13.23

- 100 gal/min
- total head = 300 ft

Selected pump = 1 ½ × 3 − 10

13.25

For 2×3 −10, describe the performance that can be expected from a pump w/an 8 in impeller operating against a system head of 200 ft. Expected Capacity? → ~225 gal/min

Efficiency? 54%

$$P = \frac{\gamma Q h_A}{\eta}$$

$$= \frac{\left(62.4 \frac{\#}{ft^{3}}\right)\left(225 \frac{\cancel{gal}}{\cancel{min}}\right)\left(200\, \cancel{ft}\right)}{0.54}\left(\frac{231\, \cancel{in^3}}{1\, \cancel{gal}}\right)\left(\frac{1\, ft}{12\, \cancel{in}}\right)^3\left(\frac{1\, \cancel{min}}{60\, s}\right)$$

$$= \frac{6256.25 \frac{\# \cdot ft}{s}}{0.54}$$

$$= 11{,}585.65 \frac{\cancel{\# \cdot ft}}{\cancel{s}} \cdot \frac{1\, kW}{737.56 \frac{\cancel{\# \cdot ft}}{\cancel{s}}}$$

Power before mechanical losses

$= (15.71\ kW)(1.15)$

$= (18.064\ kW)$ ← Power given to E.E

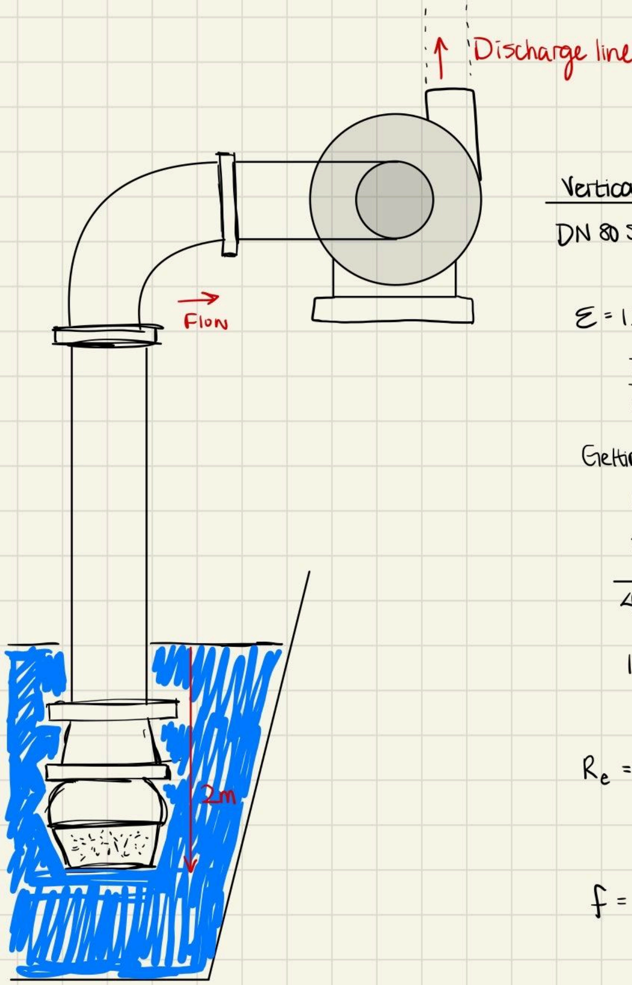
Power required?

Required NPSH?
10 ft

13.55

Determine NPSH for the system.

- Fluid is water @ 80°C
- P_{atm} = 101.8 kPa
- Water level in tank = 2m below pump inlet
- Foot valve and strainer = hinged-disk type
- Q = 300 Liter/min
- Vertical Section = DN 80 sch. 40 steel pipe
- Horizontal Section = DN 50 sch. 40, 1.5 m long
- Long radius elbows
- Neglect loss in reducer



$\gamma = 9.53 \frac{kN}{m^3}$ $\rho = 971 \frac{kg}{m^3}$

$\nu = 3.60 \times 10^{-7} \frac{m^2}{s}$

Vertical Section Losses:

DN 80 Sch 40 , 77.9 mm = Diameter

$4.768 \times 10^{-3}\ m^2$ = Flow Area

$\varepsilon = 1.5 \times 10^{-6}\ m$

$$\frac{D}{\varepsilon} = \frac{0.0779\ m}{1.5 \times 10^{-6}\ m} = 51{,}993.3$$

Getting Velocity:

