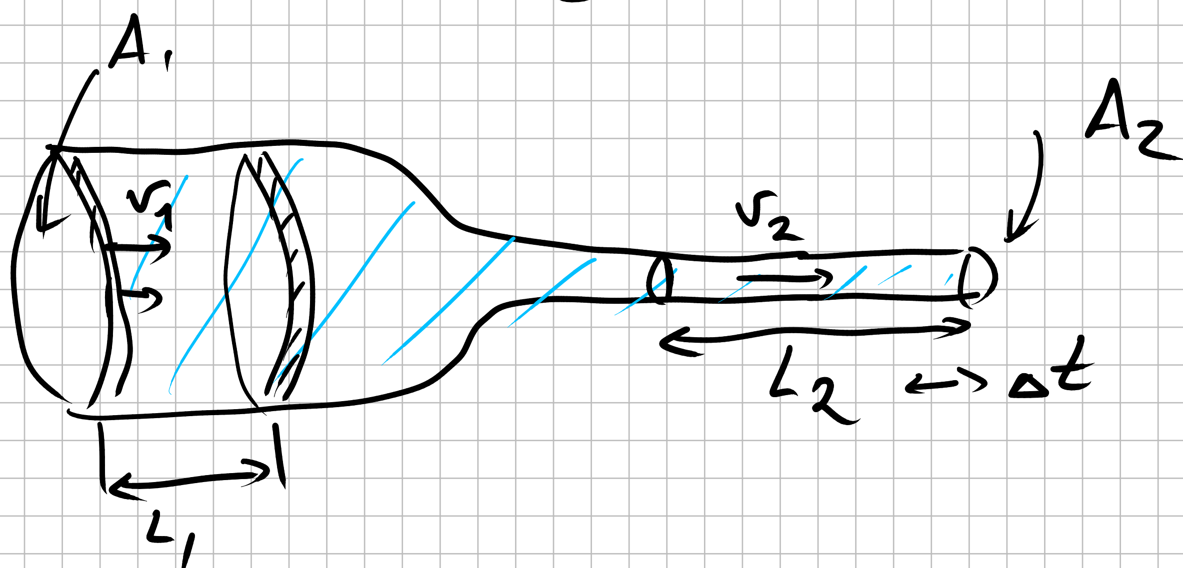
Flow of uncompressible fluids

$\rho = \text{constant}$



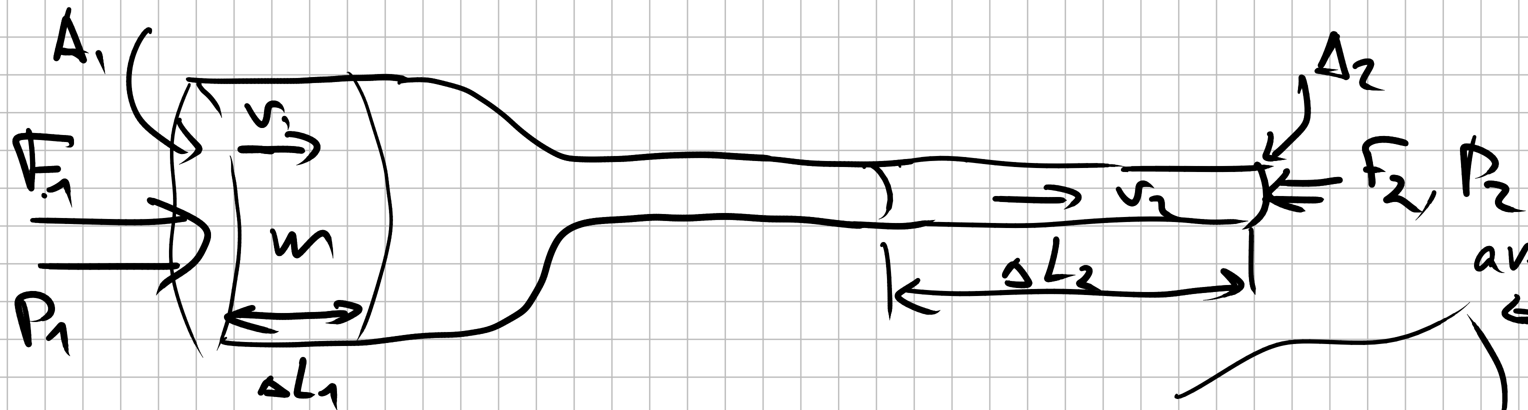
$$L_1 \cdot A_1 = V_1 = V_2 = L_2 \cdot A_2$$

$$Q = \frac{L_1 A_1}{\Delta t} = \frac{v_1 \cdot \Delta t \cdot A_1}{\Delta t} = \frac{V_1}{\Delta t} = \frac{V_2}{\Delta t} = \frac{v_2 \Delta t \cdot A_2}{\Delta t}$$

