Hw 3.3

13.22) DESCRIBE EACH PART OF THE CENTRIFUGAL PUMP DESIGNATION: $1\frac{1}{2} \times 3 - 6$

FOR $1\frac{1}{2} \times 3 - 6$ CENTRIFUGAL PUMP, $1\frac{1}{2} \rightarrow$ NOMINAL SIZE OF DISCHARGE (INCHES)

$3 \rightarrow$ NOMINAL SIZE OF SUCTION (INCHES)

$6 \rightarrow$ NOMINAL SIZE OF IMPELLER (INCHES)

13.23) FOR THE LINE OF PUMPS SHOWN IN FIG. 13.22, SPECIFY A SUITABLE SIZE FOR DELIVERING 100 GAL/MIN OF WATER AT TOTAL HEAD OF 300 FT.

FOR 100 GPM, 300 FT HEAD $\rightarrow$ $1\frac{1}{2} \times 3 - 10$ CENTRIFUGAL PUMP

13.25) FOR $2 \times 3 - 10$ CENTRIFUGAL PUMP (FIG. 13.28), DESCRIBE PERFORMANCE FOR AN 8-INCH IMPELLER, 200 FT HEAD.

EXPECTED CAPACITY $\rightarrow$ $230 \text{ GPM} \cdot \frac{1 \frac{\text{FT}^3}{\text{s}}}{449 \text{ GPM}} = 0.51225 \frac{\text{FT}^3}{\text{s}}$

POWER REQUIRED $\rightarrow$ 22 HP

EFFICIENCY $\rightarrow$ $\eta = \frac{P_o}{P_I}$; $P_o = \gamma \cdot Q \cdot h \rightarrow (62.4 \frac{\text{lb}}{\text{FT}^3})(0.51225 \frac{\text{FT}^3}{\text{s}})(200 \text{ FT}) = 6392.88$

$P_o = 6392.88 \frac{\text{lb FT}}{\text{s}} \cdot \frac{1 \text{ HP}}{550 \frac{\text{lb FT}}{\text{s}}} = 11.6234 \text{ HP}$

$\eta = \frac{11.6234 \text{ HP}}{22 \text{ HP}} = 0.5283 (100) = 52.83\%$

NPSH $\rightarrow$ 10 FT

13.34) FOR 2 OF THE FOLLOWING SETS OF OPERATING CONDITIONS, LIST ONE APPROPRIATE PUMP.

a) 500 GPM, 80 FT HEAD $\rightarrow$ RECIPROCATING PUMP

b) 500 GPM, 800 FT HEAD $\rightarrow$ RECIPROCATING PUMP

13.17) FOR A GIVEN CENTRIFUGAL PUMP, IF THE SPEED OF ROTATION OF THE IMPELLER IS CUT IN HALF, HOW DOES THE TOTAL HEAD CAPABILITY CHANGE?

GIVEN $\frac{h_{a1}}{h_{a2}} = \left(\frac{N_1}{N_2}\right)^2$, THE TOTAL HEAD CAPABILITY WOULD BE A QUARTER OF THE ORIGINAL. PLUGGING IN NUMBERS FOR EXAMPLE,

ORIGINAL $\rightarrow \left(\frac{1}{2}\right)^2 = 0.25$

HALF SPEED $\rightarrow \left(\frac{1}{4}\right)^2 = 0.0625$

13.19) FOR A GIVEN SIZE OF CENTRIFUGAL PUMP, IF THE ~~SPEED OF ROTATION~~ DIAMETER OF THE IMPELLER IS REDUCED BY 25%, HOW MUCH DOES THE CAPACITY CHANGE?

GIVEN $\frac{P_1}{P_2} = \left(\frac{D_1}{D_2}\right)^3$, IF THE DIAMETER OF THE IMPELLER IS 25% SMALLER, $D_2 = D_1(0.75)$. SO,

$$\frac{P_2}{P_1} = \left(0.75\frac{\cancel{D_1}}{\cancel{D_1}}\right)^3 \rightarrow \frac{P_2}{P_1} = 0.421875$$

$$P_2 = 0.421875 P_1$$

CALCULATING % DIFF.,

$$\left(\frac{P_1 - P_2}{P_1}\right)\cdot 100 \rightarrow \left(\frac{P_1 - 0.421875P_1}{P_1}\right)\cdot 100$$

LETS SAY POWER IS 20 HP,

$$\left(\frac{20\text{ HP} - 0.421875(20\text{ HP})}{20\text{ HP}}\right)\cdot 100 = 57.8125\%$$

THE CAPACITY CHANGES BY 57.8125%.

