2O}{Kg\ uk}\right)\times\left(\frac{KgH2O}{1000\ gram\ H2O}\right)} = m^3/Jam$$

$$LU = \frac{104{,}5\times 0{,}91}{(23-13)} = 9{,}5095\ m^3/Jam$$

So, the air rate required for drying to be completed in 12 hours is:
$9{,}5095\ (m^3/jam) \times 12\ jam = 114{,}114\ kJ$

B. Energy Required

$$E = \frac{(h_2-h_1)\left(\frac{kJ}{Kg\ uk}\right)\times LU\left(\frac{m_3}{Jam}\right)}{V_2\left(\frac{m_3}{Kg\ uk}\right)} = kJ/Jam$$

$$E = \frac{(94-71)\left(\frac{kJ}{Kg\ uk}\right)\times 9{,}5095\left(\frac{m_3}{Jam}\right)}{0{,}91\left(\frac{m_3}{Kg\ uk}\right)} = 240{,}35\ kJ/Jam$$

So the energy required for the rigging to be completed for 12 hours is 240.35 kJ/Hour $\times 12\ jam = 2884{,}2\ kJ$

3. Sugarcane sap with an initial temperature of 30 oC moisture content of 80 %bb is thickened in a single evaporator until it reaches a viscosity of 40% with a sugarcane sap velocity that enters the evaporator of 16.6667 kg / minute. The steam temperature is 120 oC and the final effect temperature is kept at 60 oC. Calculate the required steam rate.

Settlement:

$F.Xf = P.Xp$

$(1000)(0{,}2) = (P)(0{,}6)$
$(0{,}6)P = 100$
$P = 1666{,}6$ kg/jam

$F = P + v$
$(1000) = (166{,}6) + (v)$
$v = 1000 - 166{,}6$
$v = 833{,}4$ kg/jam

$Cpf = 0{,}837 + 0{,}034\ KA$
$Cpf = 0{,}837 + 0{,}034\ (80)$
Cpf = 3,557 kJ/Jam

Cpp = 0.837 + 0.034 KA
Cpp = 0,837 + 0,034 (40)
Cpp = 2,197 Kj/Hour

hs (120°C) = 2706,0 kj/kg
hp (60°C) = 2608,8 kj/kg
hw (60°C) = 251.18 kj/kg

F.Cpf.Tf + S (hs – hw) = P.Cpp.Tp + v.hv
(1000) (3,557) (30) + (S) (2706-251,18) = (16,6)(2,197)(60)+(833,4)(260,8)
106710 + 2454,82 (S) = 2188,212 + 2174173,92
2454,82 (S) = 2188,212 + 2174173,92 – 106710
2454,82 (S) = 2069652,132
(S) = 2069652,132 / 2454,82
(S) = 843,097 kg/jam

So the amount of steam needed is 843.097 kg / hour.