10.) $x = 170 mm = 0.17 m$

S.g of mecury = 13.6

So of sea water = 1.026

$$h = x\left(\frac{S_g}{S_o} - 1\right)$$

$$= 0.17$$

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

$$= 2.0834 m$$

$$V = \sqrt{2gh} = \sqrt{2 \times 9.81 \times 2.0834}$$

$$= 6.393 m/s$$

$$= \frac{6.393 \times 60 \times 60}{1000}$$

$$= 23.01 km/hr$$

1.) Section 1

$D_1 = 300mm = 0.30m$

$A_1 = \pi/4 (0.3)^2 = 0.70695 m^2$

$P_1 = 400 kN/m^2 = 400000 N/m^2$

$Z_1 = 10m$

Section 2

$D_2 = 150mm = 0.15m$

$A_2 = \pi/4 (0.15)^2 = 0.0177 m^2$, $Z_2 = 6m$, $P_2 = ?$

Rate of discharge $Q = 40 l/sec = 40/1000 = 0.040 m^3/sec$

$$Q = A_1 V_1 = A_2 V_2$$

$$V_1 = \frac{Q_1}{A_1} = \frac{0.040}{0.070695} = 0.566 m/s$$

$$V_2 = \frac{Q_2}{A_2} = \frac{0.040}{0.0177} = 2.2599 m/s$$

Applying Bernoulis equation at Section 1 and 2;

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

$$\frac{400000}{1000 \times 9.81} + \frac{0.566}{2 \times 9.81} + 10 = \frac{P_2}{1000 \times 9.81} + \frac{2.2599}{2 \times 9.81} + 6$$

$$40.77 + 0.0288 + 10 = \frac{P_2}{1000 \times 9.81} + 6.115$$

$$= 50.7988 = \frac{P_2}{9810} + 6.115$$

$$\frac{P_2}{9810} = 50.7988 - 6.115 = 44.6838$$

$$P_2 = 44.6838 \times 9810$$

$$P_2 = 438348.078 N/m^2$$

8.) $d_1 = 0.152m = A_1 = \pi/4 (0.152)^2 = 0.01814 m^2$

$d_2 = 0.076m = A_2 = \pi/4 (0.076)^2 = 0.00454m$

$\rho = 0.8 \times 1000 = 800 kg/m^3$

$Cd = 0.97$

Applying Bernoulli's equation

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

a.) $P_1 = P_2$

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

By Continuity

$Q = V_1 A_1 = V_2 A_2$

$$V_2 = V_1 \frac{A_1}{A_2} = V(cd)$$

$$\frac{V_1^2}{2g} + 0.314 = \frac{\pm 6(V_1^2)}{2g}$$

$$V_1 = \sqrt{\frac{0.314 \times 2 \times 9.81}{15}} = 1.0934 m/s$$

$Q = Cd A_1 V_1 = 0.97 \times (0.01814) \times (1.0934)$

$= 0.0192 m^3/s$

b.) $P_1 - P_2 = 15170$

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

$$\frac{15170}{800 \times 9.81} = \frac{Q^2 (220.43^2 - 55.11^2)}{2 \times 9.8} - 0.914$$

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

9.) Sect

D_1

A_1

Sect

D

A

6.) $\text{Power} = \dfrac{\text{Workdone}}{\text{Time}}$

V = Velocity of stream

ρ = density of water (1000 kg/m³)

$\text{Workdone} = \dfrac{mgh}{\text{time}}$

$m = \rho \times V$

$V = \sqrt{2gh} = \sqrt{2 \times 9.81 \times 20}$

$= 19.7989 \ m/s$

$P = \rho \pi r^2 \dfrac{Vgh}{t}$

$\text{Power} = 1000 \times \left(\dfrac{10 \times 10^{-2}}{2}\right) \times 19.7989 \times 9.8 \times 20$

$= 30478.03 \, W$

7.) $\rho_g g = 19.62 \ N/m^2$

$C_d = 0.96$

$d_1 = 0.3m$

$d_2 = 0.2m$

$Q = ?$

$V_1 = \dfrac{Q}{0.0707}$, $V_2 = \dfrac{Q}{0.0314}$

$P + \rho_g g z = P_2 + P_2 g (z_2 - Rf) + P_w g Rf$

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

$\dfrac{P_1}{\rho_g g} + \dfrac{V_1^2}{2g} + z_1 = \dfrac{P_2}{\rho_g g} + \dfrac{V_2^2}{2g} + z_2$

$P_1 - P_2 = 19.62 (z_2 - z_1) + 0.803 V_2^2$ —— (ii)

Combining (i) and (ii)

$0.803 V_2^2 = 587.423$

$V_2 \text{ Ideal} = 27.047 \ m/s$

$Q \text{ Ideal} = 27.047 \times \pi \times (0.2/2)^2$

$= 0.85 \ m^3/s$

$Q = C_d \ Q \text{ Ideal}$

$= 0.96 \times 0.85$

$= 0.816 \ m^3/s$

5.) $H = 300m$

$Q = 220 L/s = 0.22 m^3/s$

$\rho = 890 kg/m^3$

$V = 7 m/s$

I.) Power of jet $P = \frac{1}{2} \times \rho Q V^2 = \frac{1}{2} \times 890 \times 0.22 \times 7^2$

