Experiment 8
Plate heat exchanger

OBJECTIVE :

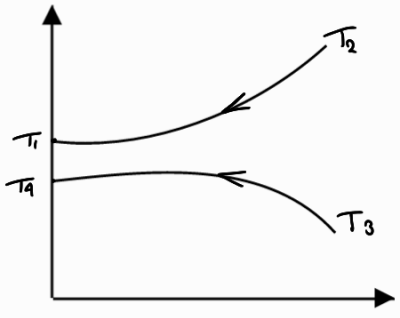
- Distinguish types of heat exchangers
- Apply basic heat exchanger theory
- Investigate flow arrangement (co and counter flows)
- Measuring log-mean- temperature difference
- Measuring the overall heat transfer coefficient U -value
- Effect of flow rate on the U-value
- Investigating heat exchanger efficiency.

Apparatus

Components are:

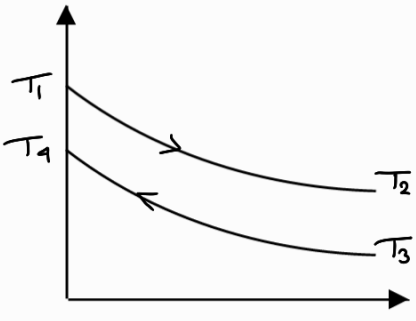
1. plate heat exchanger
2. heating reservoir
3. Thermostat to control the hot water temperature
4. Thermocouple to measure temp of flowing fluid
5. flow meter sensor

Co-current heat exchanger



- The hot and cold fluid streams flow in opposite direction

Counter-current heat exchanger



- The hot and cold fluid streams flow in opposite direction
- Better efficiency

why?

1. The difference between temp of both cold and hot fluid ↓ Since they enter from the same direction → Q ↓
2. Outlet temp of cold fluid should not exceed outlet temp of hot fluid in co-current (limited heating)

Calculations

Log mean temperature difference

Hot fluid inlet → T_1; hot fluid outlet → T_2; cold fluid outlet → T_4; cold fluid inlet → T_3

$$\Delta t_{lm} = \frac{(T_1 - T_4) - (T_2 - T_3)}{\ln\left[(T_1 - T_4) - (T_2 - T_3)\right]}$$

$$U = \frac{Q}{A F \Delta t_{lm}}$$

A → heat exchanging area

U → overall heat transfer coefficient

$$Q = \dot{m} C (T_{out} - T_{in})$$

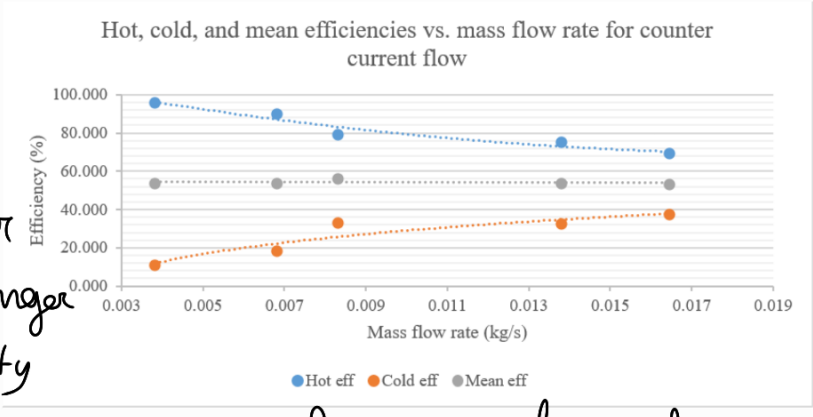
Hot water mass flow rate = $\dot{V}$ (measured) $\times 997$

$$\eta_{hot} = \frac{T_1 - T_2}{T_1 - T_3} \times 100\%$$

$$\eta_{cold} = \frac{T_4 - T_3}{T_1 - T_3} \times 100\%$$

$$\eta_m = \frac{\eta_h + \eta_c}{2}$$

Discussion of Results



* Same for co and counter current

η_h ↓ as hot flow rate increases

→ Quantity of hot water entering the heat-exchanger is increasing while Quantity of cold water is constant

So T_2 will increase since the ability to cool the hot fluid decrease

$\eta_h > \eta_c$

Since hot water flow rate is way lower than the cold flow rate and so temp of hot water decreases more than cold water temp increases

η_c ↑ as hot flow rate increases

→ Quantity of hot water entering the heat-exchanger is increasing while Quantity of cold water is constant

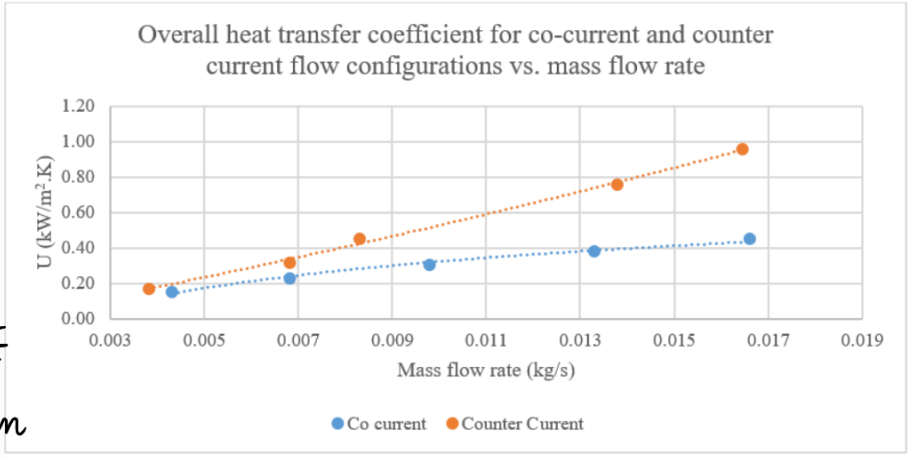
So T_1 will increase since the ability to heat the cold fluid decrease

η_{avg} ≈ constant

→ increment in temperature difference of cold fluid is almost equal to the decrement in temperature difference of hot fluid

U for counter current is higher

→ U is a measure of how good the transfer of heat is occuring in the HE (Back to Gradual contact in co current)



U is ↑ since hot flow rate is increasing which increases heat transfer