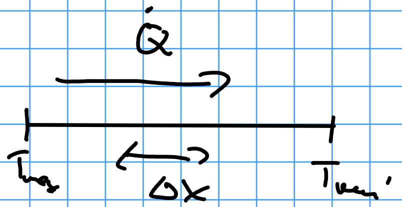
Wärmeleitung



$\frac{\Delta T}{\Delta x} \rightsquigarrow \frac{dT}{dx}$ Ursache

Wärmestromdichte $\dot q = \frac{\text{Wärme}}{\text{Zeit} \cdot \text{Fläche}}$ Wirkung

Gesetz von Fourier

$$\dot q = -\lambda \frac{\partial T}{\partial x}$$

Wärmeleitfähigkeit λ $\left[\frac{W}{Km}\right]$

$$\lambda = \lambda(\rho, T)$$

Ebene Wand

- Temperaturverteilung zeitlich konstant

$$\dot{Q} = \dot{q} A$$

$$\frac{\partial T}{\partial x} = -\frac{\dot{q}}{\lambda} = -\frac{\dot{Q}}{\lambda A} = \text{const.}$$

$$\Rightarrow T(x) = -\frac{\dot{Q}}{\lambda A} \cdot x + C$$

Randbedingung: $T(0) = T_1$

$$\Rightarrow T(0) = C = T_1$$

$$\Rightarrow T(x) = -\frac{\dot{Q}}{\lambda A} x + T_1$$

Randbedingung: $T(d) = T_2$

$$T(d) = -\frac{\dot{Q}}{\lambda A} d + T_1 = T_2$$

$$\Rightarrow \dot{Q} = \lambda A \frac{T_1 - T_2}{d}$$

$$T(x) = -\frac{T_1 - T_2}{d} x + T_1$$

Wärmeströmung durch ein Rohr

Innenradius r_1, Außenradius r_2, Länge l

$$A(r) = 2\pi r\, l$$

$$\dot{Q} = -\lambda A(r) \frac{dT}{dr} = -\lambda 2\pi r\, l \frac{dT}{dr}$$

$$\Rightarrow \int_{T_1}^{T} dT = -\frac{\dot{Q}}{2\pi l \lambda} \int_{r_1}^{r} \frac{1}{r}\, dr$$

$$\Rightarrow T - T_1 = -\frac{\dot{Q}}{2\pi l \lambda} \ln \frac{r}{r_1}$$

$$T(r_2) = T_2 \Rightarrow$$

$$T_2 - T_1 = -\frac{\dot{Q}}{2\pi l \lambda} \ln \frac{r_2}{r_1}$$

$$\Rightarrow \quad \dot{Q} = 2\pi l \lambda \frac{T_1 - T_2}{\ln\left(\frac{r_2}{r_1}\right)}$$

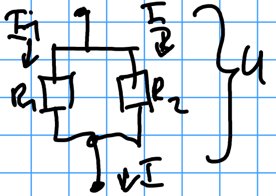
Wärmewiderstand

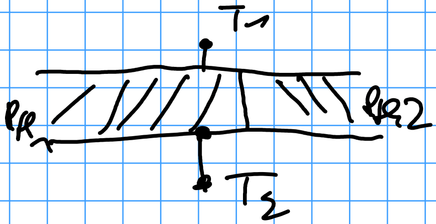
Strom		Wärme	
Potentialdifferenz	U	Temperaturdifferenz	ΔT
Strom	I	Wärmestrom	$\dot{Q}$
$I = \frac{1}{R} U$		$\dot{Q} = \frac{1}{R_{th}} \Delta T$	

Ebene Wand $R_{th} = \frac{d}{\lambda A}$

Zylinderwand $R_{th} = \frac{\ln(r_2/r_1)}{2\pi l \lambda}$

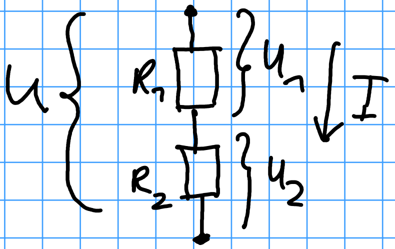
Parallelschaltung

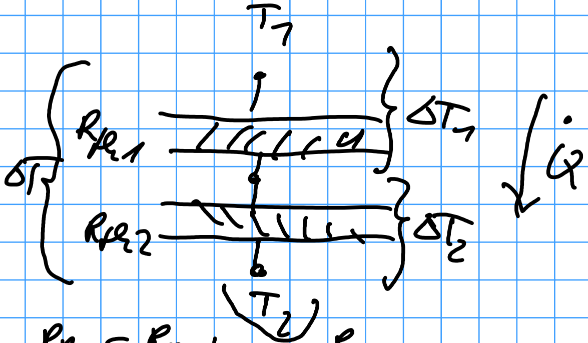




$$\frac{1}{R_g} = \frac{1}{R_1} + \frac{1}{R_2}$$

Reihenschaltung





$$R_g = R_1 + R_2$$

$$U = R_g \cdot I$$

$$U_{1/2} = R_{1/2} I$$

$$R_{th_g} = R_{th_1} + R_{th2}$$

$$\Delta T = R_{th_g} \cdot \dot{Q}$$

$$\Delta T_{1/2} = R_{th1/2} \cdot \dot{Q}$$