D203 FLUID MECHANICS Q3 2003

PART A

MANOMETRIC HEAD Δh_m

This is the head that would result if all the energy given to the water is converted into pressure head. It is found by equating the diagram power and water power.

$$mu_2 v_{w2} = mg\Delta h_m$$

$$\Delta h_m = \frac{u_2 v_{w2}}{g} = \frac{u_2}{g}\left\{u_2 - \frac{Q}{A_2 \tan(a_2)}\right\}$$

MANOMETRIC EFFICIENCY η_m

$$h_m = \frac{\text{Water Power}}{\text{Diagram Power}} = \frac{mg\Delta h}{mu_2 v_{w2}} = \frac{mg\Delta h}{mg\Delta h_m} = \frac{\Delta h}{\Delta h_m}$$

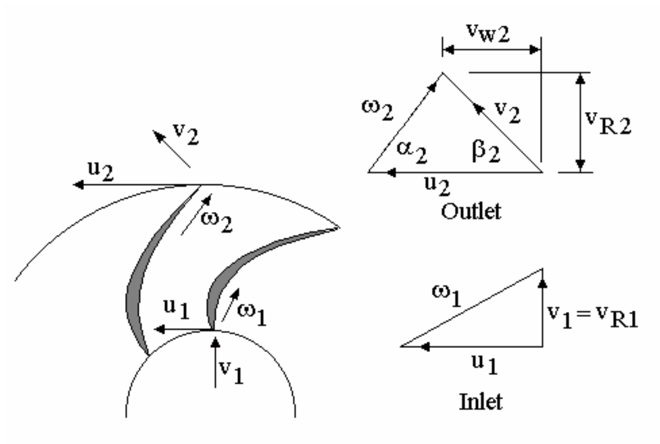
SHAFT POWER

S.P. = $2\pi NT$

OVERALL EFFICIENCY

$$h_{o/a} = \frac{\text{Water Power}}{\text{Shaft Power}}$$

PART B



D_2 = 0.2 m t_2 = 0.018 m   N = 1200/60 = 20 rev/s   Q = 0.02 m^3/s

Shaft Power = 2500 W   Outlet angle $\alpha_2 = 30^o$ recovered head = 45% of kinetic head

Tangential Velocity of blade $u_2 = \pi N D_2$ = 12.566 m/s

Radial velocity at outlet $v_{r2} = Q/(\pi D_2 t_2)$ = 1.768 m/s

Velocity of whirl at outlet $v_{w2} = u_2 - v_{r2} \cot \alpha_2$ = 9.503 m/s

Absolute outlet velocity $v_2 = \sqrt{[v_{w2}^2 + v_{r2}^2]}$ = 9.667 m/s

Manometric head $h_m = u_2 v_{w2}/g$ = 12.178 m

Kinetic Head = $v_2^2/2g$ = 4.764 m   Recovered head = 4.764 x 0.45 = 2.144 m

Manometric Efficiency $\eta_m = h_2/h_m$ = 0.176 or 17.6 %

Water Power = ρ Q g h_2 = 419.3 W

Overall Efficiency $\eta_{o/a}$ = WP/SP = 419.3/2500 = 0.168 or 16.8%