↑ flow

$$\boxed{v_1 \cdot A_1 = v_2 A_2}$$ flow conservation

Bernoulli equation



are the same
$\Leftrightarrow$ flow conserv

$$W_{ext} = \Delta K = \frac{m v_2^2}{2} - \frac{m v_1^2}{2}$$

$$F_1 \cdot \Delta L_1 - F_2 \Delta L_2 = m\frac{v_2^2}{2} - m\frac{v_1^2}{2}$$

$$\frac{1}{V}\left(P_1 \cdot \underbrace{A_1 \cdot \Delta L_1}_{V_1} - P_2 \underbrace{A_2 \Delta L_2}_{V_2} = \frac{m}{2} v_2^2 - \frac{m v_1^2}{2} \right)$$

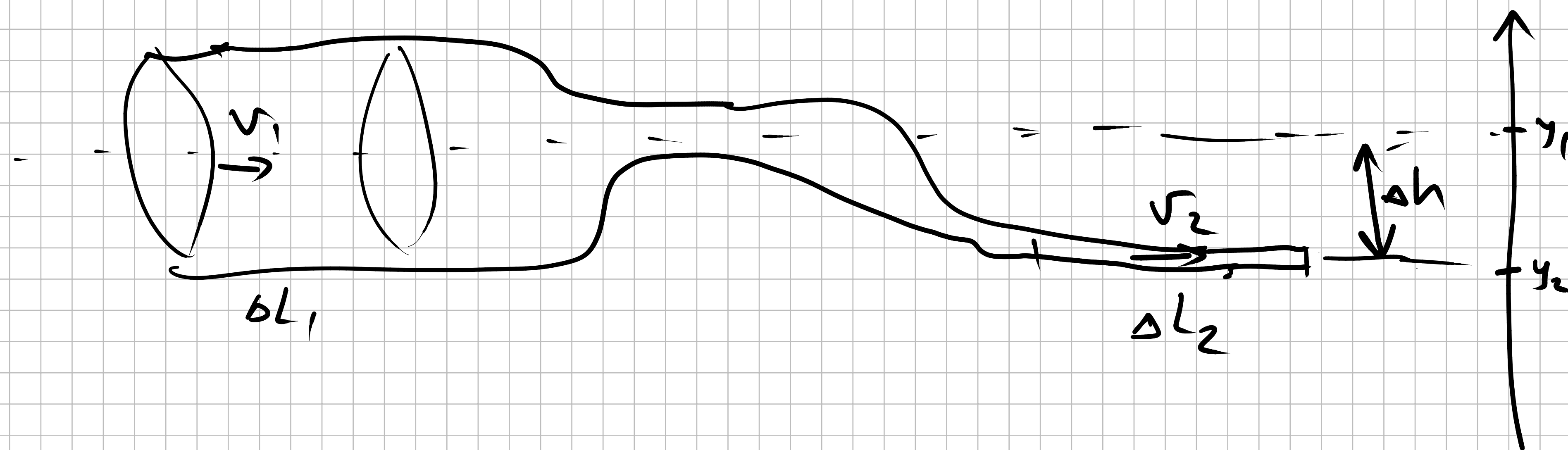
$$V_1 \Leftrightarrow V_2$$

$$P_1 - P_2 = \frac{m}{V} v_2^2 - \frac{m}{V} v_1^2$$

$$\frac{m}{V} = \rho$$

$$P_1 - P_2 = \rho \frac{v_2^2}{2} - \frac{\rho}{2} v_1^2$$

Improvement on



$$W_{ext} = \Delta K + \Delta U$$

$$\frac{1}{V}\left(F_1 \cdot L_1 - F_2 \cdot L_2 = \frac{m v_2^2}{2} - \frac{m v_1^2}{2} + m g y_2 - m g y_1\right)$$

$$P_1 \cdot \underbrace{A_1 L_1}_{V} \qquad P_2 \underbrace{A_2 L_2}_{V}$$

$$P_1 - P_2 = \rho \frac{v_2^2}{2} - \rho \frac{v_1^2}{2} + \rho g y_2 - \rho g y_1$$

