FM S1 2012

5) $\frac{e}{b} = \frac{1.2}{300}$

$= 0.004$

$f_F = 0.007$ for zone 4.

(a) $hsys = \frac{\Delta P}{\rho g} + \frac{1}{2g}\Delta V^2 + \Delta z + hf.$

$= \frac{10\times10^3}{10^3 \times 9.8} + 0 + 50 + \frac{2 \times 0.007 \times 450 \times \left(\frac{Q}{\frac{\pi \times 0.3^2}{4}}\right)^2}{0.3 \times 9.8} + \frac{1}{2\times9.8}(1.5)\left(\frac{Q}{\frac{\pi\times0.3^2}{4}}\right)^2$

$= 51 + 444.19Q^2$

(b) $hp = hsys$

$180 - 25Q^2 = 51 + 444.19Q^2$

$99 = 469.19Q^2$

$Q = \sqrt{\frac{99}{469.19}}$

$= 0.459\ m^3/s$

(c) $NPSH_A = \frac{P_1 - Pvap}{\rho g} + z_1 - hfs$

$V = \frac{0.459 m^3/s}{\frac{\pi \times 0.3^2}{4} m^2} = 6.5 m/s.$

$NPSHA = \frac{101000 - 2000}{1000 \times 9.8} + 10 - \frac{2\times0.007\times50}{0.3\times9.8} \times 6.5^2 + \frac{1}{2\times9.8} 0.5 \times 6.5^2$

$= 10.10 + 10 - 11.13$

$= 8.97\ m$

$NPSH_A > NPSH_R$ vv flowrate within permissible range

(d) $P_F = hp\,g\,\rho Q$

$= [180 - 25(0.459)^2] \times 9.8 \times 1000 \times 0.459$

$= 650360\ J/s$

$P_B = \frac{P_F}{\eta} = 1001\ kW$ //

FM S1 2012

6) (a) $\rho_A = \frac{P_A}{RT/M}$

$= \frac{400 \times 10^3}{8.314 \times \frac{303}{28 \times 10^{-3}}}$

$= 4.45 \text{ kg/m}^3$

$V_A = \frac{G}{\rho_A A}$

$= \frac{0.75 \text{ kg/s}}{4.45 \text{ kg/m}^3 \times \pi \times \frac{0.25^2}{4} \text{ m}^2}$

$= 3.44 \text{ m/s}$

(b) $\frac{(400 \times 10^3)^2 - P_J^2}{2 \times 8.314 \times \frac{303}{28 \times 10^{-3}}} + \frac{2 \times 0.005 \times 20 \times 10^3}{0.25} \left(\frac{0.75}{\pi \times 0.25^2/4} \right)^2 = 0$

$P_J = 440 \text{ kPa}$

(c) $\frac{(440 \times 10^3)^2 - (1000 \times 10^3)^2}{2 \times 8.314 \times \frac{303}{28 \times 10^{-3}}} + \left(\frac{G}{A}\right)^2 \left[\ln\left(\frac{1000}{440}\right) + \frac{2 \times 0.005 \times 80 \times 10^3}{0.25} \right] = 0.$

$\left(\frac{G}{A}\right)^2 = 1400$

$\frac{G}{A} = 37.42 \text{ kg/m}^2\text{s}$

$G = 37.42 \times \pi \times \frac{0.25^2}{4} \text{ kg/s}$

$= 1.837 \text{ kg/s}$

(d) mass balance around junction

$G_{in} = G_A + G_B.$

$G_B = 1.837 \text{ kg/s} - 0.75 \text{ kg/s}$

$= 1.087 \text{ kg/s}$ //