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18/ENG04/033
FLUID MECHANICS
ELECTRICAL/ELECTRONICS ENGINEERING

1. Ideal flow rate = Nominal Disp × speed
= 10 × 1500 = 15 dm³/min

i) Volumetric Efficiency = Actual flow / Ideal flow

= 10/15 = 67%

ii) Fluid power = ΔPQ
ΔP = 12×10³ = 1200000

Q = 10×10⁻³ / 60 = 1.67×10⁻⁴

ΔPQ = 200.4 watts

iii) Shaft Power = 2πnT / 60

= 2×π×1500×12.5
= 1964.3 Nm.

iv) Overall Efficiency = Fluid power / Shaft power

= 200.4 / 1964.3

= 0.102 = 10.2%

2. 87% = FP / S.P
Fluid power = ΔPQ
P = 100×10⁵ Nm⁻²
Q = 3.5×10⁻³ = 5.83×10⁻⁴
= 5833.3 watt

87% = 5883.3 / x

0.87 = 5833.3 / x

x = 5833.3 / 0.87 = 6705 Nm.

3) Ideal flow rate = Nominal disp × speed
= 500 × 850 = 425 dm³/min

Volumetric Efficiency = Actual flow / Ideal flow

= 35 / 42.5
= 82%

Fluid power = ΔPQ
ΔP = 100×10⁵
Q = 50×10⁻³ / 60
ΔPQ = 8300
= 8.3×10⁻⁴.

Shaft = 15 Kwatts = 15000

Overall Efficiency = Fluid Power / Shaft power

= 8300 / 15000

= 35.3%

6) $h = 20m$

$d = 10cm = 0.1m$

$A = \frac{\pi d^2}{4} = 0.785A$

$U_f = 0$

$W = ?$

$V_f^2 = V^2 - 2gh$

$V_f = \sqrt{V_f^2 + 2gh}$

$V_f = \sqrt{0^2 + 2(9.8)(20)} = 19.80m/s$

The flow rate is equal to the speed

$Q = VA = (19.80m/s)(7.884 \times 10^{-3}) = 0.155m^3/s$

$W = \rho g Q h$

$= (1000)(9.8)(0.155) \times (20)$

$= 30428 \, kgm^2/s^2$

$= 30 \times 10^3 W$

7 $P_1 g = 19.62 \, Nm^{-2}$

$Cd = 0.96$

$d_1 = 0.3m$

$d_2 = 0.2m$

$U_1 = Q_1 \, 0.0707 \quad U_2 = Q_2 \, 0.0314$

$P_1 + \rho g z_2 = P_2 + \rho g (z - P_4) + P_{2}gR_r$

$P_1 - P_2 = 19.62(22 - Z_1) + 587.423$

For the Venturimeter

$$\frac{P_1}{\rho g} + \frac{U_1^2}{2g} + Z_1 = \frac{P_2}{\rho g} + \frac{U_2^2}{2g} + Z_2$$

$1.805 U_2^2 = 387.428$

V_1 ideal $= 27.042m/s$

$Q_{ideal} = 27.047 \times \pi \left(\frac{0.2}{2}\right)^2$

$= 0.85m^3/s$

$Q = Cd Q_1$ Ideal $= 0.96 \times 0.85 = 0.816m^3$

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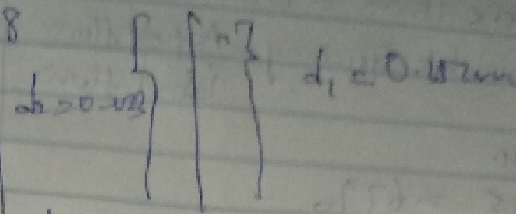

$d_1 = 0.152m$ $\quad A_1 = 0.0181m$

$d_2 = 0.076m$ $\quad A_2 = 0.00454m$

$\rho = 860kg/m^3$

$Cd = 0.99$

Apply Bernoulli Method

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

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

$Q = V_1 A_1 = V_2 A_2$

$V_2 = \frac{U_1 A_1}{A_2} = U_1 4$

$V_1 = \sqrt{\frac{0.914 \times 2 \times 9.81}{15}}$

$= 1.0934m/s$

$q = Cd \, A_1 V_1$

$Q = 0.96 \times 0.0181 \times 1.0934$

$= 0.019m^3/s$