CE 3305 Fluid Mechanics; Exercise Set 23 Name: SOLUTION

CE 3305 Engineering Fluid Mechanics
Exercise Set 23
Spring 2014

1. Problem 10.93, pg 404
2. Problem 14.35, pg 551

14.35

PUMP CURVE $h_p = 20\left[1 - \left(\frac{Q}{100}\right)^2\right]$

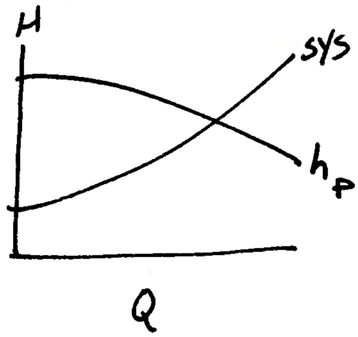
h_p IN FEET
Q IN GPM

$$h_{sys} = 5 + 0.002Q^2$$

h_{sys} IN FEET
Q IN GPM

FIND OP. POINT FOR a) ONE PUMP b) TWO PUMPS IN SERIES c) TWO PUMPS PARALLEL

a) ONE PUMP



SET $h_p = h_{sys}$; SOLVE FOR Q

$$20\left[1 - \left(\frac{Q}{100}\right)^2\right] = 5 + 0.002Q^2$$

$$20 - \frac{20}{10{,}000} Q^2 = 5 + 0.002 Q^2$$

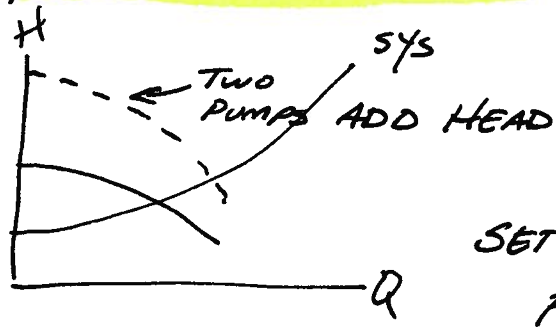
$$20 - 0.002 Q^2 = 5 + 0.002 Q^2$$

$$20 - 5 = 0.004 Q^2$$

$$\frac{20-5}{0.004} = Q^2 = 3750$$

$$Q = 61.2 \text{ gpm.}$$

b) TWO PUMPS SERIES



SET $2h_p = h_{sys}$, SOLVE FOR Q

$$40\left[1 - \left(\frac{Q}{100}\right)^2\right] = 5 + 0.002 Q^2$$

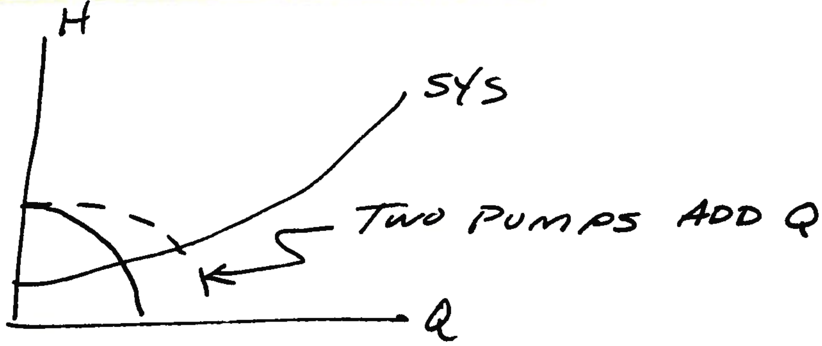
$$40 - 0.004 Q^2 = 5 + 0.002 Q^2$$

$$35 = 0.006 Q^2$$

$$\frac{35}{0.006} = Q^2 = 5833$$

$$Q = 76.37 \text{ gpm}$$

c) TWO PUMPS PARALLEL



SET $h_p\left(\frac{Q}{2}\right) = h_{sys}$; SOLVE FOR Q

$$20\left[1-\left(\frac{Q}{2\cdot 100}\right)^2\right] = 5 + 0.002Q^2$$

$$20 - 0.0005Q^2 = 5 + 0.002Q^2$$

$$15 = 0.0025Q^2$$

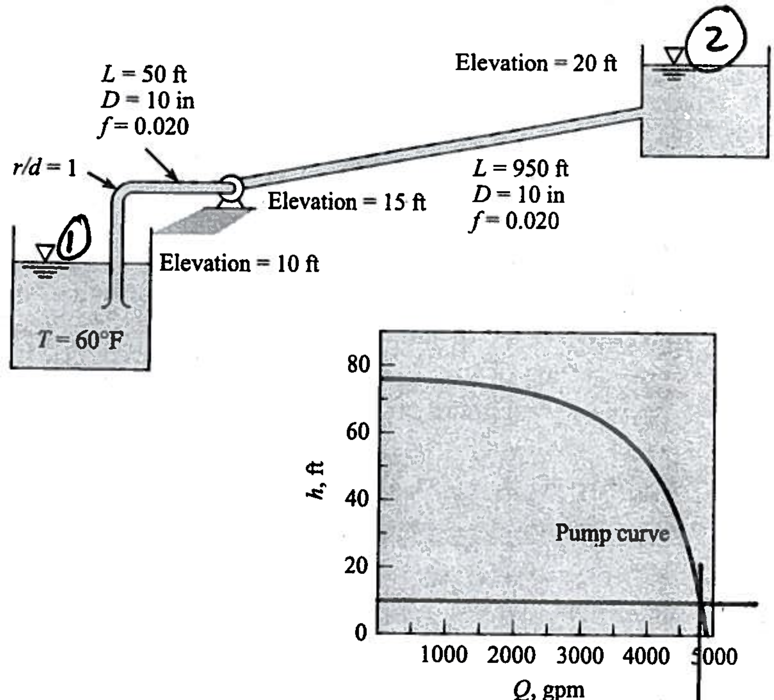
$$\frac{15}{0.0025} = Q^2 = 6000$$

$$Q = 77.4 \text{ gpm}$$

DISCUSSION

USED CONCEPTS PG 537–538, IN PARTICULAR FIG 14.18 TO GUIDE ALGEBRA.

10.93 If the liquid of Prob. 10.92 is a superliquid (zero head loss occurs with the flow of this liquid), then what will be the pumping rate, assuming that the pump curve is the same?



$Q = 4750$ gpm

PROBLEMS 10.92, 10.93

NOTE: SUPERCOOLED LIQUIDS HARD TO COME BY IN REAL WORLD — THEY EXIST, BUT MOSTLY IN LABS

SUPERCOOLED ⟹ NO FRICTIONAL LOSS

$$\cancelto{0\text{ gage}}{\frac{p_1}{\gamma}} + \cancelto{V_1=0}{\frac{V_1^2}{2g}} + z_1 + h_p = \cancelto{0\text{ gage}}{\frac{p_2}{\gamma}} + \cancelto{V_2=0}{\frac{V_2^2}{2g}} + z_2 + \cancelto{=0}{h_L}$$

$$h_p = z_2 - z_1 \qquad (\text{I.E. } h_p = \text{STATIC LIFT!})$$

$$h_p = 20 - 10 = 10\text{ ft}$$

$Q \approx 4750$ gpm according to supplied pump curve.