$= 71.1 \times 10^{-3}$ m²/sec

Volumetric efficiency $= \frac{5.833 \times 10^{-4}}{71 \times 10^{-3}} \times 100$

$= 8.22\%$

4) $Z = 24{,}000$ cm $= \frac{24{,}000}{100} = 240$ m

flow rate = 13 litres / sec

Since 1000 litres = 1m³

∴ 13 litres $= \frac{13 \times 1}{1000} = 0.013$ m³/sec

Velocity of jet = 6 m/sec

Jet issuing from nozzle is at atmospheric pressure and datum level

$P = 0, \; Z = 0$

Density = 1000 kg/m³

from equation: $P = \left(P + \rho g z + \frac{\rho v^2}{2}\right) Q$

Substitute

$P = 0; \; Z = 0$

$P = 0 \cdot Q + \frac{\rho Q v^2}{2} + \rho g \cdot 0$

$P = 28314 \; w = 28.314 \, kw$

(ii) At this point, P = 0 while V = 0

$$P = \left(PQ + \rho Qgz + \frac{\rho Q v^2}{2}\right)$$

$$P = \rho Qgz = 1000 \times 0.013 \times 9.81 \times 240$$

$$= 30576 \, W$$

$$= 30.576 \, kW$$

(iii) power loss in transmission = 30.576 − 28.314

= 2.262 kW = 2262 W

Head loss in pipeline:

$$h = \frac{\text{Power transmission loss}}{\rho g Q}$$

$$= \frac{2262}{1000 \times 9.81 \times 0.013} = 17.73 \, m$$

=> 92.6 %

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

Shaft power = 15kw = 15,000w

Actual flow rate = $35 dm^3/min$ = $\frac{35 dm^3}{1 min} \times \frac{1 min}{60 sec} \times \frac{1 m^3}{1000 dm^3}$

$= 5.833 \times 10^{-4} m^3/sec$

Speed of rotation = 850 rpm = 14.2 rps

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

fluid power = Actual flow rate × pressure Change

$= 5.833 \times 10^{-4} \times 100 \times 10^5$

= 58.33 watts

Shaft power = Torque input × angular speed

= 15kw = 15000w

Overall efficiency = $\frac{5833}{15000} \times 100$

= 38.9%

Volumetric efficiency = $\frac{\text{Actual flow rate} \times 100}{\text{Ideal flow rate}}$

Ideal flow rate = nominal displacement × Speed

$= 5 \times 100^{-4} \times 14.2$

2) Rate of delivery = 35 dm^3/min = 35/60 = 0.58 dm^3/s
Pressure Change = 100 bar = 100 $\times 10^5$ N/m^2
Overall efficiency = 87%
Shaft power = ?

Rate of delivery = 0.58 $\times \frac{1}{1000}$ = 5.83 $\times 10^{-4}$ m^3/sec

fluid power = Actual flow rate $\times$ pressure change
= 5.83 $\times 10^{-4}$ $\times$ 100 $\times 10^5$
= 5833.33 watts

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

$87 = \frac{5833.33}{S.P} \times 100$

$\frac{0.87}{5833.33} = \frac{1}{S.P}$

∴ Shaft power = ~~6.7~~ 6704.98 watts

3) nominal displacement = 50 cm^3/rev = $\frac{50 cm^3}{rev} \times \frac{1 m^3}{100^3 cm^3}$

= $\frac{5 \times 10^{-5}}{rev}$

(i) fluid power = Actual flow rate × pressure

$= 1.667 \times 10^{-4} \times 12 \times 10^{5}$

$= 200.04$ watts

(ii) Shaft power = Torque input × Angular speed

Torque input = 12.5 Nm

Angular speed = $\omega = \frac{2\pi N}{60} = 2 \times \pi \times \frac{1500}{60}$

(rps)

∴ Shaft power = $12.5 \times 2 \times \pi \times 25 = 1963.5$ watts

Overall efficiency = $\frac{\text{fluid power}}{\text{Shaft power}} \times 100\%$

