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EEE 552

a) $D = 1500m$, schedule speed $= 36 km/h$, duration of stops $= 25$ seconds, braking retardation $r = 3 km/h/s$, acceleration $= ?$
ratio of V_{max} to $V_{avg} = 1.25$

Solution:

convert retardation r to $m/s^2 = 3 km/h/s \times \frac{5}{18} = \frac{5}{6} m/s^2$
convert schedule speed V_{ss} to $m/s^2 = 36 km/h \times \frac{5}{18} = 10 m/s$
schedule time; $t_s = \frac{1500}{10} = 150s$

actual time $t = 150 - 25 = 125$ seconds.

$V_{avg} = \frac{\text{avg distance}}{\text{actual time}} = \frac{1500}{125} = 12 m/s$

$V_{max} = (\text{ratio of } V_{max} \text{ to } V_{avg}) \times V_{avg}$
$V_{max} = 1.25 \times 12 = 15 m/s$

Recall,

$$k = \frac{D}{V_{max}^2}\left(\frac{V_{max}}{V_{avg}} - 1\right) = \frac{1500}{15^2}\left(\frac{15}{12} - 1\right) = \frac{5}{3}$$

Also,

$$k = \frac{1}{2}\left(\frac{1}{a} + \frac{1}{r}\right)$$

$$a = \frac{r}{2rk - 1}$$

$$a = \frac{\frac{5}{6}}{\left(2 \times \frac{5}{6} \times \frac{5}{3}\right) - 1} = 0.469 m/s^2$$

(2) $V_{avg} = 36\ km/h \times \frac{5}{18} = 10\ m/s$

distance $= 2000\ m$

(1) $a = 1{\cdot}8\ km/h/s \times \frac{5}{18} = 0{\cdot}5\ m/s^2$

$r = 3{\cdot}6\ km/h/s \times \frac{5}{18} = 1\ m/s^2$

Solution.

time $t = \frac{\text{distance}}{V_{avg}} = \frac{2000}{10} = 200\ s$

recall,

$$k = \frac{1}{2}\left(\frac{1}{a} + \frac{1}{r}\right) = \frac{1}{2}\left(\frac{1}{0{\cdot}5} + \frac{1}{1}\right)$$

$$k = \frac{1}{2}\left(2 + 1\right) = \frac{3}{2} = 1{\cdot}5$$

$$V_{max} = \frac{t - \sqrt{t^2 - 4kd}}{2k}$$

$$= \frac{200 - \sqrt{200^2 - 4 \times 1{\cdot}5 \times 2000}}{2 \times 1{\cdot}5}$$

$V_{max} = 11\ m/s$

or $V_{max} = 11\ m/s \times {}^{18}/_{5} = 39{\cdot}6\ km/h$

volume = Area × l

= 6×l

L

(b) surface area = $6.0m^2$, % filled = 90% for 6 times daily
~~At~~ heated from 20°C to 65°C;
losses per square meter of tank surface per 1°C temp difference are 6.3W,
loading = ?
efficiency = ?
specific heat of water = 4,200 J/kg/°C
one kWh = 3.6 MJ.

Solution.
~~total~~ assume h is one side of the tank
~~the total surface area of tank is $6h^2$~~
~~$\therefore 6h^2 = 6$~~
~~volume of tank = h^3 = $1m^3$~~
~~volume of wa~~

surface area = $6.0\ m^2$
$t_2 = 65°C$, loss per 1°C = $6.3\ W/°C/m^2$
$t_1 = 20°C$.

surface area = $6 \times l^2$

$L = \sqrt{\frac{\text{surface area}}{6}} = 1$

volume = l^3 = $1m^3$

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

mass of water to be heated = 5.4×1000
$= 5400\ kg$

1 (i) heat required to raise temperature H

H = mass × specific heat × $(t_2 - t_1)$

= 5400 × 4200 × (65−20)

H = 1020.6 MJ

to kwh

$H = \frac{1020.6 \text{ MJ}}{3.6 \times 10^6} = 283.3$ kwh.

(ii)

daily loss from surface.

L = 6 × 6.3 × (65−20) × 24/1000 = 40.8 kwh.

energy supplied per day = 283.3 + 40.8 = 324.1 kwh

loading in kw = 324.1/24 = 3.5 kW

Efficiency of tank = 283.3 × 100/324.1 = 87.4%

(4) secondary voltage = 20 V.

p input = 600 kW pf = 0.6

power absorbed = ? p.f = ?

solution.

secondary current $= \frac{600 \times 10^3}{20} \times 0.6 = 5 \times 10^4$ A

secondary voltage $V_2 = 20(0.6 + j0.8) = (12 + 16j)$ V

secondary impedance $Z_2 = \frac{(12 + 16j)}{5} \times 10^4 = (2.4 + 3.2j) 10^{-4}$

If the secondary resistance is double, then total impedance when hearth is half full is $= Z_2 = (4.8 + 3.2j) \times 10^{-4}$ Ω secondary current $I_2 = \frac{20}{(4.8 + 3.2j)} \times 10^{-4}$ A

$= 3.466 \angle -33.7^\circ \times 10^4$ A

$p.f = \cos 33.7^\circ = 0.832.$

power absorbed $= 20 \times 3.466 \times 10^4 \times 0.832 \times 10^{-3} = 580$ kW.

(5) candle power CP = 300

reflector directs 50% of total emitted light uniformly

~~to a disc~~ diameter of disc = 20 m

distance of disc below lamp = 20 m.

illumination at centre and edge = ? with and without reflector.

solution.

without reflector.

(a) $E = 300 \times \frac{1}{20^2} = 0.75$ lumen/m².

(b) $\theta = \tan^{-1}\left(\frac{10}{20}\right) = 26.6^\circ$, $\cos\theta = 0.089$

$x^2 = 10^2 + 20^2 = 500^2$

$\therefore E = \frac{300 \times 0.89}{500} = 0.534$ lumen/m²

with reflector.

luminous output of lamp $= 300 \times 4\pi$ lumen.

flux directed by reflector $= 0.5 \times 1200\pi = 600\pi$ lumen.

illumination poured on the disc $= 600\pi / 100\pi = 6$ lumen/m²

It is the same at every point of the disc.