

The onion layer principle

Measurements of the surface temperature of a planar wall, comprising a $\delta_A = 12.5$ cm thick layer of material A and a $\delta_B = 20$ cm thick layer of material B, yielded following results:

T_A	260	°C	surface temperature of layer A
T_B	32	°C	surface temperature of layer B

After insulating the outer surface of layer B with an layer of $\delta_{\text{ins}} = 2.5$ cm thickness ($\lambda_{\text{ins}} = 0.075$ W/mK), following values were measured:

T_A^*	305	°C	surface temperature of layer A
T_B^*	219	°C	temperature of the contact area of layer B and the insulating layer (previously the surface temperature of layer B)
T_{ins}	27	°C	surface temperature of the insulating layer

Tasks:

- Determine the transmitted heat flux per unit area \dot{q}'' with and without the insulating layer; assume steady-state conditions.

Wooden cylinder

A hollow cylinder of radius r_i , outer radius r_a and length L is heated such that its inner and outer surfaces reach a constant and homogeneously distributed temperature of T_i and T_a , respectively. The cylinder material has a temperature dependent thermal conductivity according to the following equation:

$$\lambda = \lambda_0(1 + \gamma(T - T_0))$$

(λ_0 = thermal conductivity at reference temperature T_0)

Tasks:

- a) Derive an equation for the heat flux through the wall (mantle) of the cylinder. Compare this equation with that for the case of constant thermal conductivity. For which mean temperature T_m would the thermal conductivity λ have to be introduced in the equation for the heat flux in the case of constant conductivity, if said thermal conductivity λ were to be used to calculate the heat flux for the case of a linear temperature dependency of conductivity?
- b) State the equation describing the temperature distribution in the hollow cylinder.