

**Energiegleichung in integraler Form:**

$$\begin{aligned}
 & \int_V \frac{\partial}{\partial t} \left[ \rho \left( e + \frac{\vec{v}^2}{2} \right) \right] dV + \int_O \rho \left( e + \frac{\vec{v}^2}{2} \right) (\vec{v} \cdot \vec{n}) dO = \\
 & = \int_V (\rho \vec{v} \cdot \vec{f}^B) dV - \int_O (p \vec{v} \cdot \vec{n}) dO + \\
 & + \int_O (\vec{v} \cdot \vec{\tau}_x) n_x dO + \int_O (\vec{v} \cdot \vec{\tau}_y) n_y dO + \int_O (\vec{v} \cdot \vec{\tau}_z) n_z dO + \\
 & - \int_O (\vec{q} \cdot \vec{n}) dO + \int_V \dot{q}_Q dV
 \end{aligned}$$

Für Festkörper gilt:  $\vec{v} = 0$  ,  $\vec{\tau} = 0$

$$\Rightarrow \int_V \frac{\partial}{\partial t} [\rho e] dV = - \int_O (\vec{q} \cdot \vec{n}) dO + \int_V \dot{q}_Q dV$$

**Energiegleichung in differentieller Form:**

$$\begin{aligned}
 & \frac{\partial}{\partial t} \left[ \rho \left( e + \frac{\vec{v}^2}{2} \right) \right] + \left( \vec{\nabla} \cdot \rho \vec{v} \left( e + \frac{\vec{v}^2}{2} \right) \right) = \\
 & = \rho (\vec{v} \cdot \vec{f}^B) - (\vec{\nabla} \cdot p \vec{v}) + \frac{\partial}{\partial x} (u \tau_{xx} + v \tau_{xy} + w \tau_{xz}) + \\
 & + \frac{\partial}{\partial y} (u \tau_{yx} + v \tau_{yy} + w \tau_{yz}) + \frac{\partial}{\partial z} (u \tau_{zx} + v \tau_{zy} + w \tau_{zz}) - (\vec{\nabla} \cdot \vec{q}) + \dot{q}_Q
 \end{aligned}$$