CHAPTER 5 CONVECTION AND INFILTRATION IN ROOMS AND CAVITIES

5.2 Convective Heat Transfer Coefficients in Rooms

Horizontal Surfaces

For heat flow *downward*, that is conduction across the air-film, the following correlation is recommended (McAdams 1959). We apply it here to a cold floor.

$Ts := 10\ \Delta°C, 11\ \Delta°C .. 18\ \Delta°C$ floor surface temperature

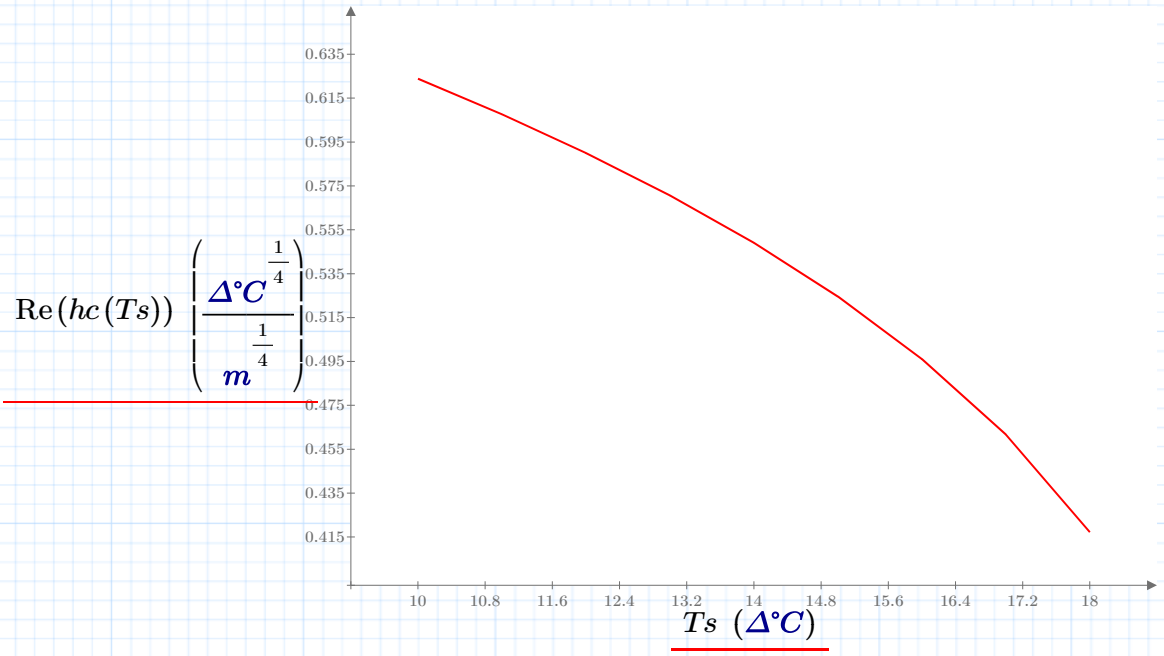
$Tai := 20\ \Delta°C$ room air temperature

$x := 2\ m$ characteristic dimension

$$hc(Ts) := 0.59 \cdot \left(\frac{Ts - Tai}{x}\right)^{0.25}$$

Laminar flow is assumed with Rayleigh number in the range

$3 \cdot 10^5$ to $3 \cdot 10^{10}$



For heat flow *upward*, for example from a heated floor, the following turbulent flow correlation is recommended:

