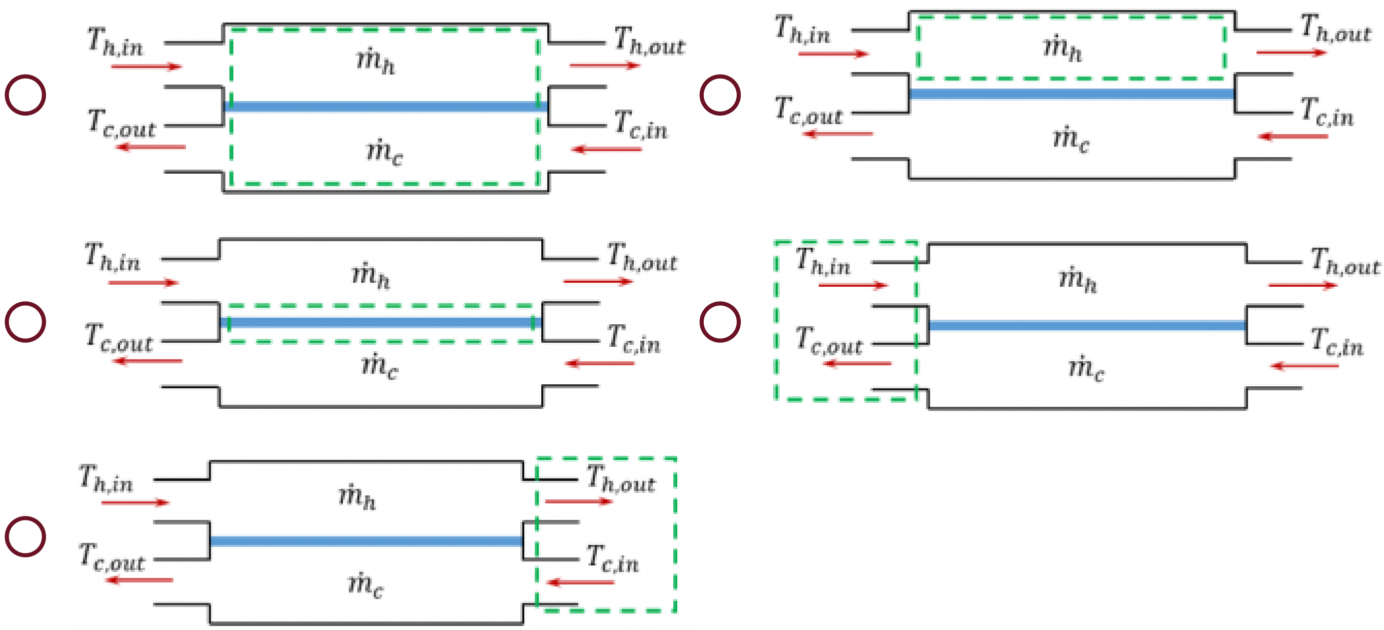
WASHINGTON STATE UNIVERSITY

## Heat Transfer questions (double pipe and shell and tube)

---

Below is the schematic of a simple heat exchanger with different system boundaries (green dashed box). If you want to determine the rate of heat transfer, Q, from the hot fluid to the cold fluid, which would you pick as the system to analyze?

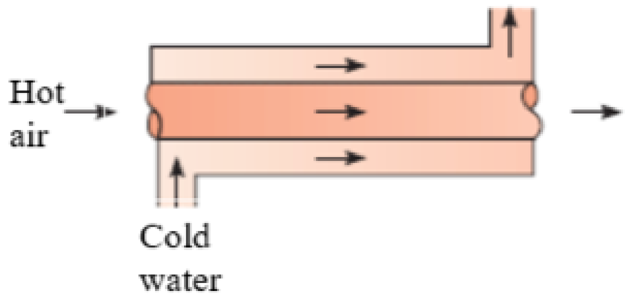



---

What area would you use for Ai in $\dot{Q} = U_i A_i \Delta T_{LM}$ in a shell and tube heat exchanger?
(Di = inner tube diameter; L = tube length; Deq = equivalent diameter; Nt = total number of tubes)

- $\pi \frac{D_i^2}{4}$
- $\pi \frac{D_{eq}^2}{4}$
- $\pi D_i L N_t$
- $\pi N_t \frac{D_i^2}{4}$
- $\pi N_t \frac{D_{eq}^2}{4}$

In a parallel-flow heat exchanger, hot air flows through the inner tubes and cold water flows through the annular side as shown below. If the mass flow rates of the hot air and the cold water are the same, which fluid will experience the largest temperature change?




