ESO201A

Lecture#23

(Class Lecture)

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By

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Heat Exchangers

Heat exchangers are devices where two moving fluids exchange heat through a separating wall (Fig.1). A schematic diagram is shown in Fig.2.

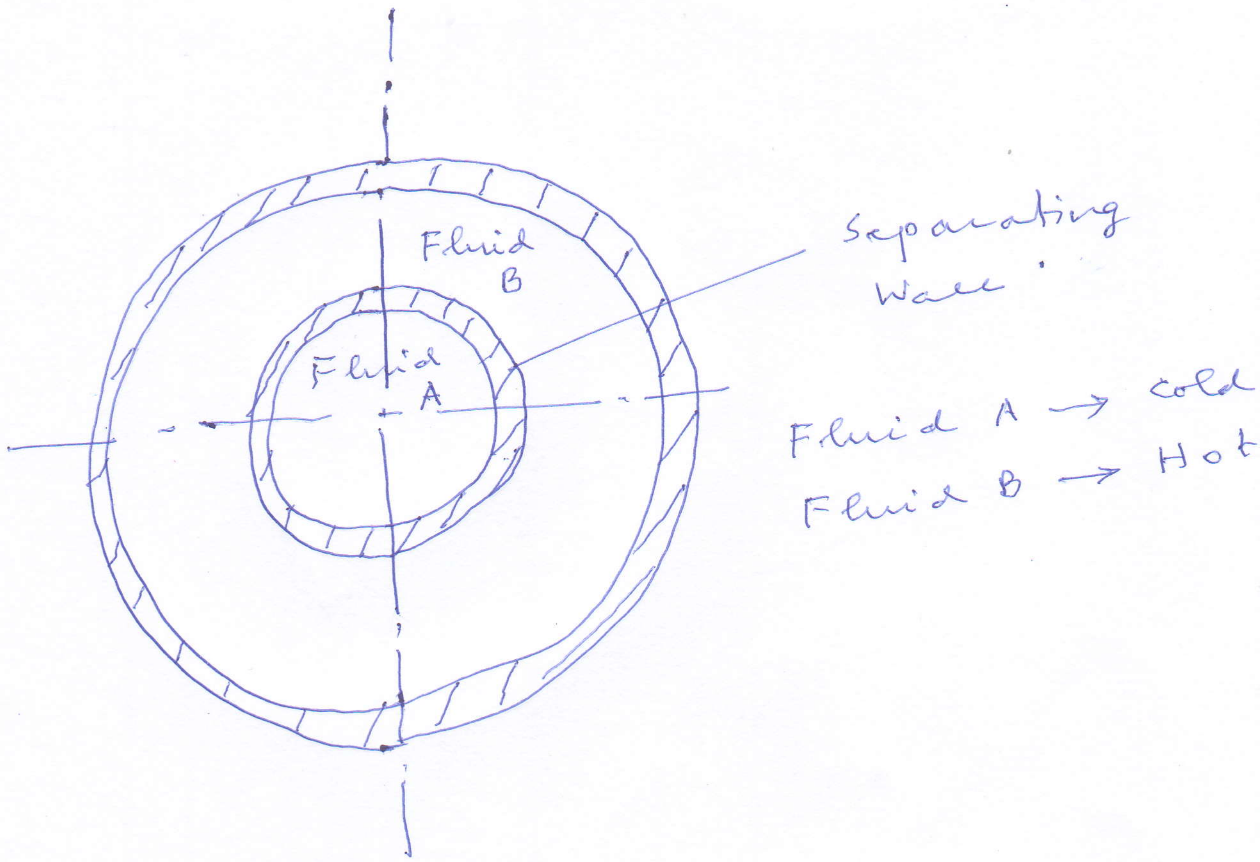
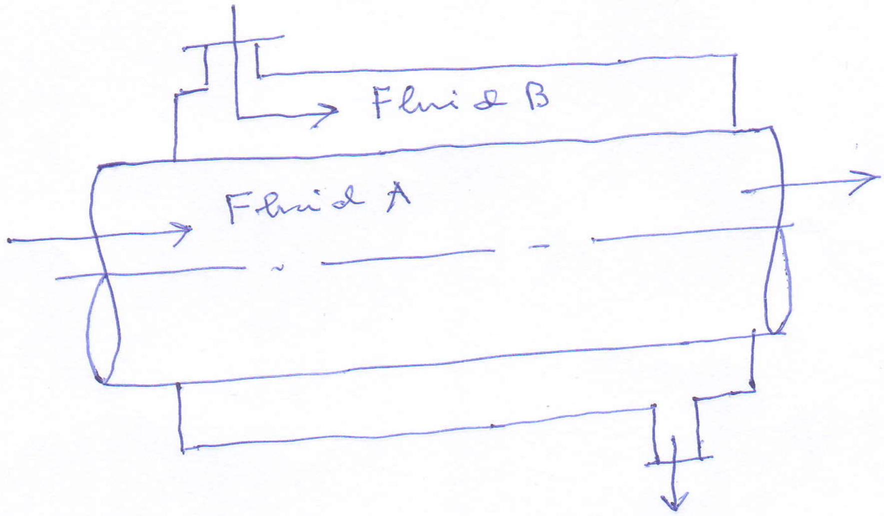


