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15/ENG04/038

1. $D = 1.5Km = 1.5\times10^3 m = 1500m$

Schedule speed $= 36 Km/h = \frac{36\times1000}{60\times60} = 10 m/s$

$\beta = 3km/h/s = \frac{3\times1000}{60\times60} = \frac{30}{36} = \frac{5}{6} m/s^2$ or $0.83 m/s^2$

Schedule time of run $= \frac{1500}{10} = 150s$

Actual time of run $= 150 - 25 = 125s$

$V_a = \frac{1500}{125} = 12 m/s$

$V_m = 1.25 \times 12 = 15 m/s$

$K = \frac{D}{V_m^2}\left(\frac{V_m}{V_a} - 1\right) = \frac{1500}{15^2}(1.25 - 1) = \frac{5}{3}$ or 1.67

$K = \frac{1}{2}\left(\frac{1}{\alpha} + \frac{1}{\beta}\right)$

substituting the values for K and β

$\frac{5}{3} = \frac{1}{2}\left(\frac{1}{\alpha} + \frac{6}{5}\right)$

$\frac{10}{3} = \frac{5+6\alpha}{5\alpha}$

$50\alpha = 15 + 18\alpha$

$50\alpha - 18\alpha = 15$

$32\alpha = 15$

$\alpha = \frac{15}{32} = 0.47 m/s^2 = \frac{0.47\times1000}{\frac{1}{60\times60}} = 1.7Km/h/s$

2 $V_a = 36 km/h = 36 \times \frac{1000}{60 \times 60} = 10 m/s$

$\alpha = 1.8 Km/h/s = 1.8 \times \frac{1000}{60 \times 60} = 0.5 m/s^2$

$\beta = 3.6 Km/h/s = 3.6 \times \frac{1000}{60 \times 60} = 1 m/s^2$

$D = 2 Km = 2000 m$

$t = \frac{D}{V_a} = \frac{2000}{10} = 200 s$

$K = \frac{1}{2}\left(\frac{1}{\alpha} + \frac{1}{\beta}\right)$

$K = \frac{1}{2}\left(\frac{2}{1} + \frac{1}{1}\right) = \frac{3}{2} = 1.5$

$V_m = \frac{t - \sqrt{t^2 - 4KD}}{2K} = \frac{200 - \sqrt{(200)^2 - 4 \times 1.5 \times 2000}}{2 \times 1.5}$

$V_m = \frac{200 - \sqrt{40000 - 12000}}{3}$

$= \frac{200 - \sqrt{28000}}{3} = \frac{200 - 167.33}{3} = \frac{32.67}{3} = 10.89 m/s$

$V_m = 10.89 m/s = 10.89 \times \frac{1000}{\frac{1}{60 \times 60}} = 39.2 Km/h$

$\frac{W}{°C}/m$

3. surface area, $A = 6.0 m^2$ $\qquad$ $90\% = 0.9$

$T_1 = 20°C$

$T_2 = 65°C$

loss per square metre per $1°C = 6.3\ W/°C/m^2$

Specific heat, $s = 4200\ J/Kg/°C$

$1\ KWh = 3.6 MJ$

Assume $A = 6 \times l^2$

$\therefore 6 = 6 \times l^2$

$l = 1 m^2$

Volume $= 1 m^3$

Volume of water to be heated daily, $V_d = 6 \times 1 \times 0.9 = 5.4 m^3$

Since $1m^3$ of water weighs $1000 Kg$

$\therefore$ mass of water to be heated daily $m = V_d \times 1000 = 5.4 \times 1000$

$= 5400 Kg$

Heat required to raise temp, $H = m \times s \times \Delta T$

$= 5400 \times 4200 \times 45$

$= 1020 MJ$

converting to $KWh = \frac{1020}{3.6} = 283.3\ KWh$

Daily loss from the surface of the tank $= 6.3 \times 6 \times (65-20) \times \frac{24}{1000}$

$= 40.8 KWh$

Energy supplied daily $= 283.3 + 40.8 = 324.1\ KWh$

Loading in $KW = \frac{324.1}{24} = 13.5\ KW$

Efficiency of tank $= \frac{283.3}{324.1} \times 100 = 87.4\%$

4 Secondary voltage, $V = 20V$

Input Power, $P = 600KW$ or $600 \times 10^3 W$

Power Factor, $pf = 0.6$

Secondary current, $I = \frac{P}{V \times pf} = \frac{600 \times 1000}{20 \times 0.6} = 5 \times 10^4 A$

Voltage across resistance, $V_r = V \times pf = 20 \times 0.6 = 12V$

Voltage across reactance, $V_x = V \times \sqrt{1 - pf^2} = 20 \times \sqrt{1 - 0.6^2} = 16V$

$V_r = I \times R$; $R = \frac{V_r}{I} = \frac{12}{5 \times 10^4} = 2.4 \times 10^{-4} \Omega$

$V_x = I \times X$; $X = \frac{V_x}{I} = \frac{16}{5 \times 10^4} = 3.2 \times 10^{-4} \Omega$

when hearth is half-full

$R_2 = 2 \times R = 2 \times 2.4 \times 10^{-4} = 4.8 \times 10^{-4} \Omega$

$X_2 = X = 3.2 \times 10^{-4} \Omega$

$pf_2 = \frac{R_2}{\sqrt{R_2^2 + X_2^2}} = \frac{4.8 \times 10^{-4}}{\sqrt{(4.8 \times 10^{-4})^2 + (3.2 \times 10^{-4})^2}} = 0.83$

$V_{r_2} = V \times pf_2 = 20 \times 0.83 = 16.6V$

From $V_r = I \times R$

$I_2 = \frac{V_{r_2}}{R_2} = \frac{16.6}{4.8 \times 10^{-4}} = 34583.3A$ or $3.5 \times 10^4 A$

Power absorbed, $P_2 = \frac{V \times I_2 \times pf}{1000} = \frac{20 \times 3.5 \times 10^4 \times 0.83}{1000}$

Power absorbed, $P_2 = 581 KW$

Power factor, $pf = 0.83$

Scanned with CamScanner

5. Intensity, $I = 300 cd$
height, $h = 20m$
diameter of luminous area, $d = 20m$

WITHOUT REFLECTOR

ⓐ $E_c = \frac{I}{h^2} = \frac{300}{20 \times 20} = \frac{3}{4} = 0.75$ lumens/m^2

ⓑ $\theta = \tan^{-1}\left[\frac{d}{2} \times \frac{1}{h}\right] = \tan^{-1}\left[\frac{20}{2} \times \frac{1}{20}\right] = \tan^{-1}(0.5) = 26.6°$

distance between edge and source lamp

$l^2 = h^2 + \left(\frac{d}{2}\right)^2$

$l = \sqrt{20^2 + \left(\frac{20}{2}\right)^2} = 22.36m$

$E_d = \frac{I}{l^2} \times \cos\theta = \frac{300}{22.36^2} \times \cos(26.6) = 0.537$ lumens/m^2

WITH REFLECTOR

Luminous output of the lamp, $= 4\pi I = 4\pi \times 300 = 3769.9$ lumens

Flux directed by the reflector $= 0.5 \times 4\pi I = 1884.96$ lumens

Area of disc $= \frac{\pi d^2}{4} = \frac{\pi \times 20^2}{4} = 314.2 m$

Illumination at any point $E_p = \frac{0.5 \times 4\pi I}{A}$ ~~0.5x~~

$= \frac{1884.96}{314.2} =$ ~~5~~ 6 lumens/m^2