CHIMA WISDOM ENYICHE
18/ENG04/025
Electrical /electronics) engineering
ENG214

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4 ① flow rate $= 10\ dm^3/min = 0.000167\ m^3/s$
Pressure change $= 12bar = 1.2\times10^6\ N/m^2$
speed of rotation $= 1500\ rev/min = 25\ rev/sec$
nominal displacement $= 10\ cm^3/rev = 1\times10^{-5}\ m^3/rev$
torque input $= 12.5\ Nm$

i volumetric efficiency $= \frac{\text{actual flowrate}}{\text{theoretical flowrate}} \times \frac{100}{1}$

theoretical flow rate = speed of rotation × displacment
$= 25\times(1\times10^{-5}) = 2.5\times10^{-4}\ m^3/sec$

volumetric efficiency $= \frac{0.000167}{2.5\times10^{-4}} \times 100$ $= 66.8\%$

ii fluid power $= Q(P_2 - P_1)$
$= 0.000167(1.2\times10^6)$
$= 200.4$ watts

iii Shaft Power $= T\times\omega$
$\omega = 2\pi \times$ speed of rotation
$\omega = 2\times\pi\times25 = 157.08\ rad/sec$
Shaft power $= 12.5 \times 157.08$
$= 1963.5$ watts

iv overall efficiency $= \frac{\text{fluid power}}{\text{Shaft power}} \times 100$
$= \frac{200.4}{1963.5} \times 100$
$= 10.21\%$

Question (2)

flow = $35 dm^3/min$ = $0.0005833\ m^3/s$

Pressure change = 100bar = $100 \times 10^5\ N/m^2$

If Overall efficiency is 87%

Overall efficiency = $\frac{\text{Fluid Power}}{\text{Shaft Power}} \times 100$

Fluid Power = $Q(P_2 - P_1)$

= $0.0005833(100 \times 10^5)$

= 5833 watts

$\frac{87\%}{100} = \frac{\text{fluid Power}}{\text{Shaft Power}}$

$0.87 = \frac{5833}{\text{Shaft Power}}$ // $\frac{5833}{0.87}$ = 6704.598 watts

Question (3)

Nominal displacement = $50 cm^3/rev$ = $5 \times 10^{-5}\ m^3/rev$

Change in Pressure = 100bar = $100 \times 10^5\ N/m^2$

Shaft Power = 15 kilowatts = 15×10^3 watts

Actual flow rate = $35 dm^3/min$ = $0.0005833\ m^3/s$

Speed of rotation = 850 r.p.m = 14.1667 r.p.s

Overall efficiency = $\frac{\text{Fluid power}}{\text{Shaft Power}} \times 100$

Fluid Power = $Q(P_2 - P_1)$

= $0.0005833(100 \times 10^5)$ = 5833 watt

~~Shaft Power = $T \times \omega$~~

~~ω = $2 \times \pi \times$ speed of rotation, $2 \times \pi \times 14.1667$ = 89.0[illegible]~~

(i) Overall efficiency = $\frac{5833}{15 \times 10^3}$ = 38.9%

(ii) Volumetric efficiency = actual flow rate / theoretical flow

theoretical flowrate = $14.1667 \times 5 \times 10^{-5}$ = $7.08 \times 10^{-4}\ m^3/s$

volumetric efficiency =

$0.0005833 / 7.08 \times 10^{-4}$ = 82.4%

Question (4)
water level = 24000 cm
flow = 13 liters/sec
Jet velocity = 66 m/s

Power of Jet $= \frac{1}{2} \rho Q v^2$
$= \frac{1}{2} \times \frac{1000}{9.81} \times 66^2 \times 0.13 = 28862$ kgm/sec
$= 28862 \times 981 =$
28314010

(i) Power supplied from reservoir $= \rho Q g z = \gamma Q z$
$= 1000 \times 0.13 \times 240 = 31200$ kgm/sec
$31200 \times 9.81 = 306072$ W

(ii) Power lost in transmission $= \gamma Q h = 9 - 5 = 2338$ kgm/sec
Head loss in pipe $= h =$ power lost $/ \gamma Q$
$h = 2338 / (1000 \times 0.13)$
$h = 17.98$ m

$40000 = 416.67Q + 0.0625Q^2$
$0.0625Q^2 + 416.67Q - 40000 = 0$
$Q^2 + 6666.72Q - 640000 = 0$
$Q = 9465$ ft/day

Question (5)
Specific gravity of oil = 0.89
$h = 30{,}000$ cm $= 300$ m
Flowrate = 220 lit/s = $0.22\ m^3/s$
velocity = 7 m/s
(i) Power of Jet $= \frac{1}{2} \rho Q v^2 = \frac{1}{2} \times 890 \times 0.22 \times 7^2$
$= 4797.1$ watt

Power supplied from reservoir = $P = WQH$
$= 890 \times 9.81 \times 0.22 \times 300$
$= 576239.4$ W

Power supplied from reservoir = VQH

$= 890 \times 0.22 \times 300 = 58740$ kgm/sec

Power issuing Jet $= \frac{1}{2}\rho v^2 Q = \frac{1}{2} \times \frac{890}{9.81} \times 7^2 \times 0.22$