- Hot air
- Cold water
- Both experience the same temperature change

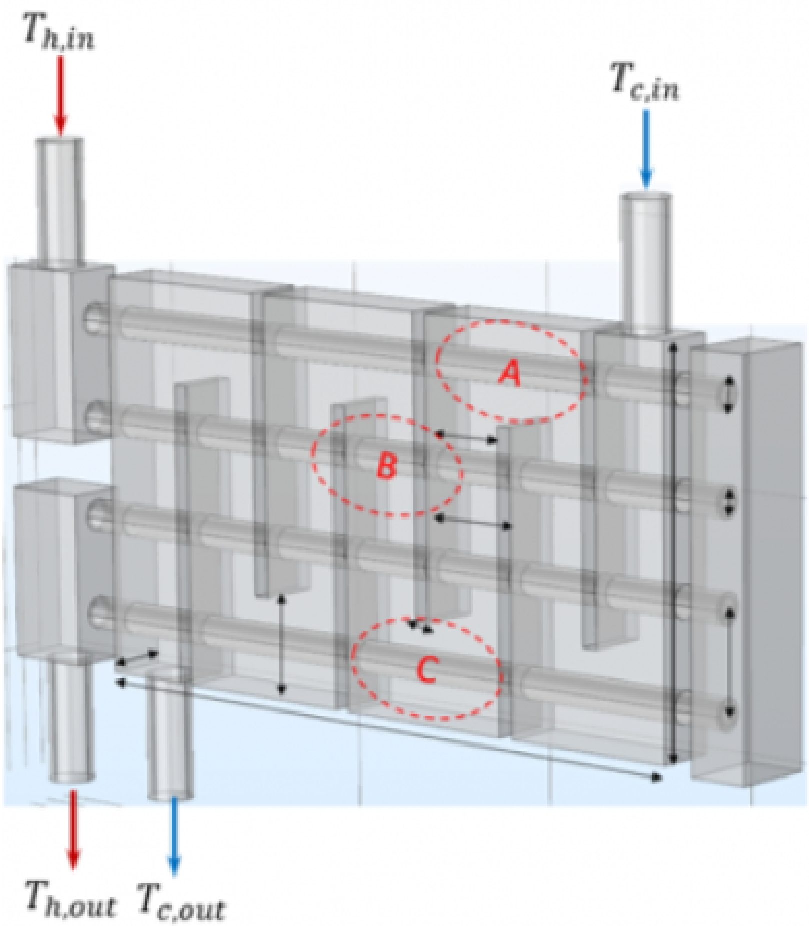
---

Because...

- Of flow arrangement
- Both fluids have the same mass flow rate, but Cp_air < Cp_water
- Both fluids have the same mass flow rate, but Cp_air > Cp_water
- Both fluids have the same mass flow rate and the same heat capacity
- Air will lose heat at a faster rate than the water will gain heat
- Water will gain heat at a faster rate than the air will lose heat

---

For the following arrangement of a shell & tube heat exchanger what types of flows are occurring in regions A, B, and C (identified by red circles)?




| | Counter Flow | Cross Flow | Parallel Flow |
|---|---|---|---|
| A | ○ | ○ | ○ |
| B | ○ | ○ | ○ |
| C | ○ | ○ | ○ |

Consider two double-pipe, parallel-flow heat exchangers that are identical except that one is two times longer than the other one. If flow rates and inlet conditions are same, which of the exchangers is more likely to have a higher heat transfer rate?

- ○ Longer one
- ○ Shorter one
- ○ Same in both heat exchangers

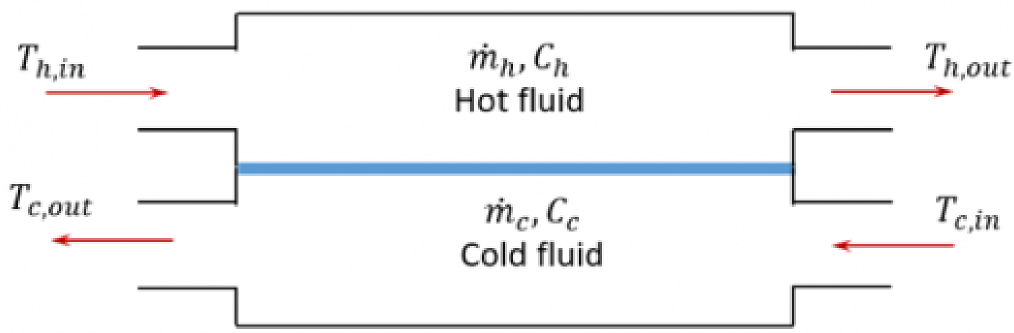
Because...