$= \frac{200.4}{1963.5} \times 100$

$= 10.21\%$

Adedoyin Mayowa
18[illegible]
fluid mech

i) Rate of pump delivery = 10 $L\,min^{-1}$ ($10\,L/min$)

pressure change = 12 bar = $12 \times 10^5\ N/m^2$

Speed of rotation = 1500 rev/min = $\frac{1500\ rev}{1\ min} \times \frac{1\ min}{60\ sec}$

$= 25\ rev/sec$

Torque input = 12.5 Nm

ii) Volumetric efficiency = $\frac{\text{Actual flowrate}}{\text{Ideal flow rate}} \times 100\%$

Actual flow rate = $10\ L/min = \frac{10\ L}{1\ min} \times \frac{1\ m^3}{1000\ L} \times \frac{1\ min}{60\ sec}$

$= 1.667 \times 10^{-4}\ m^3/sec$

nominal displacement = $\frac{10\ cm^3}{1\ rev} \times \frac{1\ m^3}{100^3\ cm^3} = 1 \times 10^{-5}\ m^3/rev$

Ideal flow rate = nominal displacement × Speed

$= 1 \times 10^{-5} \times 25$

$= 2.5 \times 10^{-4}\ m^3/sec$

Volumetric efficiency = $\frac{1.667 \times 10^{-4}}{2.5 \times 10^{-4}} \times 100 = 66.68\%$

$Q = 40$ litres/sec $= 0.04\ m^3/sec$

$Z_1 = 10m$; $Z_2 = 6m$

$p_1 = 400\ kN/m^2$; $p_2 = ?$

$= 400kp_a$

$u_1 = \frac{Q}{A_1} = \frac{0.04}{0.071} = 0.583\ m/s$

$u_2 = \frac{Q}{A_2} = \frac{0.04}{0.018} = 2.27\ m/s$

from bernoulli's equation $\frac{p_1}{w} + \frac{u_1^2}{2g} + Z_1 = \frac{p_2}{w} + \frac{u_2^2}{2g} + Z_2$

$$\frac{400}{9.81} + \frac{0.563^2}{2 \times 9.81} + 10 = \frac{p_2}{9.81} + \frac{2.27^2}{2 \times 9.81} + 6$$

$$\frac{p_2}{9.81} = 44.53$$

Pressure at Section 2 $= 9.81 \times 44.5$

∴ Intensity of Pressure $= 436.82\ kN/m^2$ //

$p_2 = 436.82$

(c) Gxis. $= 12m$ below sea-level

$y = 170mm = 0.17m$ of mercury

Sp. gravity of Hg $= 13.6$

5) Specific gravity of oil = 0.89

$z = 30{,}000\,cm = 300m$

$Q = 220$ litres /sec

since 1000 litres = $1m^3$

220 litres = $\frac{220}{1000} = 0.22m^3/sec$

Velocity of Jet = 7m/sec

i) Specific gravity = $\frac{\text{Specific weight of liquid}}{\text{Specific weight of water}}$

0.89×9.81 = Specific weight of liquid

=> $8.7309\ kN/m^3 = 8730.9\ N/m^3$

∴ density $(\rho) = \frac{8730.9}{9.81} = 890\ kg/m^3$

Recall

At the point of jet issuing from nozzle

$P = 0,\ z = 0.$

from equation : $\left(PQ + \rho g z Q + \frac{\rho v^2 Q}{2}\right)$ = power

$$P = \frac{\rho v^2 Q}{2} = \frac{890 \times 7^2 \times 0.22}{2}$$

$= 4797.1\,W = 4.7971\,kW$

5) When $P_1 - P_2 = 15.70$; $0.8 \times 1000 = 800 kg/m^3$

$h = \frac{15.70}{9.848}$ — density of the liquid

$w = \rho g$

$W = 800 \times 9.81 = 7.848 kN/m^3$

$h = 1.933 m + 0.914 m$

$\therefore h = 2.847 m$

$\therefore$ Discharge $(Q) = Cd \times \frac{A_1 A_2}{\sqrt{A_1^2 - A_2^2}} \times \sqrt{2gh}$

$$Q = \frac{0.97 \times 0.0181 \times 4.54 \times 10^{-3} \times \sqrt{2 \times 9.81 \times 2.847}}{\sqrt{(0.018)^2 - (4.54 \times 10^{-3})^2}}$$