Fig. 1 Cross-section of a double-pipe heat exchanger



Fluid A → cold
Fluid B → Hot

Fig. 2 Schematic diagram of a double-pipe heat exchanger

- The conservation of mass principle for a heat exchanger in steady operation requires that the sum of the inbound mass flow rates equals the sum of the outbound mass flow rates.

- Heat exchangers typically involve no work interactions ($\dot{W} = 0$) and negligible kinetic and potential energy changes for each fluid stream ($\Delta ke = 0$, $\Delta pe = 0$).

- The heat transfer rates associated with heat exchangers depends on how control volume is selected.

- Heat exchangers are intended for heat transfer between two fluids within the device, and the outer shell is usually well insulated to prevent any heat loss to the surrounding medium.

See Fig. 3(a) and Fig. 3(b).

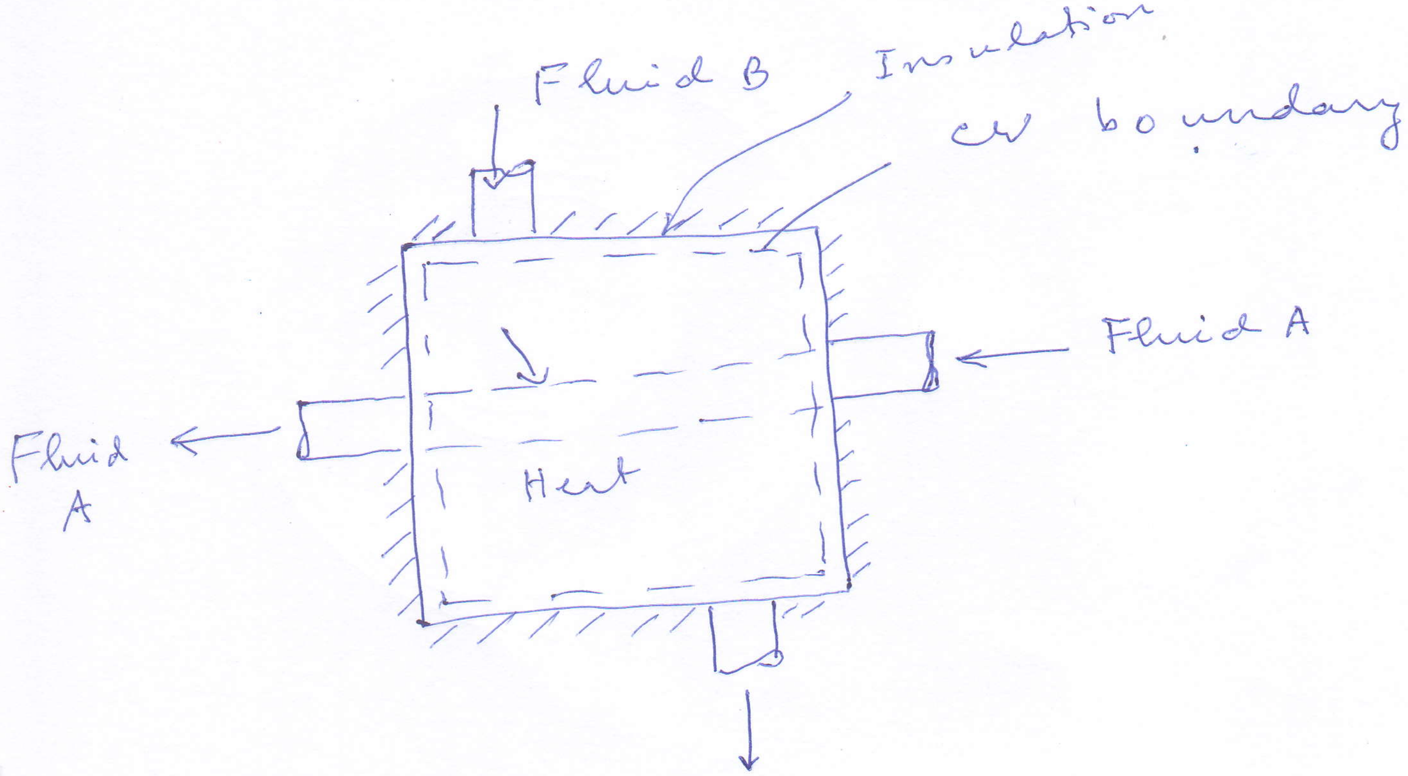


Fig. 3 (a) System: Entire heat exchanger ($\dot{Q}_{cv} = 0$)

