Make-up lecture, 11/30/00
Thanks to Logan for taking the notes.

We wrote down momentum balance

\[ \frac{\partial}{\partial t} \int \rho \vec{u} \cdot d\vec{v} = \rho \left( \int \vec{u}_1 \cdot \Delta \vec{A}_1 - \rho \left( \int \vec{u}_2 \cdot \Delta \vec{A}_2 \right) - \int \vec{F} + \int \vec{m} \right) \]

Pressure terms act on fluid areas in specific directions.

"F" is force on fluid by a solid surface in specified direction.
Body force is total force on the fluid in CV by body forces

"F" is shear, non-specified normal force (both)
- possibly from solid surfaces

Apply first to the simplest problem to see what the equation will tell us. We are not asking a specific question.

\[ \frac{P_1 - P_2}{L} = \frac{F}{L} \]

Find walls shear stress
We can always get the pressure drop for a pipe flow from f-Re plot

\[ f = \frac{\Delta P}{L} R / \rho u^2 \]

Substitute for \( \Delta P \) in terms of the friction factor

\[ \Delta P = \frac{F}{L} = \frac{\rho u^2 f \pi R^4}{R} = \rho u^2 f \pi R^4 \]

\[ F = \frac{\Delta P A}{L} = \frac{\rho u^2 f \pi R^4 A}{L} \]

Area of pipe inside

Use momentum balance to get forces on things

Ultimately - \( \Delta P A = C_{wall} A_{\text{section}} \)

We can tell how much tangential force it will take to keep the straight pipe in

"F" are forces on the fluid caused by the solid surfaces.

Force on a pipe bend - how much force to keep it in place?

\[ F_x = \rho u_1^2 A_1 + \rho A_1 \]

\[ F_y = -\rho u_2^2 A_2 - P_2 A_2 + F_y \]

We can solve for both directions
Summary of lecture:

Make sure that you know what the terms mean. You will get a better understanding by using the equation in problems.

If the question asks for the force on something, you need the momentum equation.

Remember that momentum is a vector quantity. Thus we need to be careful about direction and we will use the balance 1 direction at a time.

Questions about "pumping power" or pressure drop in complex pipe networks are not easily answered by the momentum balance. You will use the Bernoulli equation.