$Q = VA$

$$\frac{300 \frac{\text{Liters}}{\cancel{\text{min}}} \cdot \frac{1\ m^3}{1000\ \cancel{L}} \cdot \frac{1\ \cancel{\text{min}}}{60\ s}}{4.768 \times 10^{-3}\ m^2}$$

$1.049 \frac{m}{s}$

$$R_e = \frac{VD}{\nu} = \frac{(1.049 \frac{\cancel{m}}{s})(0.0779\ \cancel{m})}{3.60 \times 10^{-7} \frac{\cancel{m^2}}{\cancel{s}}} = 226{,}991.94$$

$$f = \frac{0.25}{\left[\log\left(\frac{1}{3.7(51{,}993.3)} + \frac{5.74}{226{,}991.94^{0.9}}\right)\right]^2}$$

$f = 0.0145$

$$h_L = \left(f \frac{L}{D}\right)\left(\frac{V^2}{2g}\right)$$

$$= \left(0.0145 \cdot \frac{2m}{0.0779m}\right)\left(\frac{(1.049\ m/s)^2}{2 \times 9.81\ m/s^2}\right)$$

$= 0.0209\ m$

Losses through elbow

$$h_L = (20 \cdot 0.0145)\left(\frac{(1.049\ m/s)^2}{2 \cdot 9.81 \frac{m}{s^2}}\right)$$

$= 0.016\ m$

Horizontal Section: $0.0525\,m$ = Diameter

DN50, Sch. 40 $1.5\,m$ $2.168\times10^{-3}\,m^2$ = Flow Area

$\varepsilon = 1.5\times10^{-6}\,m$

$$\frac{D}{\varepsilon} = \frac{0.0525\,m}{1.5\times10^{-6}\,m} = 35{,}000$$

Getting Velocity:

$Q = VA$

$$\frac{300\,\frac{\cancel{Liters}}{\cancel{min}}\cdot\frac{1\,m^3}{1000\,\cancel{L}}\cdot\frac{1\,\cancel{min}}{60\,s}}{2.168\times10^{-3}\,m^2}$$

$2.306\,\frac{m}{s}$

$$Re = \frac{VD}{\nu} = \frac{(2.306\,\frac{\cancel{m}}{s})(0.0525\,\cancel{m})}{3.60\times10^{-7}\,\frac{m^2}{s}} = 336{,}291.67$$

$$f = \frac{0.25}{\left[\log\left(\frac{1}{3.7(35{,}000)}+\frac{5.74}{336{,}291.67^{0.9}}\right)\right]^2}$$

$f = 0.0158$

$$h_L = \left(f\,\frac{L}{D}\right)\left(\frac{v^2}{2g}\right)$$

$$= \left(0.0158\,\frac{1.5\,m}{0.0525\,m}\right)\left(\frac{[2.306\,m/s]^2}{2\cdot9.81\,m/s^2}\right)$$

$h_L = 0.122\,m$

$Q = 0.005\,\frac{m^3}{s}$

$P_{sp}/\gamma = 10.682\,m$

$(0.016 + 0.0209 + .122)\,m$
$= 0.1589$

$$NPSH_A = h_{sp} \pm h_s - h_f - h_{vp}$$

$-2\,m$ $\quad$ $6.775\,m$

$= 10.682 - 2 - .1589 - 6.775\,m$

$NPSH_A = 1.7481\,m$

13-65

$T = 45°C$

$SG = .48$

$P_{atm} = 98.4$ kpa

$h_s = 1.84$ m

$h_f = .92$ m

$NPSH_A = 1.5$m

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

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

$= 1.5m + 1.84m + .92m + 340m$

$= 344.26$ m

$h_{sp} = \frac{P_{sp}}{\gamma}$

$P_{sp} = h_{sp}\gamma$

$\gamma = SG \cdot \gamma_w$

$= .48 \cdot 9.81$

$= 4.7088$ kN/m3

$P_{sp} = h_{sp}\gamma$

$= 344.26 \cdot 4.7088$

$= 1621.05$ kpa

$P_{sp} = P_{atm} + P_g$

$P_{sp} = P_{atm} + P_g$

$P_g = P_{sp} - P_{atm}$

$= 1621.05 \text{ kpa} - 98.4 \text{ kpa}$

$\boxed{= 1522.65 \text{ kpa}}$