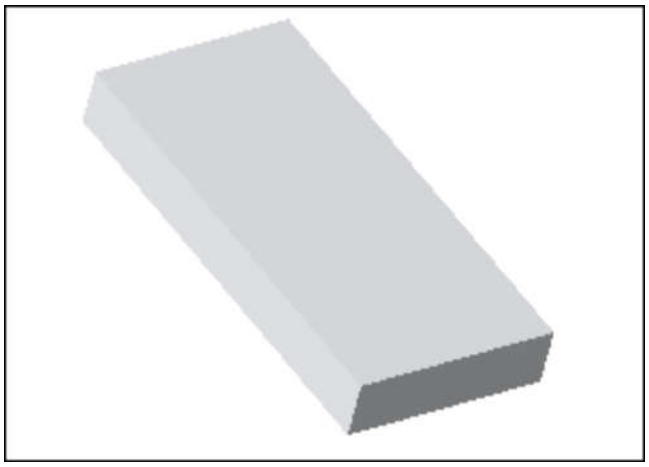
Heat Transfer Coefficient of Air Flowing Across a Flat Plate

This application calculates the heat transfer coefficient of air flowing across a flat plate



Parameters

> restart :
with(ThermophysicalData) : with(Units[Standard]) :

Length of plate in flow direction

> L := 0.5 m :

Plate surface temperature

> Ts := 27.5 degC :

Ambient air temperature

> Tinfinity := 50.0 degC :

Film temperature

> $\text{Tfilm} := \frac{\text{Tinfinity} + \text{Ts}}{2}$

$\text{Tfilm} := 38.75000000\ °C$

Air velocity and pressure

> v := 10 m s^-1 :

> press := 100 kPa :

Fluid Properties

> $\rho := \text{Property}(\text{"density"}, \text{temperature} = \text{Tfilm}, \text{pressure} = \text{press}, \text{"air"})$

$$\rho := 1.117173110 \frac{\text{kg}}{\text{m}^3}$$

> $k := \text{Property}(\text{"thermalconductivity"}, \text{temperature} = \text{Tfilm}, \text{pressure} = \text{press}, \text{"air"})$

$$k := 0.02726226214 \frac{\text{W}}{\text{m K}}$$

> $\mu := \text{Property}(\text{"viscosity"}, \text{temperature} = \text{Tfilm}, \text{pressure} = \text{press}, \text{"air"})$

$$\mu := 0.00001910585146 \text{ Pa s}$$

> $Cp := \text{Property}(\text{"CPMASS"}, \text{temperature} = \text{Tfilm}, \text{pressure} = \text{press}, \text{"air"})$

$$Cp := 1006.843606 \frac{\text{J}}{\text{kg K}}$$

Calculations

Prandtl number

> $Pr := \frac{Cp \cdot \mu}{k}$

$$Pr := 0.7056129195$$

Reynolds number

> $Rey := \frac{\rho \cdot v \cdot L}{\mu}$

$$Rey := 2.92364125310^5$$

The average Nusselt number for flow over a flat plate [1]

> $N := 0.664 \cdot Rey^{0.5} \cdot Pr^{0.333}$:

Hence the heat transfer coefficient is

> $h := \frac{N \cdot k}{L}$

$$17.42989046 \frac{\text{W}}{\text{m}^2 \text{K}}$$

References

[1] https://en.wikipedia.org/wiki/Nusselt_number#Flat_plate_in_laminar_flow