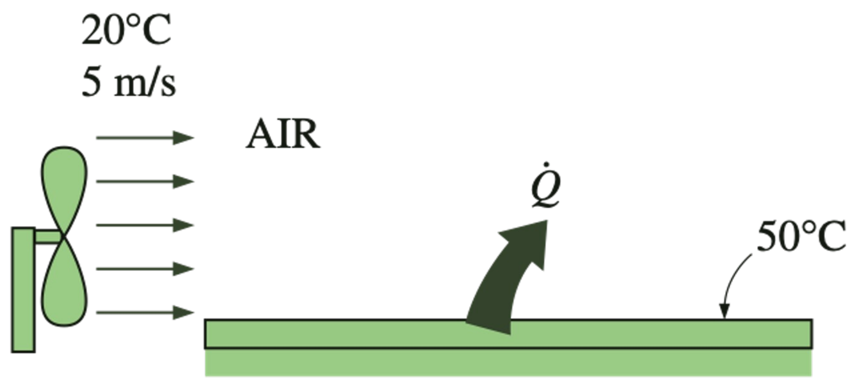
HEAT TRANSFER

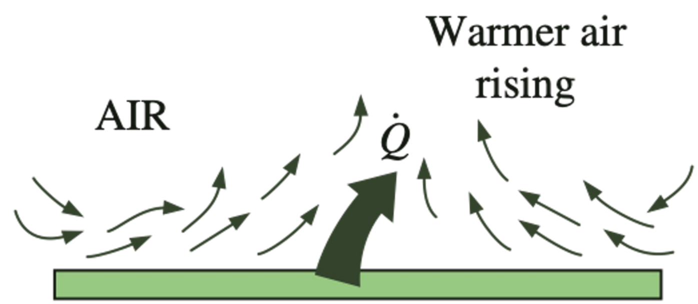
[CH21204]