13.55)

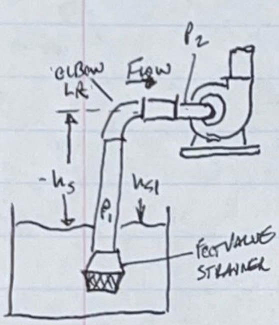
$$NPSH = h_{sp} - h_s - h_f - h_{vp}$$

$\rightarrow h_{sp} = \frac{P}{\gamma} \rightarrow \frac{101.8\ kPa}{9.53\ \frac{kN}{m^3}} = 10.68\ m$

$\rightarrow h_s = 2\ m$

$\rightarrow h_{vp} = 4.967\ m$ (TABLE 13.2)

$\rightarrow h_f = h_{Lp_1} + h_{Lv} + h_{Le} + h_{Lp_2}$



$$= f_1 \frac{L}{D}\frac{V_1^2}{2g} + K_1 \frac{V_1^2}{2g} + f_T(K_e)\frac{V_1^2}{2g} + f_2 \frac{L}{D}\frac{V_2^2}{2g}$$

$$= (0.0195)\left(\frac{2m}{0.0779m}\right)(0.0562m) + (75(0.0195)(0.0562m))$$
$$+ (0.018(26)(0.0562m) + (0.0201\left(\frac{1.5m}{0.0525m}\right)(0.271m)$$

$= 0.2862\ m$

$NPSH = 10.68m - 2m - 0.2862m - 4.967m$
$= 3.4268\ m$

$\underline{NPSH = 3.43\ m}$

$\gamma @ 80°C = 9.53 \frac{kN}{m^3}$

$h_{vp} = 4.967\ m$

DN80 SCH.40

$D = 0.0779\ m$
$A = 4.768 \times 10^{-3}\ m^2$

DN50 SCH40

$D = 0.0525\ m$
$A = 2.168 \times 10^{-3}\ m^2$

$f_T = 0.018$

$K_1 = 75 f_1$

$K_e = 20 f_1$

$Q = 300 \frac{L}{min} \cdot \frac{1 \frac{m^3}{s}}{60000} = 0.005 \frac{m^3}{s}$

$V_1 = \frac{Q}{A} = \frac{0.005}{.004768} = 1.05 \frac{m}{s}$

$\frac{V_1^2}{2g} = \frac{1.05^2}{2(9.81)} = \cancel{0.0535}$ $0.0562\ m$

$Re_1 = \frac{V_1 D_1}{\nu} = \frac{(1.05)(0.0779)}{3.6 \times 10^{-7}}$
$= 2.3 \times 10^5$

$\frac{D}{\varepsilon_1} = \frac{0.0779}{4.6 \times 10^{-5}} = 1694$

$f_1 = 0.0195$

$V_2 = \frac{Q}{A_2} = \frac{0.005}{0.002168} = 2.306 \frac{m}{s}$

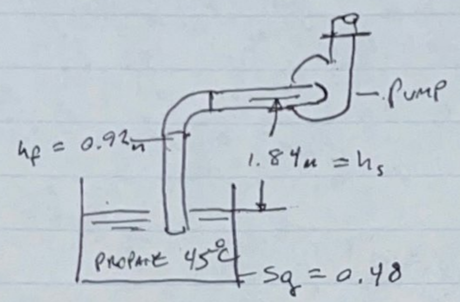
$\frac{V_2^2}{2g} = \frac{2.306^2}{2(9.81)} = 0.271\ m$

$Re_2 = \frac{(2.306)(0.0525)}{3.6 \times 10^{-7}}$
$= 336292$

$\frac{D}{\varepsilon_2} = \frac{0.0525}{4.6 \times 10^{-5}} = 1141$

$f_2 = 0.0201$

13.65)



$sg = 0.48$

$\gamma_p = (0.48)(9.71 \frac{kN}{m^3})$

$= 4.661 \frac{kN}{m^3}$

$NPSH_A = 1.5m = h_{sp} + h_s - h_f - h_{vp}$

$\rightarrow h_{sp} = \frac{P}{\gamma_p} = \frac{P}{4.661 \frac{kN}{m^3}}$

$\rightarrow h_s = 1.84m$

$\rightarrow h_f = 0.92$

$\rightarrow h_{vp} = 350m$ (45C from CHART)

$\frac{P}{4.661} = NPSH_A - h_s + h_f + h_{vp}$

$\rightarrow P = (1.5m - 1.84m + 0.92m + 350m)(4.661 \frac{kN}{m^3})$

$P = 1634.05$ kPa