Olajide Sanyaolu 16/eng04/069 EEE552 assignment 25/05/20

25/05/2020 EEE 552: Industrial utilization of Electric Power

(1) Distance between stations $D = 1.5km$
$= 1500m$

Schedule Speed $= 36 km/h = \frac{36 \times 1000}{60 \times 60} = \frac{36000}{3600} = 10 m/s$

Braking retardation $\beta = 3 km/h/s = \frac{3 \times 1000}{3600} = 5/6 \ m/s^2$

Schedule run time $T_S = \frac{1500}{10 m/s} = 150s$

$T_S = T_{run} + T_{stop}$

Actual run time $= T_S - T_{stop} = 150 - 25 = 125s$

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

$\frac{V_m}{V_a} = 1.25$; $V_m = 1.25 \times 12$
$= 15 m/s$

Recall, $K = \frac{D}{V_m^2}\left(\frac{V_m}{V_a} - 1\right) = \frac{1500}{15^2}\left(\frac{15}{12} - 1\right) = 5/3$

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

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

$$\frac{5}{3} \div \frac{1}{2} = \frac{1}{\alpha} + \frac{6}{5}$$

$$\frac{10}{3} = \frac{1}{\alpha} + \frac{6}{5}$$

$$\therefore \frac{1}{\alpha} = \frac{32}{15}$$

$$\alpha = \frac{15}{32}$$

$$= 0.469\, m/s^2$$

OR

$1.688\, km/h/s$

(2) $v_a = 36\, km/h = 36 \times \frac{1000}{3600} = 10\, m/s$

$\alpha = 1.8\, km/h/s = 1.8 \times \frac{1000}{3600} = 0.5\, m/s^2$

$\beta = 3.6\, km/h/s = 3.6 \times \frac{1000}{3600} = 1\, m/s^2$

$D = 2km = 2000m$

Recall, $V_a = \frac{D}{t}$

$$\therefore t = \frac{D}{V_a}$$

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$= \frac{2000}{10} = 200$

also, $k = \frac{\alpha + \beta}{2\alpha\beta} = \frac{0.5 + 1}{2(0.5)(1)} = 1.5$

$V_m = \frac{t - \sqrt{t^2 - 4kD}}{2k}$

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

$= 10.889 m/s$ OR $39.2 km/h$

(3) Total surface area = $6m^2$

let 'l' = side of tank so that T.S.A. $= 6l^2 = 6m^2$

$l = 6/6 = 1m^2$

∴ Volume $= l^3 = 1m^3$ (equivalent to 1000kg)

Volume to be heated 6 times daily $= 6 \times \left(1 \times \frac{90}{100}\right) = 5.4m^3$

Mass to be heated daily $= 5.4 \times 1000 = 5400$ kg

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Heat required to raise temp of water

$= mc\Delta\theta = 5400 \times 4250 \times (65-20)$

$= 1020 \times 10^6 J$

$= 1020 MJ$

Since 1 kWh = 3.6MJ

$x = 1020 MJ$

$x = \frac{1020}{3.6} = 283.3 kWh$

Daily loss per square meter per 1°C temperature difference is

$6.3 \times 6 \times (65-20) \times \frac{24}{1000} = 40.8 kWh$

Energy supplied per day = 283.3 kWh + 40.8 kWh

= 324.1 kWh

loading in kW = $\frac{324.1 kWh}{24h} = 13.5 kW$

efficiency = $\frac{283.3}{324.1} \times 100 = 87.41\%$

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(4) $P = IV\cos\phi$

Secondary Current $I_2 = \frac{P}{V\cos\phi} = \frac{600\times10^3}{20\times0.6} = 50\times10^3 A$

Secondary Voltage $V_2 = V(\cos\phi + j\sin\phi)$

$= 20(0.6 + j0.8) = (12 + j16)V$

$\therefore Z_2 = \frac{V_2}{I_2} = \frac{12 + j16}{50\times10^3} = (2.4\times10^{-4} + j3.2\times10^{-4})$

At half full level, resistance is double and reactance does not change

$\therefore Z_2 = 2\times(2.4\times10^{-4} + j3.2\times10^{-4})$

$= (4.8\times10^{-4} + j3.2\times10^{-4})$

$I_2 = \frac{V_2}{Z_2} = \frac{20}{4.8\times10^{-4} + j3.2\times10^{-4}} = 28846.15 - j19230.8$

$= \sqrt{28846.15^2 + (-19230.8)^2} \angle \tan^{-1}\frac{-19230.8}{28846.15}$

$I_2 = 34668.78 \angle -33.69°$

$= 3.467\times10^4 \angle -33.7° A$

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$P.F = \cos -33.7 = 0.832$

$\text{Power absorbed} = I_2 V_2 \cos\phi$

$= 34118.78 \times 20 \times 0.832$

$= 571888.4992\ W$

$\simeq 576.888 \times 10^3\ W$

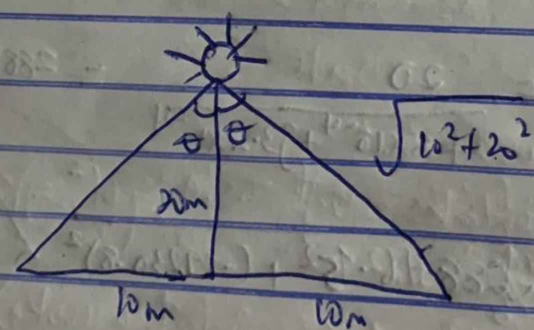
$\simeq 580\ kW$

(5) Without reflector

$E = \frac{I}{h^2} \cos\theta$

(a) $E = \frac{300}{20^2} \cos\theta = 0.75\ lm/m^2$

(b)



$\theta = \sin^{-1}\left(\frac{10}{\sqrt{10^2+20^2}}\right) = 26.56°$

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at the edge

$$E = \frac{300}{10^2+20^2} \times \cos 26.56°$$

$$= 0.537 \, lm/m^2$$

with reflector

$$I = \frac{\phi}{\omega}$$

$$\therefore \phi = I \times \omega = 300 \times 4\pi \text{ lumens}$$

Total flux $\phi = 1200\pi$

Flux directed by reflector $= 50/100 \times 1200\pi = 600\pi$ lumens

$$E = \frac{\phi}{A} = \frac{600\pi}{\pi \times 10^2} = 6 \, lm/m^2$$

The illumination is the same at every point on the disc while using the reflector.