$= 489$ kgm/s

Power loss during transmission $= rQh = 58740 - 489 =$

58251 kgm/s

$h = \frac{58251}{890 \cdot 0.22} = 297.50$ m

$\eta = \frac{\text{Power of Jet}}{\text{Power supplied}} = \frac{489}{58740} = 0.0083 = 0.8324$

$= 83.24\%$

(6) Question (6)

$P = \frac{w}{t} = \frac{mgh}{t} = \frac{\rho \pi r^2 v g h}{t}$

$v = \sqrt{2gh} = \sqrt{2 \times 9.8 \times 20} = 19.798$ m/s

$(1000)\pi \times \left(\frac{10 \times 10^{-2}}{2}\right)^2 \times 19.798 \times 9.8 \times 20$

$= 1000 \times \pi \times 2.5 \times 10^{-3} \times 19.798 \times 9.8 \times 20$

$= 30478.03$ W

(7) question (4)

inlet diameter = 0.3 m throat diameter = 0.2 m

$C_d = 0.96$

$S_w = 19.62\ N/m^3$

$a_1 V_1 = a_2 V_2 = q$ $a = \frac{\pi d^2}{4}$

$Q = a_1 V_1$ $Q = a_2 V_2$ $a_1 = \frac{\pi (0.3)^2}{4} = 0.0700$

$a_2 = \frac{\pi d^2}{4} = \frac{\pi (0.2)^2}{4} = 0.0319\ m$

$V_1 = \frac{Q}{0.070}$ $V_2 = \frac{Q}{0.0319}$

$P_1 + \rho_s g z = P_2 + \rho_s g (z_2 - R_p) + \rho_m g R_p$

$P_1 - P_2 = 19.62(z_2 - z_1) + 587.423$

$\frac{P_1}{\rho_s g} + \frac{u_1^2}{2g} + z_1 = \frac{P_2}{\rho_s g} + \frac{u_2^2}{2g} + z_2$

$P_1 - P_2 = 19.62(z_2 - z_1) + 0.803 u_2^2$

$0.803 u_2^2 = 587.423$

$u_2 = 27.047\ m/s$

$Q = 27.047 \times 0.0319 = 0.85\ m^3/s$

[illegible] $Q = C_d Q = 0.96 \times 0.85 = 0.816\ m^3/s$

(8) $d_1 = 0.152\ m$ $d_2 = 0.076\ m$ $C_d = 0.97$

$A_1 = \frac{\pi (0.152)^2}{4} = 0.01814\ m^2$ $A_2 = \frac{\pi (0.076)^2}{4} = 0.00454\ m^2$

$\frac{P_1}{w} + z_1 + \frac{V_1^2}{2g} = \frac{P_2}{w} + \frac{V_2^2}{2g} + z_2$

$P_1 = P_2 \therefore z_1 + \frac{V_1^2}{2g} = z_2 + \frac{V_2^2}{2g}$

$V_2 = \frac{V_1 A_1}{A_2} = V_1 4$

$\frac{V_1^2}{2g} + 0.914 = \frac{16 u_1^2}{2g}$, $V_1 = \sqrt{\frac{0.914 \times 2 \times 9.81}{15}} = 1.0934\ m/s$

$Q = 0.96 \times 0.01814 \times 1.0934 = 0.019\ m^3/s$

6 $P_1 - P_2 = 15170$

$$\frac{P_1 - P_2}{\rho g} = \frac{V_2^2 - V_1^2}{2g} - 0.914$$

$$\frac{15170}{\rho g} = \frac{Q^2(220.43^2 - 55.11^2)}{2g} - 0.914$$

$$55.86 = Q^2(220.43^2 - 55.11^2)$$

$$Q = \sqrt{\frac{55.08}{(220.43^2 - 55.11^2)}}$$

$$Q = 0.035\, m^3/s$$

9 $D_1 = 0.3m$ $A_1 = 0.07068 m^2$ $D_2 = 0.15m$ $A_2 = 0.01767 m^2$

$P_1 = 400 kN/m^2$ $Z_2 = 6m$

$Z_1 = 10m$ $Q = 0.04 m^3/sec$

$$Q = A_1 V_1 = A_2 V_2$$

$$V_1 = \frac{Q}{A_1} = \frac{0.04}{0.07068} = 0.5658 m/s$$

$$V_2 = \frac{Q}{A_2} = \frac{0.04}{0.0767} = 2.2635 m/s$$

$$\frac{P_1}{w} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{w} + \frac{V_2^2}{2g} + Z_2$$

$$\frac{P_2}{w} = \frac{P_1}{w} - \frac{V_1^2 - V_2^2}{2g} + (Z_1 - Z_2)$$

$$\frac{P_2}{w} = \frac{400 \times 10^3}{1000 \times 9.81} + \frac{(0.5658^2 - 2.2635^2)}{2 \times 9.81} + 10 - 6$$

$$\frac{P_2}{w} = 44.53$$

$$P_2 = 44.53 \times 9.81 \times 1000$$

$$P_2 = 436.838 kN/m^2$$

10 $h = y\left[\frac{S.g \text{ of mercury}}{S.g \text{ of water}} - 1\right] = 0.17\left[\frac{13.6}{1.026} - 1\right]$

$h = 2.0534m$

$V = C_v\sqrt{2gh}$

$V = 1.\sqrt{2 \times 9.81 \times 2.0834}$

$V = 6.398\ m/s^2$