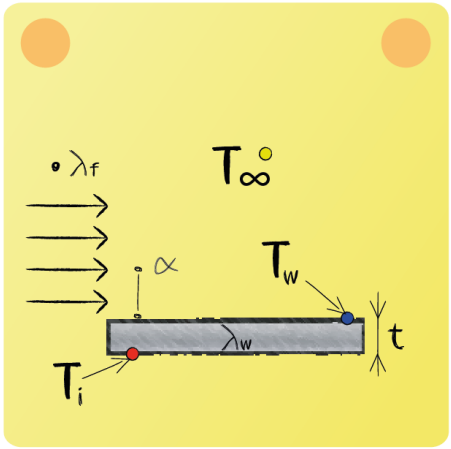
Lecture 6 Question 3

Air blows over a horizontal plate, which is loosing heat. The plate surface is maintained at a constant temperature. Give an expression for the heat transfer coefficient. Assume one-dimensional steady-state heat transfer.



Energy balance around the hot steel plate:

$$\dot{Q}_{\text{cond}} - \dot{Q}_{\text{cond}} = 0$$

Heat fluxes:

$$\dot{Q}_{\text{cond}} = -\lambda_{\text{w}} \cdot A_{\text{c}} \cdot \frac{T_{\text{w}} - T_{\text{i}}}{t}$$

$$\dot{Q}_{\text{conv}} = \alpha \cdot A_{\text{s}} \cdot (T_{\text{w}} - T_{\infty})$$

Substitution into the energy balance:

$$-\lambda_{\text{w}} \cdot A_{\text{c}} \cdot \frac{T_{\text{w}} - T_{\text{i}}}{t} - \alpha \cdot A_{\text{s}} \cdot (T_{\text{w}} - T_{\infty}) = 0$$

Note that in the expressions of $\dot{Q}_{\text{cond}}$ and $\dot{Q}_{\text{conv}}$ $A_{\text{s}} = A_{\text{c}}$. Rewriting yields:

$$\alpha = -\lambda_{\text{w}} \cdot \frac{T_{\text{w}} - T_{\text{i}}}{t} \cdot \frac{1}{\cdot T_{\text{w}} - T_{\infty}}$$