FE467 List of Formula

Vacuum Systems

$$m_s*[x.\lambda + Cp*(T_{steam} - T_{condensate})] = m_w*Cp*(T_{water\ out} - T_{water\ in})$$

$$\text{Vacuum Efficiency} = \frac{\textit{Actual vacuum at the steam inlet to the condenser}}{\textit{Barometric } P - \textit{Absolute } P \textit{ corresponding to the } T \textit{ of condensation}}$$

$$\text{Condenser Efficiency} = \frac{\textit{Rise in temperature of cooling water}}{\textit{Saturation } T \textit{ corresponding to the absolute } P \textit{ in condenser} - \textit{Inlet } T \textit{ of cooling water}}$$

Vacuum Pump Power (in hp) = $3.03*10^{-5}*P_1*q_1*\ln(P_2/P_1)$

P : lb_f/ft^2,   q : ft^3/min

Solids Conveying Systems

A) Belt Conveyors

Carrying capacity of the conveyor: $T = a*b*v$

1. The power required to move the empty belt, We = $m_i*(lt + 0.10l_t)*g*\mu_e*v$

2. Power required to convey material, Wm = $m_m*l_t*g*\mu_m*v$

3. Power required to raise or lower the material, Wr = $T*g*h*(1.5)$

Motor Power Capacity = W_T/E_{eff}

B) Bucket Elevators

Carrying capacity of the elevator: $T = (c*b*v)/p$

Total power required $W_T = 2*T*g*h*(1.5)$,

Motor Power Capacity = W_T/E_{eff}

C) Screw Conveyors

Carrying capacity of the screw conveyor: $T = a*b*v$

$a = (k*\pi*d^2)/4$

Motor Power Capacity = $[(3*T*g*l_t*\mu)/\text{Efficiency}]*(1.5)$

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Cold Storage Room Design

Size of Cold Storage: V = v(C+S)

<u>Total Cooling Load (Heat Load) Estimation</u>

1 - Transmission Heat Loads:

$Q = U \times A \times (T_0 - T_i) \times 24/1000$

- Q = kWh / per day heat load
- U = Insulation value of sandwich panel ($W / m^2.K$)
- A = Surface area of ceiling, wall, and floor (m^2)
- T_i = Air temperature inside the room (°C)
- T_0 = Ambient outside temperature (°C)
- 24 = Hours in a day
- 1000 = Watt to kW conversion.

2 - Product Heat Loads:

a) Calculate the cooling capacity due to the products placed in the warehouse

$Q = m \times Cp \times (T_P - T_i) / 860$

- Q = kWh / day
- C_P = Specific Heat Capacity of the Products (kJ/kg.°C)
- m = Mass of added products (kg)
- T_P = Product inlet temperature (°C)
- T_i = Temperature inside the cold room (°C)
- 860 = Kcal to kWh conversation rate

b) Calculating cooling load from product respiration

$Q_{resp} = m \times q / 3600$

- Q_{resp} = kWh / day = cooling load from product respiration
- m = amount of product in the warehouse (kg)
- q = heat of respiration of product (kJ / kg)
- 3600 = Converts kJ to kWh.

3 - Internal Heat Loads:

a) Calculation of cooling load from people

$Q = P \times t \times q_p / 1000$

- Q = kWh / day
- P = Number of people working in the warehouse
- t = Length of time spent in the warehouse per person (Hours)
- q_p = Heat losses per person per hour (Watts)
- 1000 = Converts watts to kW only

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b) Calculation of cooling load from lighting (lamps)

$Q = L \times t \times q_L / 1000$

- Q = kWh / day,
- L = number of lamps in the cold room
- t = daily usage hour of cold room lighting
- q_L = power rating of the lighting (Lamps)
- 1000 = Watts to Kw

c) Calculation of cooling load from fan motors

$Q = F \times t \times q_f / 1000$

- Q = kWh/day
- F = Number of fans
- t = Fan running time per day (hours)
- q_f = Fan motors nominal power (Watts)
- 1000 = Watts to kW.

4 - Infiltration Heat Loads:

$Q = V \times E \times C \times (T_0 - T_i) / 3600$

- Q = kWh / day
- C = Number of volume changes per day
- V = Cold storage volume
- E = Energy per cubic meter in degrees Celsius
- T_0 = Outdoor air temperature
- T_i = Cold room temperature
- 3600 = kJ to kWh.

5 - Refrigeration Equipment Heat Loads:
Cooling load from fan motors defrost

$Q = P \times t \times DC \times eff$

- Q = kWh / day,
- P = Heating element power (kW)
- t = Defrost operation time (Hours)
- DC = How many times per day the defrost cycle occurs
- eff = what % of the heat will be transferred into the ambient