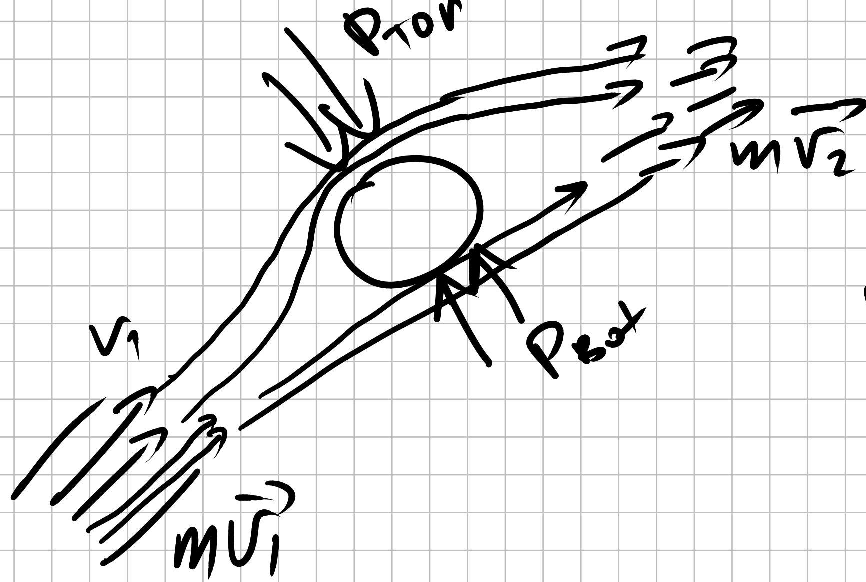
$$\boxed{P_1 + \rho \frac{v_1^2}{2} + \rho g y_1 = P_2 + \rho \frac{v_2^2}{2} + \rho g y_2 = \text{const}}$$

Bernoulli equation

$\Longleftrightarrow$ Energy conservation

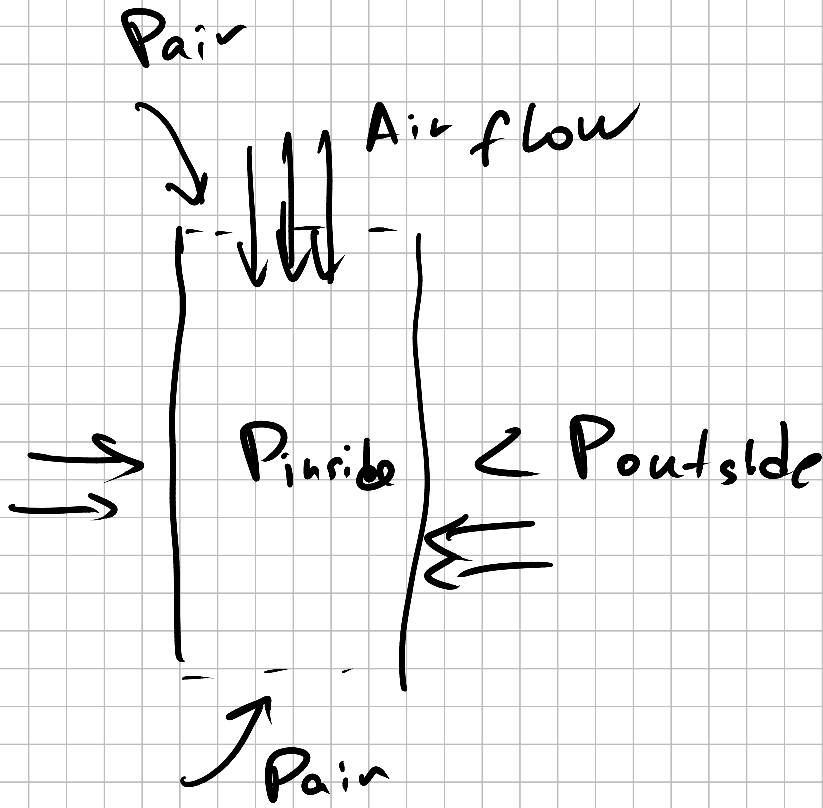
True for laminar flow

$\Longleftrightarrow$ no turbulence



$$P_{TOP} < P_{Bot}$$

$$F \sim \frac{\Delta P}{\Delta t} = \frac{m\vec{v}_2 - m\vec{v}_1}{\Delta t}$$



$$P_{in} + \rho \frac{v_{in}^2}{2} = P_{out}$$

$\downarrow v = 0$

Bernoulli lifter