- ○ Heat transfer does not depend on the length of the heat exchangers

- ○ Having a constant mass flow rate and heat capacity should yield the same heat transfer rate
- ○ The longer tube length offers a higher surface area for heat transfer
- ○ The longer tube length provides a larger residence time
- ○ Shorter tube length offers higher velocity through the tube which offers higher heat transfer rates

---

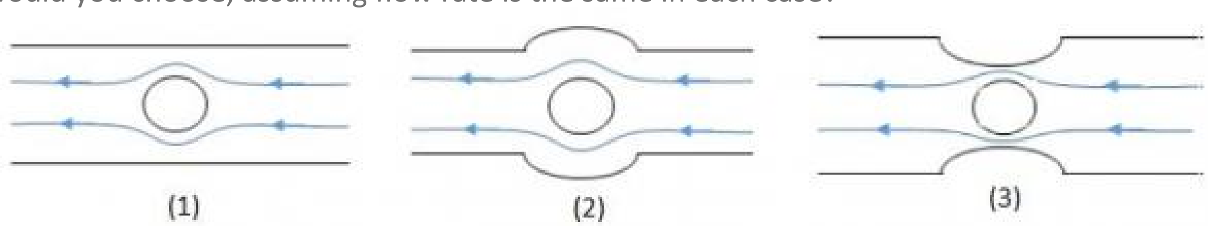
The following figure represents a block diagram of a heat exchanger. Which of the following statements are correct?




- ○ The cold fluid picks up heat; $\dot{m}_c C_c (T_{h,in} - T_{c,in})$
- ○ The hot fluid gives up heat; $\dot{m}_h C_h (T_{h,in} - T_{c,in})$
- ○ The cold fluid picks up heat; $\dot{m}_c C_h (T_{c,out} - T_{h,out})$
- ○ The hot fluid gives up heat; $\dot{m}_h C_h (T_{h,in} - T_{h,out})$

---

To remove heat at the highest possible rate from a hot tube placed in a duct with cold flow which setup would you choose, assuming flow rate is the same in each case?




- ○ Setup (2) because it will provide the lowest fluid velocity passing over the duct

- Setup (1) because it offers a balance between velocity and pressure drop passing over the duct
- Setup (3) because it will offer the highest possible fluid velocity passing over the duct
- All setups will give the same rate of heat transfer because flow rate is the same in each case

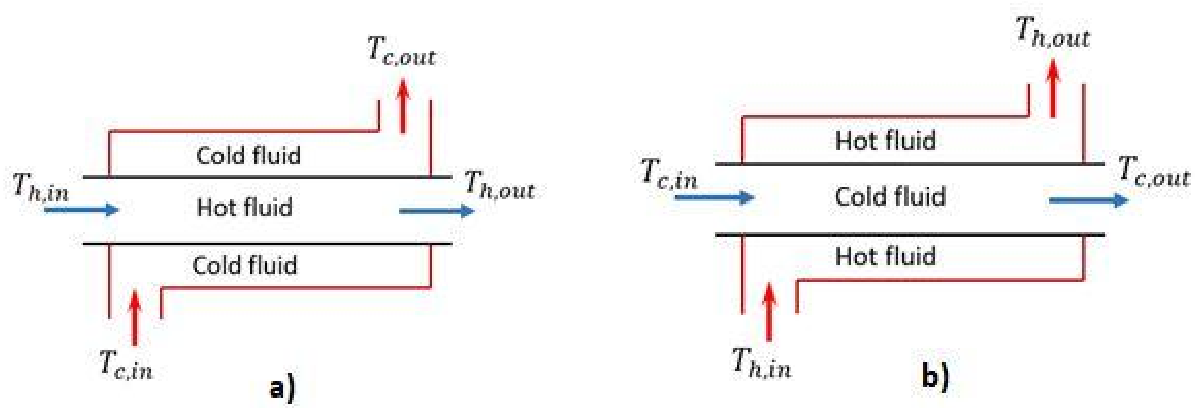
---

Consider two systems filled with air: system A at a uniform temperature $T_A$ and system B at another uniform temperature $T_B$ where $T_A > T_B$ . Both systems have the same volume and pressure. Let the two systems be brought into contact by a heat conductive surface and be thermally insulated from their surroundings. Energy will flow from:

- System A to system B by energy difference
- System B to system A by energy difference
- System A to system B by temperature difference
- System B to system A by temperature difference

---

If there is no insulation between the outer pipe and the surroundings (surrounding temperature is $T_s$ and $T_s < T_{c,in}$ ) which arrangement below will provide the highest heat transfer rate from the hot to the cold fluid?




- Arrangement a) because arrangement b) will lose more heat than arrangement a) to the surroundings

- ○ Arrangement b) because arrangement a) will lose more heat than arrangement b) to the surroundings
- ○ Either arrangement will provide the same heat transfer because surrounding temperature is fixed