



Clausius Inequality

The Clausius Inequality

$$\left(\int_b \frac{\delta Q_{into}}{T} \right)_{cycle} \leq 0$$

- “*b*” refers to an integral over the system boundary surface area
- *T* is the absolute temperature where the heat enters (or leaves) the boundary
- the equal sign holds for internally reversible processes in the cycle
- the less than sign holds when internal irreversibilities are present

Written another way:

$$\left(\int_b \frac{\delta Q_{into}}{T} \right)_{cycle} = -\sigma_{cycle}$$

- σ_{cycle} is known as the **entropy production** over the cycle
- internally irreversible cycle: $\sigma_{cycle} > 0$
- internally reversible cycle: $\sigma_{cycle} = 0$
- impossible cycle: $\sigma_{cycle} < 0$

Can also write,

$$\left(\int_b \frac{\delta \dot{Q}_{into}}{T} \right)_{cycle} = -\dot{\sigma}_{cycle}$$

where $\dot{\sigma}_{cycle}$ is the **rate of entropy production** over the cycle