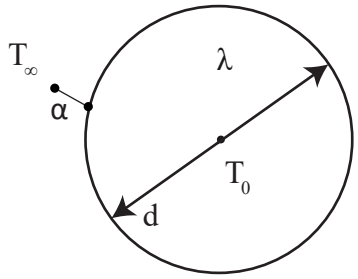
1.13 Cooling of a copper rod ★★

A long copper rod is initially at a uniform temperature T_0. It is now exposed to an air stream at T_∞ with a heat transfer coefficient α. How long will it take for the copper rod to cool to a temperature of 25 °C?



Hints

- Heat radiation can be neglected.
- Setup an energy balance.

Given parameter

- Diameter of the copper rod: d = 2 cm
- Initial temperature: T_0 = 100 °C
- Air stream temperature: T_∞ = 20 °C
- Heat transfer coefficient: α = 200 W/m^{2}K
- Thermal conductivity of copper: λ = 399 W/mK
- Specific heat capacity of copper: c_p = 382 J/kgK
- Density of copper: ρ = 8930 kg/m^3

1.14 The temperature delay ★★

A body with a temperature of T_b is located within an environment with the linearly rising temperature T_e and heats up accordingly to the diagram below. Assume that the temperature is uniform within the body and that the environment, and its temperature, is not affected by the body. As $t \to \infty$, the temperature of the body follows that of the environment with a constant time delay Δt. Determine this delay Δt.

- Heat transfer coefficient, body - environment, α
- Surface of the body, A
- Mass of the body, m
- Heat capacity of the body, c_p
- Temperature of the environment, $T_\mathrm{e}\,(t)$