$Q = 0.034 m^3/seconds$

(9) Section 1 Diameter $= 300 mm = 0.3 m$ (D_1)

Section 1 Area $= \frac{\pi \times 0.3^2}{4} = 0.07 m^3$ (A_1)

Section 2 Diameter $= 150 mm = 0.15 m$ (D_2)

Section 2 Area $= \frac{\pi \times 0.15^2}{4} = 0.018 m^2$ (A_2)

Sp. gravity of water = 1.026

$h = y\left(\frac{S_{hl}}{S_l} - 1\right)$

$h = 0.17 \cdot \left(\frac{13.6}{1.026} - 1\right)$

$h = 2.08\,m$

$\therefore$ Velocity of submarine $(v) = \sqrt{2gh}$

$= \sqrt{2 \times 9.81 \times 2.08}$

$= 6.39\,m/s$

$$Q = 0.96 \times \frac{0.071 \times 0.031}{\sqrt{(0.071)^2 - (0.031)^2}} \times \sqrt{2 \times 9.81 \times 0.06}$$

$Q = 0.0359 m^3/s$

Volume flowing $= 0.0359 m^3$

5) Throat diameter $(D_t) = 0.076 m$

Throat area $(A_t) = \frac{\pi \times (0.076)^2}{4} = 4.542 \times 10^{-3} m^2$

Relative density $= 0.8$

Pipe diameter $= 0.152 m = D_2$

Pipe area $(A_1) = 0.0181 m^2$

Difference between inlet and throat $= 0.96 m$

$C_d = 0.97$

Since $h = \left(\frac{P_1}{\omega} - \frac{P_2}{\omega}\right) + (Z_1 - Z_2)$

6) When $P_1 = P_2$

$\therefore h = 0$

Discharge $(Q) = C_d \times \frac{A_1 A_2}{\sqrt{A_1^2 - A_2^2}} \times \sqrt{2gh}$

Since $h = 0$

$\therefore Q = 0$

6) power = pressure × flowrate

pressure of water = $\rho g h$ = 1000 × 9.81 × 20

= 196200 N/m²

Area = π × (0.05)² = 7.854 × 10⁻³ m²

Volume = 7.854 × 10⁻³ × 20 = 0.1571 m³

Q = flowrate = $\frac{0.1571}{60}$ = 2.62 m³/s

power = 196200 × 2.62

= 514044 W = 514.044 kW

7) Inlet diameter = 0.3m ⇒ $\frac{\pi \times 0.3^2}{4}$ = 0.07 m² = Inlet Area (A_1)

Throat diameter = 0.2m ⇒ $\frac{\pi \times 0.2^2}{4}$ = 0.031 m² = throat area (A_2)

(D_2)

C_d = 0.96 : h = 0.06m;

Sp. gr. of water = 1

Specific weight of gas = 19.62 N/m³

Sp gr of gas = $\frac{19.62 \div 1000}{9.81}$ = 0.002

$$Q = C_d \frac{A_1 A_2}{\sqrt{A_1^2 - A_2^2}} \times \sqrt{2gh}$$

(ii) power supplied from reservoir reservoir $p_0, v_0 = 0$

power. $(P_0 + \rho g Q + \frac{\rho v^2 Q}{2})$

power $= \rho g Q = 890 \times 300 \times 9.81 \times 0.22$

$= 576239.44 = 576.2394$ kw

(iii) power loss in transmission $= 576239.4 - 4797.1$

$= 571442.3$ w

Head used $= \frac{\text{power loss in transmission}}{\rho g Q}$

$\Rightarrow \frac{571442.3}{890 \times 9.81 \times 0.22}$

$= 297.50$ m

(iv)

efficiency $= \frac{\text{power of jet}}{\text{power of reservoir}} \times 100$

$= \frac{4797.1}{576239.4} \times 100$

$= 0.83\%$