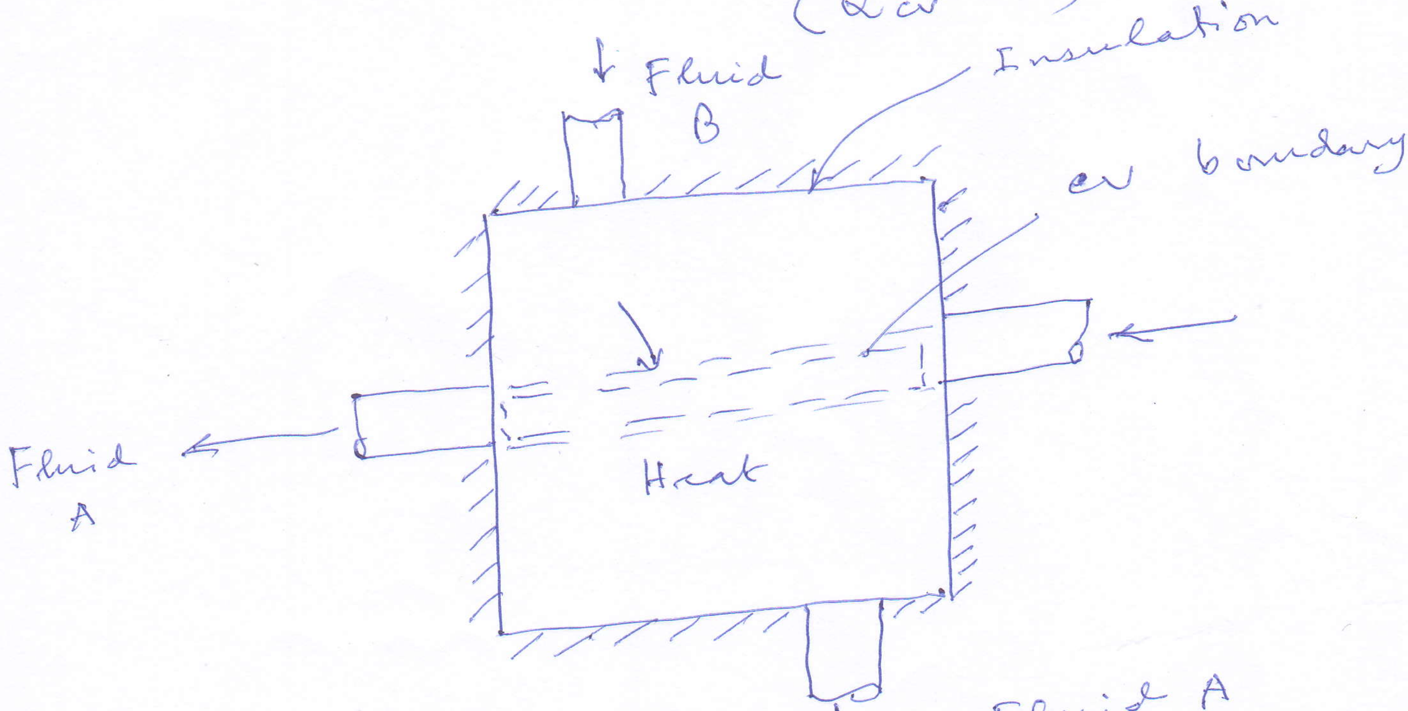


Fig. 3 (b) System: Fluid A ($\dot{Q}_{cv} \neq 0$)

Pipe and Duct Flow

The transport of liquids or gases in pipes and ducts is of great importance in many engineering applications. Flow through a pipe or a duct usually satisfies the steady-flow conditions.

- Under normal operating conditions, the amount of heat gained or lost by the fluid may be very significant, particularly if the pipe or duct is long. See Fig. 4.

- At other times, heat transfer is undesirable, and the pipes or ducts are insulated to prevent any heat loss or gain.

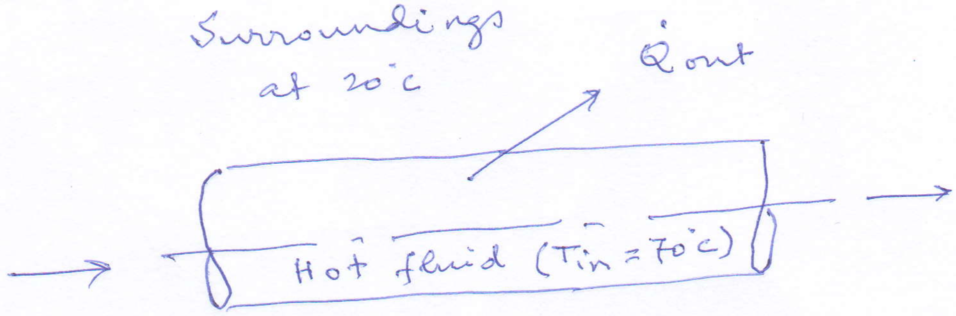


Fig. 4 Heat losses in an uninsulated pipe

