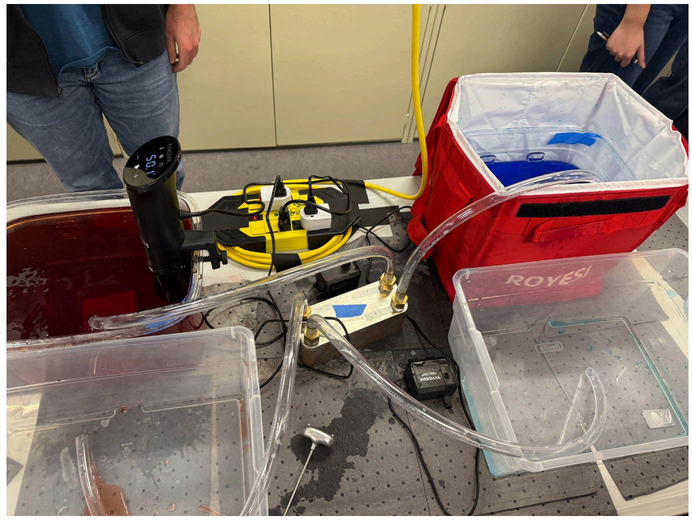
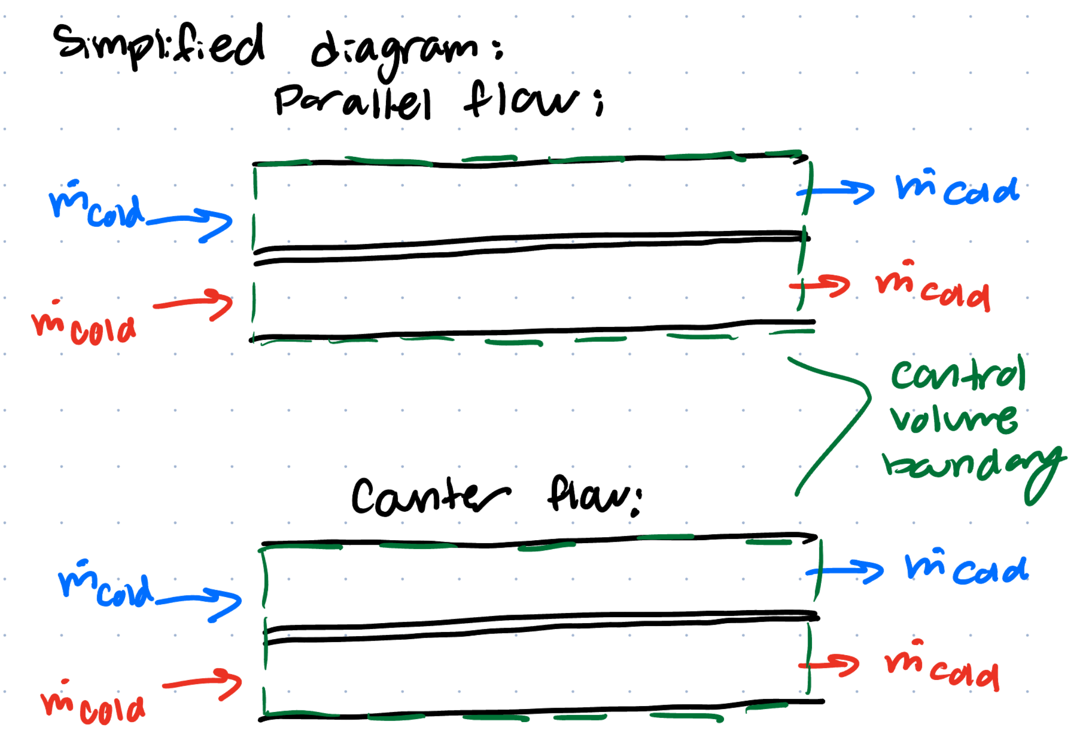
Heat Exchanger



The heat exchanger allows two liquids to flow past each other many times in either parallel or counterflow. We had two liquid reservoirs, a hot one (red) and cold one (blue) that we pumped into the heat exchanger and out to two separate containers. We ran this in both parallel and counterflow at slow and fast speeds to measure the change in temperature of both liquids.

The heat exchanger itself was a control volume system.



assume: steady state, $\Delta KE \approx 0$ & $\Delta PE \approx 0$, adiabatic, no work done

mass balance:

$$\Sigma \dot{m} = 0 = \dot{m}_{in} - \dot{m}_{out} \rightarrow \underline{\dot{m}_{in} = \dot{m}_{out}}$$, true for both hot & cold

energy balance:

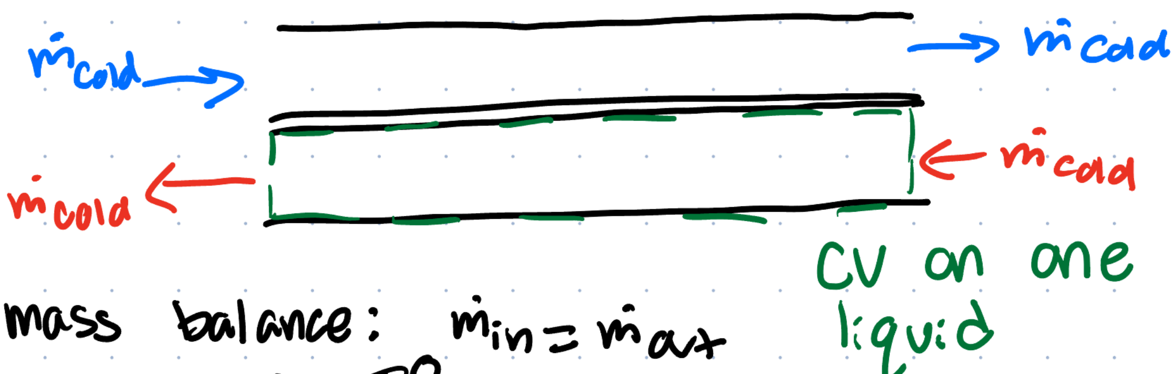
$$\Sigma E = 0 = \cancel{\dot{Q}}^{0} - \cancel{\dot{W}}^{0} + \dot{m}\left(h_i - h_e + \cancel{\frac{v_i^2}{2} - \frac{v_e^2}{2}}^{0} + \cancel{z_i g - z_e g}^{0}\right)$$

$$0 = \dot{m}(h_i - h_e)$$

$h_i = h_e$ for whole system

It can also be looked at as a control volume around one of the liquids:

Counter flow:



mass balance: $\dot{m}_{in} = \dot{m}_{out}$

$$\Sigma E = 0 = \dot{Q} - \cancel{\dot{W}}^{0} + \dot{m}(h_i - h_e)$$

$$\frac{\dot{Q}}{\dot{m}} = h_e - h_i$$

A few changes that we made were switching from parallel flow to counter flow and from a fast to slow flow rate. In parallel flow, the red liquid stayed hotter than the cold liquid at the end whereas the opposite was true with counter flow. This is due to the fact that counter flow has a more efficient heat transfer as it has a greater temperature distance across all the coils of the tubes. With the flow rate, we found that flowing faster allowed the two liquids to end up at a closer temperature to each other.