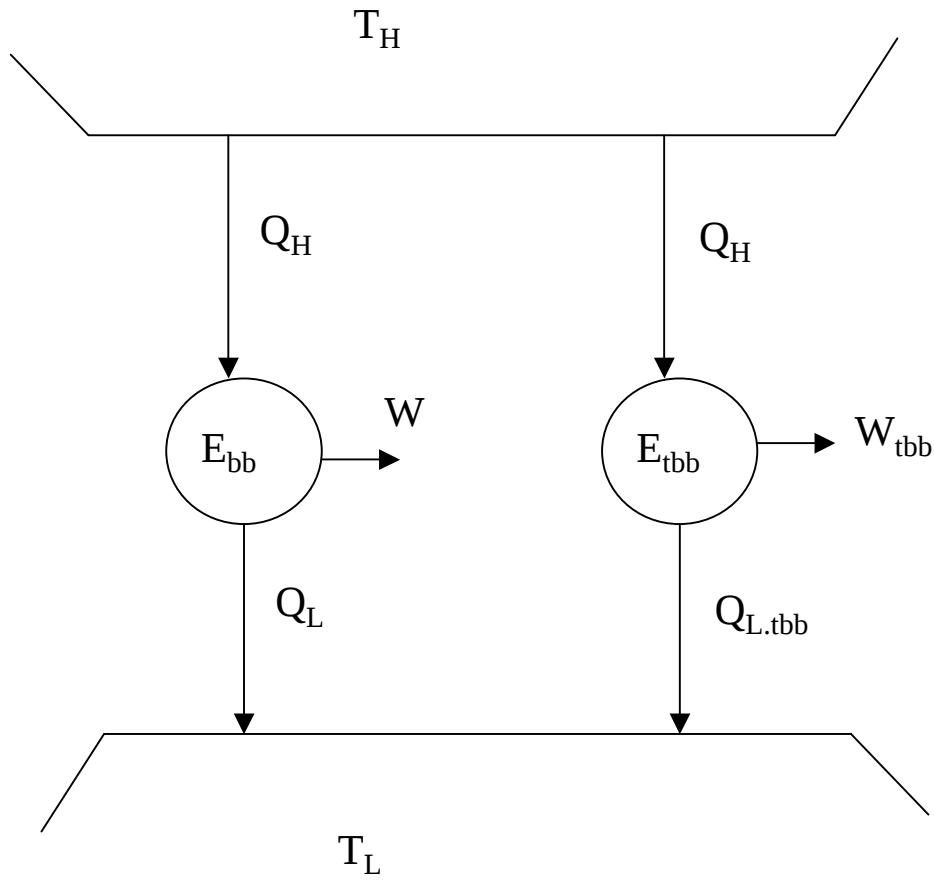


Ketaksamaan Clausius



Dua mesin haba antara dua suhu yang sama

Kaji $\frac{\delta Q}{T}$ seluruh kitaran

(a) E_{bb}

$$\begin{aligned}
 \oint \left(\frac{\delta Q}{T} \right)_{bb} &= \int \frac{\delta Q_H}{T_H} - \int \frac{\delta Q_L}{T_L} \\
 &= \frac{1}{T_H} \int \delta Q_H - \frac{1}{T_L} \int \delta Q_L \\
 &= \frac{Q_H}{T_H} - \frac{Q_L}{T_L} \\
 &= 0
 \end{aligned}$$

$$\oint \left(\frac{\delta Q}{T} \right)_{bb} = 0$$

(b) E_{tbb}

$$Q_{L,tbb} > Q_L$$

$$Q_{L,tbb} = Q_L + \Delta Q$$

$$\begin{aligned}\oint \left(\frac{\delta Q}{T} \right)_{tbb} &= \frac{Q_H}{T_H} - \frac{Q_{L,tbb}}{T_L} \\ &= \frac{Q_H}{T_H} - \frac{Q_L + \Delta Q}{T_L} \\ &= \underbrace{\frac{Q_H}{T_H} - \frac{Q_L}{T_L}}_{=0} - \frac{\Delta Q}{T_L} \\ &= -\frac{\Delta Q}{T_L} < 0\end{aligned}$$

$$\oint \left(\frac{\delta Q}{T} \right)_{tbb} < 0$$

Digabungkan menjadi:

$$\oint \frac{\delta Q}{T} \leq 0 \quad \text{Ketaksamaan Clausius}$$

$= 0$ jika bolehbalik
 < 0 jika takbolehbalik