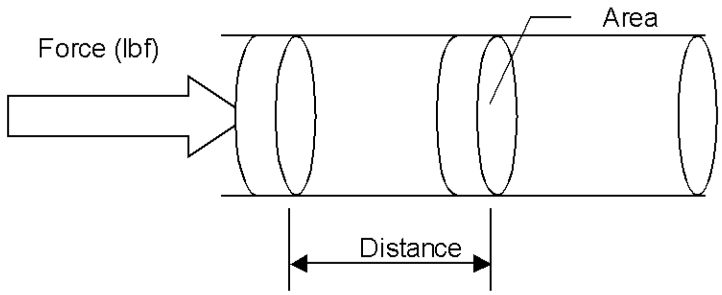
Derivation of Bernoulli's Equation:

Flow Energy can be defined as **Force** moving liquid a certain **Distance** in a pipe.



Since **Pressure = Force/Area**, you can rearrange it so that **Force = Pressure x Area**

Flow Energy = Force x Distance = **(Pressure x Area) x Distance**

However, Area x Distance = Volume, therefore

Flow Energy = Pressure x Volume.

However, Weight = Volume x Specific Weight, or **Volume = Weight/(Sp. Wt.)**

Flow Energy = (Pressure x Weight)/(Sp. Wt.) Which is shown as: $\frac{pW}{\gamma}$

$$Therefore: Flow\ Energy = \frac{pW}{\gamma}$$

Potential Energy can be defined as weight x height (or elevation).

PE = W x z

This is the same work as calculating the amount of energy gained by carrying a bucket of water up a hill. The energy is in lbs-ft, just like the units of Flow Energy.

Kinetic Energy can be defined as the energy due to motion of the mass of fluid.

KE = ½ mv², but we know **mass = W/g.** Therefore **KE = Wv²/2g.**

$$KE = \frac{Wv^2}{2g}$$

$$Total\,Energy = Flow\,Energy + Potential\,Energy + Kinetic\,Energy$$

$$or$$

$$E = \frac{pW}{\gamma} + W \cdot z + \frac{Wv^2}{2g}$$

For simplification, we can look at the **Energy per Pound of Fluid (W)** at any point in the system. We do this by dividing the equation by W.

$$\frac{E}{W} = \frac{p}{\gamma} + z + \frac{v^2}{2g}$$

We know energy must be constant, so we can look at the energy at two places in a system and set them equal to each other. Assuming no friction, we have Bernoulli's Equation:

$$\frac{p_1}{\gamma} + z_1 + \frac{v_1^2}{2g} = \frac{p_2}{\gamma} + z_2 + \frac{v_2^2}{2g}$$