Florida International University Department of Civil and Environmental Engineering
CWR 3201 Fluid Mechanics,
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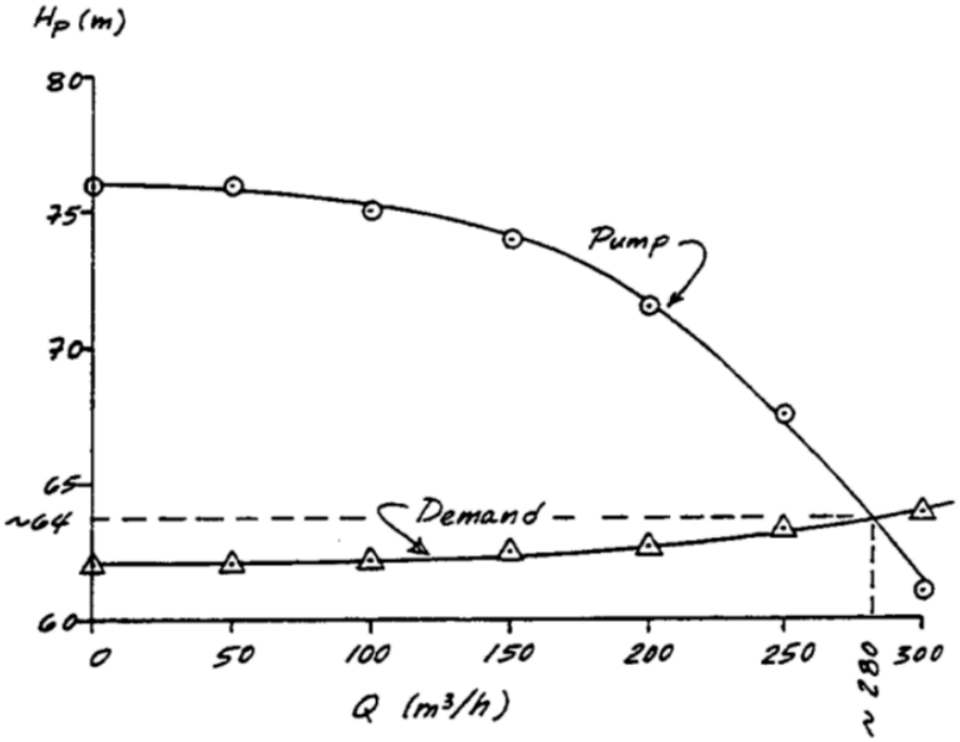
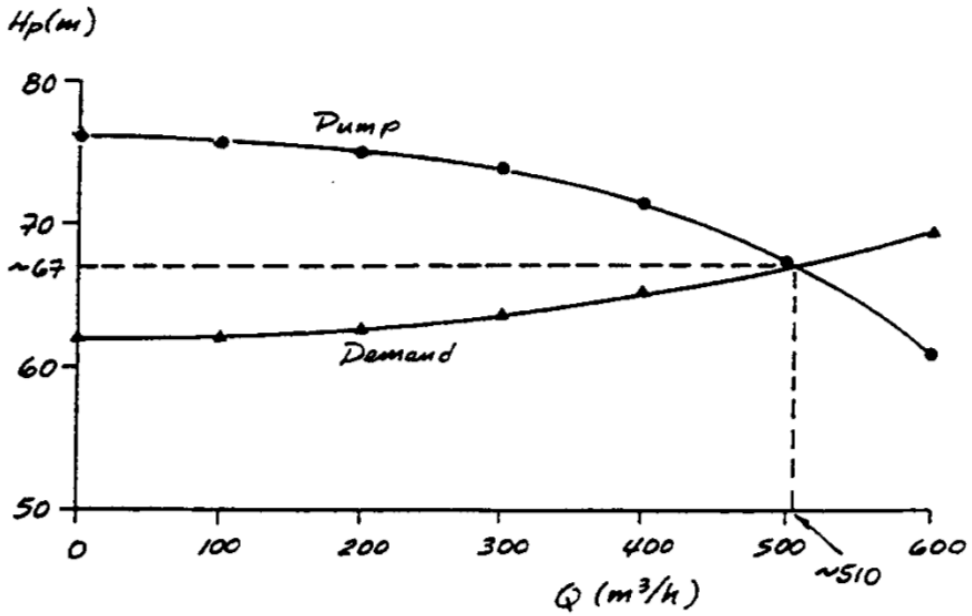
Homework Assignment 7 Solutions

Mechanics of Fluids (Fifth edition), by M.C. Potter, D.C. Wiggert and B.H. Ramadan.

1. 12.6
   Loss Factor: $\sum K = 2K_1 + K_2 = 2 * 0.19 + 0.8 = 1.18$
   Loss in suction pipe: $\left(f\frac{L}{D} + \sum K\right)\frac{Q^2}{2gA^2} = \left(0.015 * \frac{11}{0.1} + 1.18\right)\frac{0.05^2}{2*9.81*(\frac{\pi}{4}*0.1^2)^2} = 5.85\ m$
   Solve for: $\Delta z = \frac{p_{atm}-p_v}{\gamma} - h_L - NPSH = \frac{101000-2340}{9792} - 5.85 - 3 = 1.23m$
2. 12.28



a)
Intersection of pump curve with demand shows $H_p = 64\ m$ and $Q = 280\ m^3/h$
Using figure 12.6 from the textbook, $W_p = 64\ kW\ and\ NPSH = 8.3m$



b)

Intersection of pump curve with demand shows $H_p = 67\ m$ and $Q = 510\frac{m^3}{h}\ or\ 225\ for\ one\ pump$

Using figure 12.6 from the textbook, $W_p = 2 * 60\ kW = 120kW\ and\ NPSH = 7.6$

3. 12.30

Use energy eqn. to establish system demand:

$$f \cong 1.325\left[\ln 0.27\frac{e}{D}\right]^{-2} = 1.325\left[\ln 0.27 \times \frac{0.00085}{1.5}\right]^{-2} = 0.017,$$

$$H_P = \Delta z + f\frac{L}{D}\frac{Q^2}{2gA^2} = 640 + \frac{0.017 \times 3 \times 5280}{2 \times 32.2 \times (\pi/4)^2 \times 1.5^5}Q^2 = 640 + 0.893Q^2.$$

From Fig. 12.6, at best η_P, $Q \cong \frac{1100}{449} = \underline{2.45\ \text{ft}^3/\text{sec}}$, and $H_P \cong 215$ ft.

*Conversion factor

Assume three pumps in series, so that $H_P = 3 \times 215 = 645$ ft. Then the demand head is

$$H_P = 640 + 0.893 \times 2.45^2 = \underline{645\ \text{ft}}.$$

Hence <u>three pumps in</u> <u>series</u> are appropriate. The required power is

$$\dot{W}_P = \gamma Q H_P/\eta_P = 62.4 \times 0.86 \times 2.45 \times 645/0.75 = \underline{1.13 \times 10^5\ \frac{\text{ft - lb}}{\text{sec}}},$$

or $\dot{W}_P = 1.13 \times 10^5/550 = \underline{206\ \text{hp}}.$