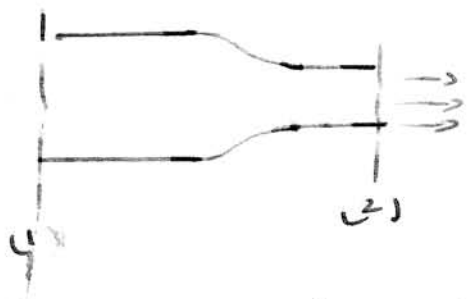
Q1 2001



$d_1 = 40\,mm$
$d_2 = 25\,mm$
$\rho = 997\,kg/m^3$

BERNOULLI $\quad p_1 + \frac{\rho u_1^2}{2} = p_2 + \frac{\rho u_2^2}{2}$

$p_2 = 0$ (change pressure)

$p_1 = \frac{\rho}{2}(u_2^2 - u_1^2)$

$u_1 A_1 = u_2 A_2 \qquad u_1 = u_2 A_2 / A_1 = u_2 / r$

$r = A_1/A_2 = 40^2/25^2 = 2.56 \qquad u_1 = u_2/r$

$p_1 = \frac{\rho}{2}\left\{u_2^2 - \frac{u_2^2}{r^2}\right\} = u_2^2\left\{1 - 1/r^2\right\}$

$u_2^2 = \frac{2p_1}{\rho(1-1/r^2)} = \frac{2 \times 50 \times 10^3}{997(1 - 1/2.56^2)}$

$u_2^2 = 118.36 \qquad u_2 = 10.88\ m/s$

$u_1 = 10.88/2.56 = 4.25\ m/s$

$\dot{m} = \rho A_2 u_2 = 997 \times \frac{\pi \times .025^2}{4} \times 10.88$

$\dot{m} = 5.284\ kg/s$

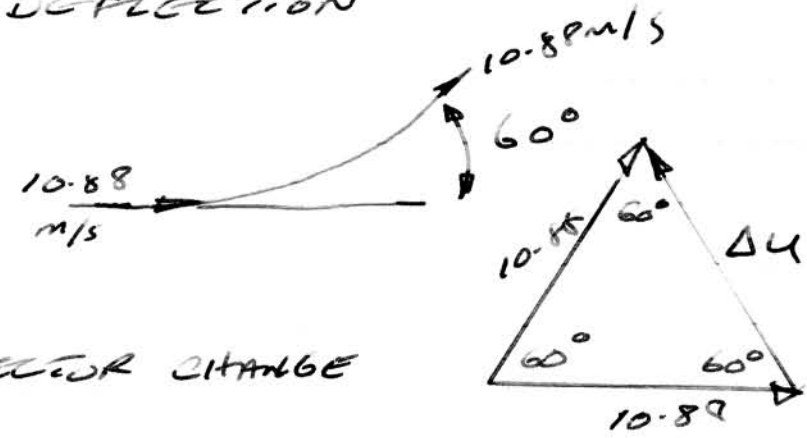
MOMENTUM FORCE $= \dot{m}\,\Delta u$
$= 5.284\,(u_2 - u_1)$
$= 5.284\,(10.88 - 4.249)$
$= 35\,N \leftarrow$

PRESSURE FORCE $= p_1 A_1 = 50 \times 10^3 \times \frac{\pi \times .04^2}{4}$

$= 62.83\,N \rightarrow$

NET FORCE $= 27.83\,N \rightarrow$

DEFLECTION



VECTOR CHANGE

BECAUSE THE TRIANGLE IS 60°

$\Delta u = u_2 = 10.88$

$F = \dot{m}\,\Delta u = 5.284 \times 10.88 = 57.5\ N$

$F = \dot{m}\,\Delta u = \dot{m}\,u_2 = \rho A_2 u_2 \times u_2$

$F = \rho A_2 u_2^2$

$= \rho A_2 \times \dfrac{2P_1}{\rho(1 - 1/r^2)} = 200\ N\ (MAX)$

$200 = 997 \times \dfrac{\pi \times .025^2}{4} \times \dfrac{2P_1}{997(1 - 1/2.56^2)}$

$\dfrac{200 \times 4 \times (1 - 1/2.56^2)}{\pi \times .025^2 \times 2} = P_1 \quad (MAX)$

$P_1 = 172.6\ kPa \quad (MAX)$