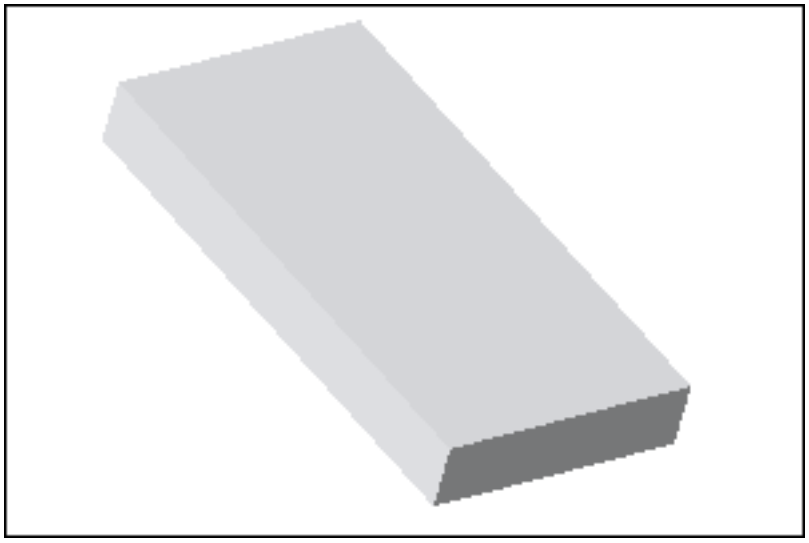
Heat Transfer Coefficient of Air Flowing across a Flat Plate

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 := 0.5m :
```

Plate surface temperature

```
> Ts := 27.5degC :
```

Ambient air temperature

```
> Tinfinity := 50.0 degC :
```

Film temperature

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

$$38.75\ °C \tag{1.1}$$

Air velocity and pressure

> $v := 10\ m\,s^{-1}$:

> $\mathrm{press} := 100\,kPa$:

Fluid Properties

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

$$1.117\ \frac{kg}{m^3} \tag{2.1}$$

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

$$.027\ \frac{W}{m\,K} \tag{2.2}$$

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

$$1.911 \times 10^{-5}\ Pa\,s \tag{2.3}$$

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

$$1006.844\ \frac{J}{kg\,K} \tag{2.4}$$

Calculations

Prandtl number

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

$$Pr := 0.7056129195 \tag{3.1}$$

Reynolds number

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

$$Rey := 2.92364125310^{5} \tag{3.2}$$

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

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

$$N := 319.6706562 \tag{3.3}$$

Hence the heat transfer coefficient is

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

(3.4)

$$17.430\ \frac{W}{m^2\,K} \tag{3.4}$$

>

References

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