$= 4797.1$ watt

$= 4.797$ kwatt

II.) Power supplied from reservoir $\bar{P} = WQH$

$= 890 \times 9.81 \times 0.22 \times 300$

$= 576239.4 W$

$= 576.239 kW$

III.) Power supplied from reservoir $= \gamma Q H$

$= 890 \times 0.22 \times 300 =$ ~~58746 kgm~~ 58740 kgm/sec

Power issuing jet

$= \frac{1}{2} \rho V^2 Q = \frac{1}{2} \times 890/9.81 \times 7^2 \times 0.22$

$= 489$ kgm/s

Power lost in transmission

$= \gamma Q h = 58740 - 489$

$= 58251$ kgm/s

IV.) $\eta = \frac{\text{power of jet}}{\text{Power supplied}}$

$= \frac{489}{58740} = 0.0083 = 0.8324\%$

4.) i) Power of Jet = $\frac{1}{2} \rho V^2 Q$
$= \frac{1}{2} \times 1000/98.1 \times 66^2 \times 0.13$
$= 28862$ kgm/sec
$= 28862 \times 9.81$
$= 283140W = 283.14$ kW

ii.) Power supplied from reservoir $= \rho Q g z$
$= \gamma Q z$

$= 1000 \times 0.13 \times 240$
$= 31200$ kgm/sec
$= 31200 \times 9.81 = 306072W$
$= 306.072$ kW

iii.) If H_1 = Total head at the reservoir
H_2 = Total head at the Jet
h = Head loss in transmission
a, power supplied from reservoir $= \gamma Q H_1 = 31200$ kg m/s
b_2 Power ~~sup~~ of issuing Jet $= \gamma Q H_2 = 28862$ kg/sec
Power lost in transmission $= \gamma Q h = 2338$ kgm/sec
$a - b = c$; Power lost in transmission $= \gamma Q h = 2338$ kgm/sec

dm³/min

Head loss in pipe $h = \frac{(\text{power lost})}{\gamma Q}$

$= \frac{2338}{1000 \times 0.13}$

$= 17.98$ m

$40000 = 416.67Q + 0.0625Q^2$
$= 94.65$ ft/day

No 2 Continued

$\Delta P = 100 \text{ bar} = 100 \times 10^5 \text{ Pa}$

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

Overall efficiency of Pump is given as

$\% = \frac{SgQH}{P}$

P = Shaft power

$SgH = \Delta P$

$P = \frac{Q\Delta P}{\%} = \frac{5.8333 \times 10^{-4} \times 100 \times 10^5}{0.87}$

$P = 6.705$ watts,

3.) Norminal displacement of pump = $50 cm^3/rev$

Speed of rotation = 850 rev/min

Q theory = Theoretical discharge

= Norminal displacement × Speed of rotation

$= 50 \times 850 = 42500 cm^3/min = 42.5 dm^3/min$

Volumetric efficiency $= \frac{Q_{actual}}{Q_{theory}} = \frac{35 dm^3/min}{42.5 dm^3/min} \times 100$

$= 82.353\%$

Overall efficiency of pump;

$\% = \frac{SgQH}{P(shaft)}$

$SgH = \Delta P = 100 \text{ bar} = 100 \times 10^5 N/m^2$

$Q = Q_{actual} = 35 dm^3/min$

$= \frac{35 \times 10^{-3}}{60} = 5.8333 \times 10^{-4} m^3/sec$

$P = 15 \text{ kwatts} = 15 \times 10^3$ watts

$\% = \frac{100 \times 10^5 \times 5.8333 \times 10^{-4} \times 100}{15 \times 10^3}$

$\% = 38.88\%$,

4.) i) Power

ii.) Pow

iii.)

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ENG 214 FLUID MECHANICS

1.) $Q = 10\,dm^3/min$

$\Delta P = 12bar$

Speed = 1500rpm

Normal Displacement = $10cm^3/rev$

Torque Input (T) = 12.5N-m

Q = Normal displacement x speed

$= 10\,cm^3/rev \times 1500rpm$

$= 15000\,cm^3/min = 15\,dm^3/min$

1.) Volumetric efficiency $= \frac{\text{Actual flow}}{\text{Ideal flow}} = \frac{10}{15} = 0.6667$

II.) $Q = \frac{10 \times 10^{-3}}{60}\,m^3/sec = 16.7 \times 10^{-5}\,m^3/sec$

$\Delta P = 12 \times 10^5\,N/m^2$

Fluid power $= \Delta P \times Q = 16.7 \times 10^{-5}\,m^3/sec \times 12 \times 10^5\,N/m^2$

$= 200$watts

III.) Shaft Power $= \frac{2\pi NT}{60} = \frac{2 \times \pi \times 1500 \times 12.6}{60}$

$= 1963.5$ watts

IV.) overall efficiency $= \frac{F.P}{S.P} = \frac{200}{1963.5}$

$= 0.1018$

$\simeq 0.102$

2.) $P = \frac{2\pi NT}{60}$ (Shaft)

Q_{actual} = Volume flow rate from the pump

$= 35\,dm^3/min$

$= \frac{35 \times 10^{-3}}{60}\,m^3/sec = 5.8333 \times 10^{-4}\,m^3/sec$