How To Size A Pump

1) Remember Bernoulli's Equation!

2) Losses are proportional to $\frac{1}{2}\rho U^2$

OK, If we know the flow rate and the pipe diameter, it's easy!

1) $$U = \frac{Q}{A} = \frac{Q}{\frac{\pi D^2}{4}}$$

2) $$Re = \frac{UD}{\nu}$$

3) we need the total head required of the pump:

$$P_T = \rho g \Delta h + \frac{1}{2}\rho U^2\left[1 + 4f_f\frac{L}{D} + \sum K\right]$$

- $\rho g \Delta h$: change in elevation
- 1: acceleration of fluid
- $4f_f\frac{L}{D}$: pipe losses
- $\sum K$: fitting losses

4) To get pipe losses:

a) Determine L/D

b) Get f_f.

If $Re < 10^5$ we have:

$$f_f \approx \frac{0.0791}{Re^{1/4}}$$

If $Re > 10^5$:

$$f_f \approx \left(4.0 \log_{10}\{Re\sqrt{f_f}\} - 0.40\right)^{-2}$$

usually one iteration is good enough!

If the pipe is <u>rough</u> use:

$$f_f \approx \left(4.0 \log_{10}\left(\frac{D}{e}\right) + 2.28\right)^{-2} \; ; \frac{e}{D} > \frac{10}{Re\sqrt{f_f}}$$

5) Count up all the fitting K values

⇒ If you have a final "expansion", that's just the "1" for fluid acceleration, so don't double count it

6) The head is just $h_T = \frac{P_T}{SG}$ → so find the Q, h_T operating point on the pump curve!

7) Determine NPSHR. For a given Q, read NPSHR off the pump curve.

To avoid cavitation:

$$P_{atm} - P_{vap} - \rho g h - \frac{1}{2}\rho U^2\left[1 + 4f_f\frac{L}{D} + \Sigma K\right]$$

- P_{atm}: atmosph. pressure
- P_{vap}: vapor pressure
- h: height pump is above source
- U: acc. of fluid
- L: leading to pump
- K: values to pump

This must be greater than NPSHR

(divide by ρg to get it in terms of height!)

8) Efficiency is just $\frac{Q \cdot P_T}{\text{Power In}}$

↳ from pump curve