- If the control volume involves a heating section (electric wires), a fan, or a pump (shaft), the work interactions should be considered. See Fig. 5.

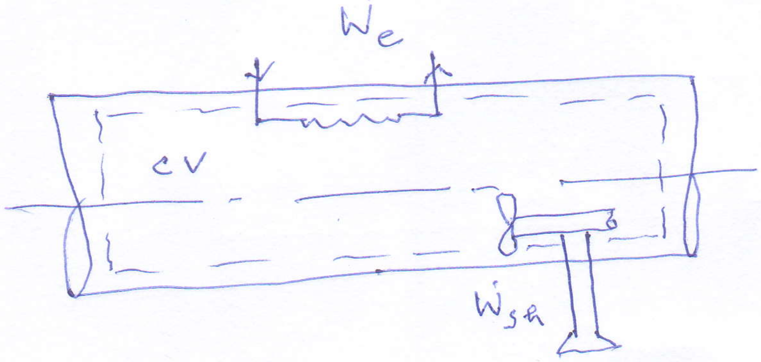


Fig. 5 Pipe or duct flow may involve more than one form of work at the same time

- The kinetic energy changes are relatively small. This is particularly true when the pipe or duct diameter is constant and the heating effects are negligible.

- Kinetic energy changes may be significant, however, for gas flow in ducts with variable cross-sectional areas especially when the compressibility effects are significant.

- The potential energy change may also be significant when the fluid undergoes a considerable elevation change as it flows in a pipe or duct.