

## The onion layer principle

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

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

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

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$T_A^*$	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)
$T_{\text{ins}}$	27	°C	surface temperature of the insulating layer

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### 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:

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

( $\lambda_0$  = 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  $\lambda$  have to be introduced in the equation for the heat flux in the case of constant conductivity, if said thermal conductivity  $\lambda$  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.