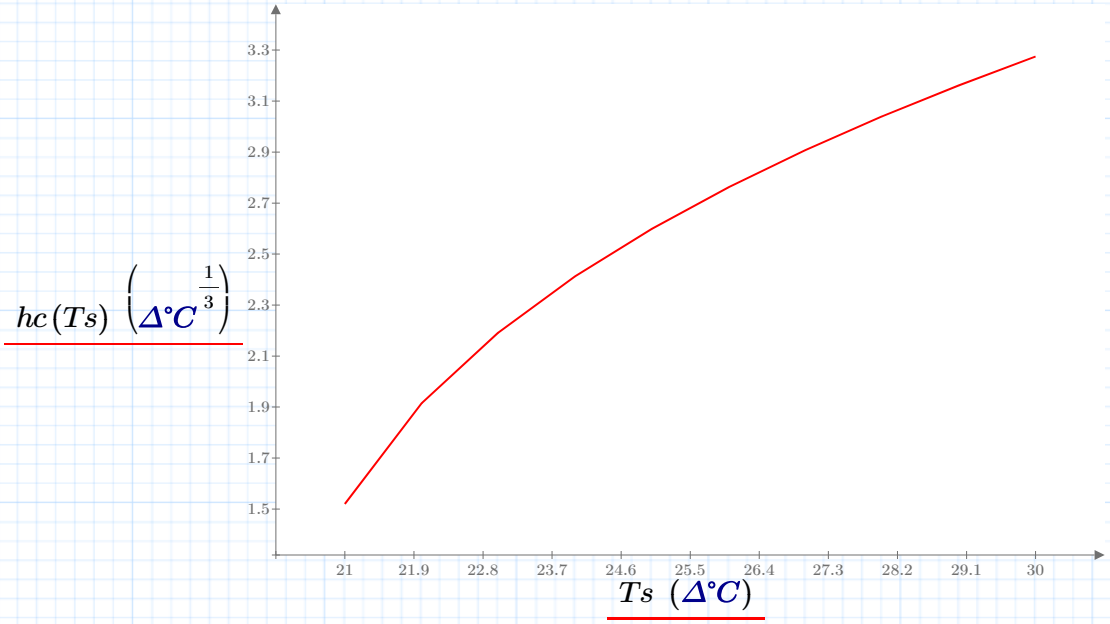
Let

$Ts := 21\ \Delta°C, 22\ \Delta°C .. 30\ \Delta°C$

$hc(Ts) := 1.52 \cdot (Ts - Tai)^{\frac{1}{3}}$

The Rayleigh number is assumed to be in the range

$2 \cdot 10^{7}$ to $3 \cdot 10^{10}$



Vertical Surfaces

The following turbulent flow correlation is often used:

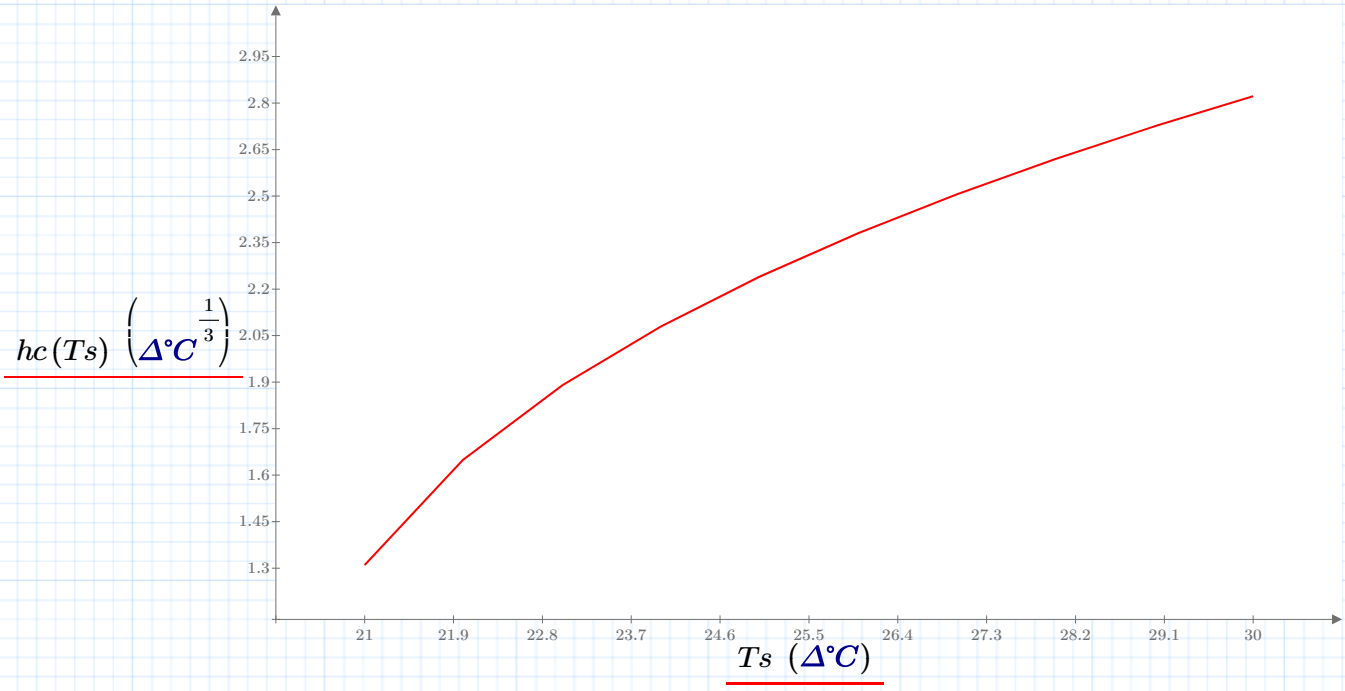
Let

$Ts := 21\ \Delta°C, 22\ \Delta°C .. 30\ \Delta°C$ surface temperature

$hc(Ts) := 1.31 \cdot (Ts - Tai)^{\frac{1}{3}}$

The Rayleigh number is assumed to be in the range

10^4 to 10^9



Note that the above heat transfer coefficients do not include the effect of radiation. If a combined heat transfer coefficient is to be calculated, the radiative heat transfer coefficient hr must also be calculated. Usually, hr is calculated as follows:

$$hr = \varepsilon \cdot \sigma \cdot 4 \cdot Tm^3$$

where

$$Tm = \frac{Ts + Te}{2} = \frac{\left(Ts^2 + Te^2\right) \cdot (Ts + Te)}{4}$$

with Ts and Te being the surface and environment (enclosure) temperatures respectively. ($4 \cdot Tm^3$ is a linearization factor for radiation heat transfer).

References

McAdams.1959. *Heat Transmission.* 3rd ed. McGraw-Hill.