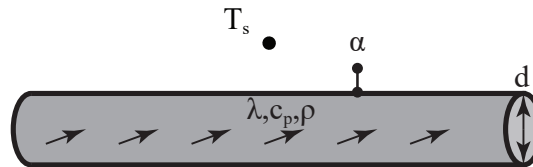


Exercise II.13: (Cooling of a copper rod ★★)

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 .

**Given parameters:**

- | | |
|-------------------------------------|----------------------------------------|
| • Diameter of the copper rod: | $d = 2 \text{ cm}$ |
| • Initial temperature: | $T_0 = 100 \text{ }^\circ\text{C}$ |
| • Air stream temperature: | $T_\infty = 20 \text{ }^\circ\text{C}$ |
| • Heat transfer coefficient: | $\alpha = 200 \text{ W/m}^2\text{K}$ |
| • Thermal conductivity of copper: | $\lambda = 399 \text{ W/mK}$ |
| • Specific heat capacity of copper: | $c_p = 382 \text{ J/kgK}$ |
| • Density of copper: | $\rho = 8930 \text{ kg/m}^3$ |

Hints:

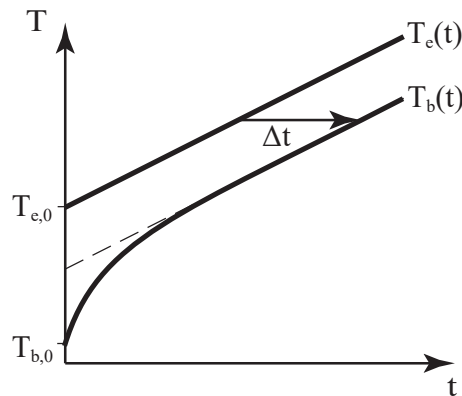
- Heat radiation can be neglected.
- Setup an energy balance.

Tasks:

- a) Determine how long will it take for the copper rod to cool to a temperature of $T_1 = 25 \text{ }^\circ\text{C}$.
- b) Sketch the temperature profile over the course of time.

Exercise II.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. As $t \rightarrow \infty$, the temperature of the body follows that of the environment with a constant time delay Δt .

**Given parameters:**

- Heat transfer coefficient of the body: α
- Surface of the body: A
- Mass of the body: m
- Heat capacity of the body: c_p
- Temperature of the environment: $T_e(t)$

Hints:

- The temperature is uniform within the body
- The environment, and its temperature, are not affected by the body.
- Heat radiation can be neglected.
- Setup an energy balance.

Tasks:

- a) Determine this delay Δt .