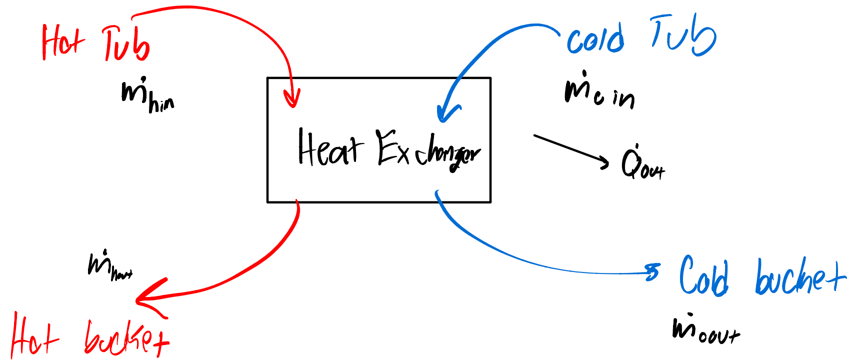
This is a liquid to liquid heat exchanger system. It consists of two seperate loops, one hot and another cold, circulating through a compact metal heat exchanger. The purpose of this is to transfer thermal energy from the hot fluid to the cold fluid without the two fluids ever mixing.

- Red → hot water
- Blue → Cold water
- As the two pumps run, the hot liquid gives heat through the exchanger and return cooler while the cold liquid absorbs heat and returns hotter

System Diagram: CV



Initial Set Up:

- Counter Flow: $T_{ci} = 6.7°C$, $T_{Hi} = 42.5°C$, $T_{co} = 14.1°C$, $T_{HO} = 24.4°C$

Change to Devic:

- Parallel Flow: $T_{ci} = 6.5°C$, $T_{Hi} = 42.5°C$, $T_{co} = 21.5°C$, $T_{Ho} = 25.1°C$

Assumption:

- Steady state → The total liquid (mass) in ≈ Total liquid (mass) out
- $\Delta PE = 0$ → negligeable
- $\Delta KE = 0$ → negligeable

Mass Balance:

- $\dot{m}_h = \dot{m}_{hi} = \dot{m}_{ho}$
- $\dot{m}_c = \dot{m}_{ci} = \dot{m}_{cin}$

Energy Balance (Combined CV):

- $\dot{E}_{cv} = \Sigma \dot{Q} - \Sigma \dot{W} + \dot{m}_h (h_{ho} - h_{hi}) + \dot{m}_c (h_{co} - h_{ci})$

$$\Downarrow$$

$$\dot{Q} = \dot{Q}_h - \dot{Q}_c$$

- $\dot{Q}_h = \dot{m}_h (h_{hi} - h_{ho})$
- $\dot{Q}_c = \dot{m}_c (h_{ci} - h_{co})$

Entropy Balance:

- $\dot{S} = \Sigma \frac{\dot{Q}}{T_b} + \dot{m}_h (s_{hi} - s_{ho}) + \dot{m}_c (s_{ci} - s_{co}) + \dot{\sigma}$ ↗ $\dot{S}_{gen}$

$$\frac{\dot{Q}_{loss}}{T_{amb}} + \dot{m}_h (s_{hi} - s_{ho}) + \dot{m}_c (s_{ci} - s_{co}) + \dot{\sigma} = 0$$

Analysis:

- Counter Flow:
  - Hot: inlet → $T_{hi} = 42.5°C$ → outlet → $T_{ho} = 29.4°C$
    $\Delta T_h = -18.1°C$
  - Cold: inlet → $T_{ci} = 6.7°C$ → outlet → $T_{co} = 19.1°C$
    $\Delta T_c = 12.4°C$
- Parallel Flow:
  - Hot: inlet → $T_{hi} = 42.5°C$ → outlet → $T_{ho} = 25.1°C$
    $\Delta T_h = -18.1°C$
  - Cold: inlet → $T_{ci} = 6.5°C$ → outlet → $T_{co} = 21.5°C$
    $\Delta T_c = 15°C$
- Key observations:
  - Hot side temperature drops slightly larger in counterflow. This indicates counterflow removes more energy from hot stream under these conditions.
  - Cold side temperature seems to be larger in parallel flow. This demonstrates how parallel flow is better at heating the cold side which is counterintuitive. This indicates there are other variables at play that need to be adjusted.