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

$$= \frac{0.98 \times 3.14 \times 10^{-3} \times 7.85 \times 10^{-4}}{\sqrt{(3.14 \times 10^{-3})^2 - (7.85 \times 10^{-4})^2}} \times \sqrt{2 \times 9.81 \times 22.08}$$

$$= 0.98 \times 8.12 \times 10^{-5} \times 20.81$$

$$= 1.656 \times 10^{-2} m^3/s$$

3) $D_0 = 15cm = 0.15m$

$D_1 = 30cm = 0.3m$.

$y = 50cmHg = 0.5mHg$

S.g of NL = 0.9; S.g of mercury = 13.6

$C_d = 0.64$.

Area of pipe $(A_1) = \frac{\pi \times 0.3^2}{4} = 0.07m^2$.

Area of orifice meter $(A_c) = \frac{\pi \times 0.15^2}{4} = 0.017$.

$$h = y\left[\frac{S_{ghL}}{S_0} - 1\right].$$

S_{ghL} = specific gravity of heavier liquid

$$h = 0.5\left[\frac{15.6}{0.9} - 1\right].$$

$$= 7.056m \text{ of oil}.$$

$$Q = C_d \frac{A_c A_1 \sqrt{2gh}}{\sqrt{A_1^2 - A_0^2}}$$

$$= \frac{0.64 \times 0.0177 \times 0.071 \times \sqrt{2 \times 9.81 \times 7.056}}{\sqrt{0.081^2 - 0.0177^2}}$$

$$= 0.138 m^3/s.$$

4 manometer reading (y) = 170mmHg = 0.17mHg

$S_{g hi} = 13.6$

S.g of seawater (S_w) = 1.026

$$h = 0.17\left[\frac{13.6}{1.026} - 1\right]$$

$= 2.08$

Velocity of the submarine

$$V = \sqrt{2gh}$$

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

$= 6.39 m/s$

5 $Q = 5 dm^3/min$

$$= \left[\frac{5}{1000} \times \frac{1}{60}\right] m^3/s$$

$= 8.3 \times 10^{-5} m^3/s$

$V = 1700 rev/min = \frac{1700}{60} = 28.33 rev/sec$

$Q_p = 10 cm^3/rev = 10 \times 10^{6} m^3/rev$

Ideal flow rate = speed × displacement

$1 \times 10^{-5} \times 28.33$

$= 2.833 \times 10^{-4} m^3/sec$

(i) Vol. efficiency $= \frac{\text{actual } Q}{\text{Ideal } Q} \times 100$

$$\frac{8.3 \times 10^{-5}}{2.83 \times 10^{-4}} \times 100$$

$= 29.33\%$

(ii) fluid power = flow rate × pressure

$= 8.3 \times 10^{-5} \times (15 \times 10^{5})$

$= 124.5 W$

(iii) Shaft power = torque × angular velocity

$\omega = 2\pi v$

$= 2\pi \times 28.33 = 178\ rad\,s^{-1}$

shaft power

$= 15 \times 178$

$= 2670\ W$.

(iv) Overall efficiency = $\frac{\text{Fluid power}}{\text{Shaft power}} \times 100$

$= \frac{124.5}{2670} \times 100$

$= 4.66\%$

OSANWEREN JANE
18/ENG06/063
MECHANICAL ENG

1. $l = 2m$
$V_1 = 5m/s$
$V_2 = 2m/s$
$\frac{P_2}{w} = 2.5m$
$h_L = \frac{0.35(V_1 - V_2)^2}{2g} = \frac{0.35(5-2)^2}{2 \times 9.81} = 0.161m$

To get $\frac{P_2}{w}$; comparing:
$$\frac{P_1}{w} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{w} + \frac{V_2^2}{2g} + z_2 + h_L$$
$z_2 = 0$
$z_1 = 2m$
$$2.5 + \frac{5^2}{2 \times 9.81} + 2 = \frac{P_2}{w} + \frac{2^2}{2 \times 9.81} + 0 + 0.161$$
$$5.77 = \frac{P_2}{w} + 0.365$$
$$\frac{P_2}{w} = 5.77 - 0.365$$
$$\frac{P_2}{w} = 5.405m$$

2. $d_1 = 0.2m$; $d_2 = 0.1m$; $P_1 = 17.058 N/cm^2$; $P_2 = -30mmHg$; $Cd =$
$$A_1 = \frac{\pi \times 0.2^2}{4} = 3.14 \times 10^{-3} m^2$$
$$A_2 = \frac{\pi \times 0.12^2}{4} = 7.85 \times 10^{-4} m^2$$
$$h = \frac{P_1 - P_2}{w}$$
$$P_1 = \frac{17.654}{10^{-4}} = 176.58 \times 10^2 N/m^2$$
$$\frac{P_1}{w} = \frac{176.58 \times 10^3}{1000 \times 9.81} = 18m$$
$$\frac{P_2}{w} = -0.30 \times 13.6$$
$$= -4.08$$
$$h = 18 + 4.08$$