January 11, 2023

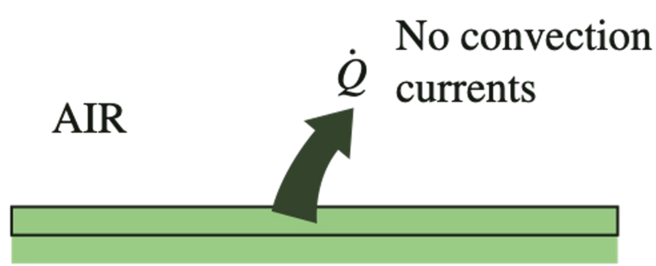
Convection



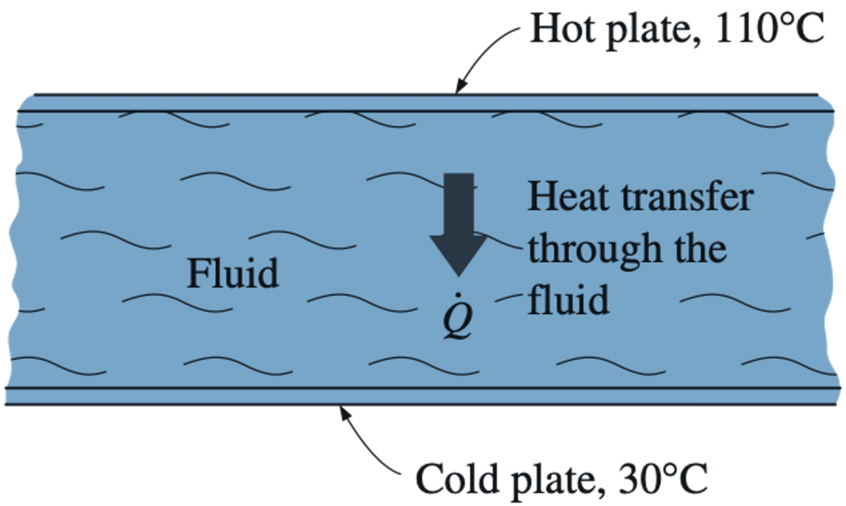
(a) Forced convection



(b) Free convection

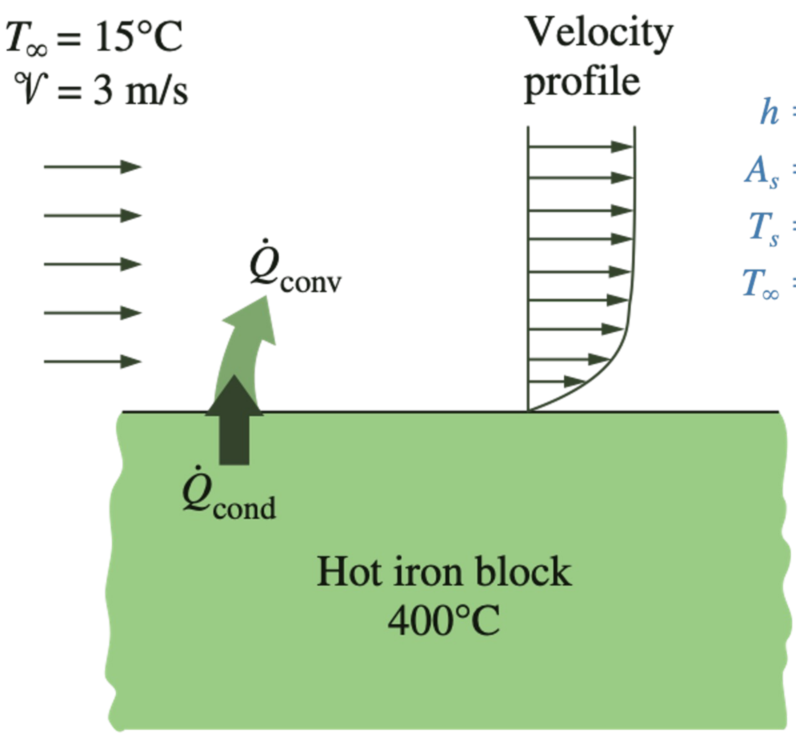


(c) Conduction

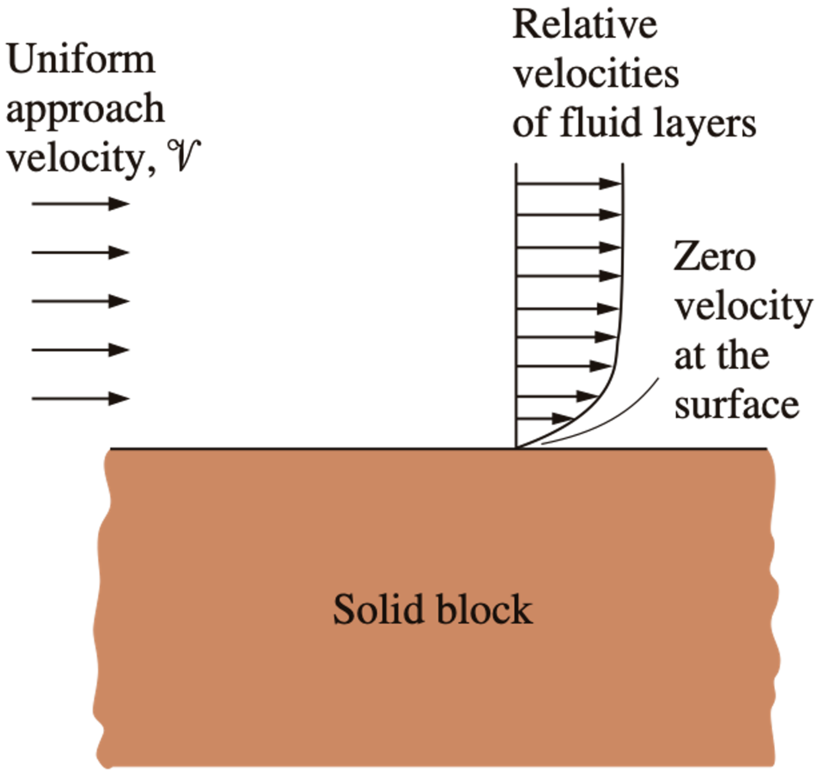


$$\dot{q}_{conv} = h(T_s - T_\infty) \qquad (\mathrm{W/m^2})$$

$$\dot{Q}_{conv} = hA_s(T_s - T_\infty) \qquad (\mathrm{W})$$



h = convection heat transfer coefficient, $\mathrm{W/m^2 \cdot °C}$
A_s = heat transfer surface area, $\mathrm{m^2}$
T_s = temperature of the surface, °C
T_∞ = temperature of the fluid sufficiently far from the surface, °C



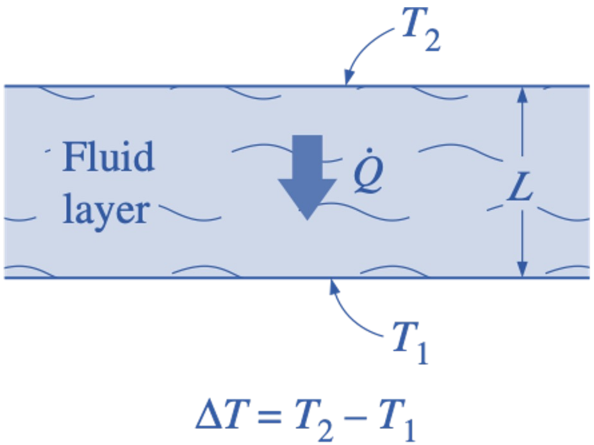
$$h = \frac{-k_{\text{fluid}}(\partial T/\partial y)_{y=0}}{T_s - T_\infty} \qquad (\text{W/m}^2 \cdot {}^\circ\text{C})$$

$$\boxed{\dot{q}_{\text{conv}} = \dot{q}_{\text{cond}} = -k_{\text{fluid}} \left.\frac{\partial T}{\partial y}\right|_{y=0} \qquad (\text{W/m}^2)}$$

$$\boxed{\dot{q}_{\text{conv}} = h(T_s - T_\infty) \qquad (\text{W/m}^2)}$$

Nusselt Number

$$\mathrm{Nu} = \frac{hL_c}{k}$$



$$\dot{q}_{\text{conv}} = h\Delta T$$

$$\dot{q}_{\text{cond}} = k\frac{\Delta T}{L}$$

$$\frac{\dot{q}_{\text{conv}}}{\dot{q}_{\text{cond}}} = \frac{h\Delta T}{k\Delta T/L} = \frac{hL}{k} = \mathrm{Nu}$$

Nusselt number represents the enhancement of heat transfer through a fluid layer as a result of convection relative to conduction across the same fluid layer.