§13.5 卡诺过程

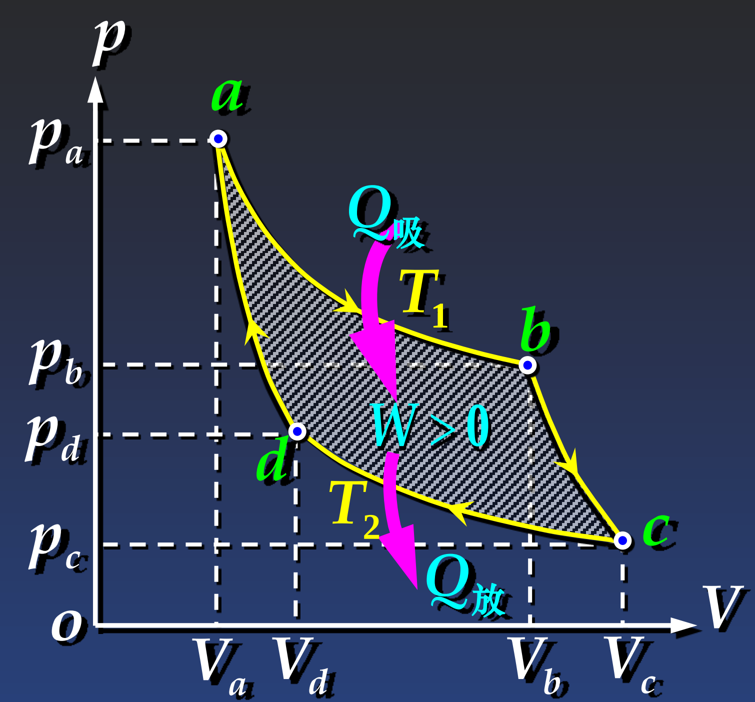
一、卡诺正循环

$a \rightarrow b$：等温膨胀（T_1）

$b \rightarrow c$：绝热膨胀

$c \rightarrow d$：等温压缩（T_2）

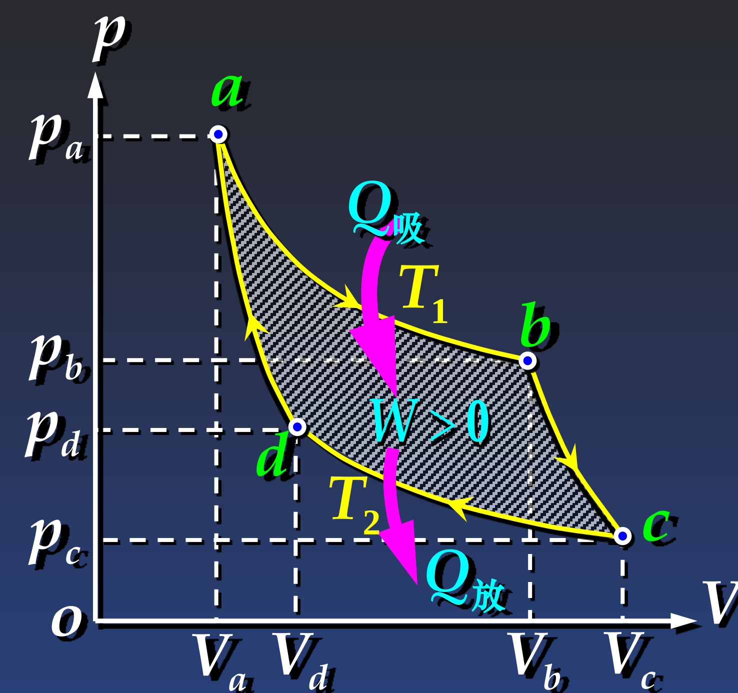
$d \rightarrow a$：绝热压缩



$$\left.\begin{aligned} Q_{吸} &= \nu R T_1 \ln \frac{V_b}{V_a} \\ Q_{放} &= \nu R T_2 \ln \frac{V_d}{V_c} \end{aligned}\right\} \quad \eta_{卡诺} = 1 - \frac{|Q_{放}|}{Q_{吸}}$$

$$\eta_{卡诺} = 1 - \frac{T_2}{T_1}\frac{\ln(V_c/V_d)}{\ln(V_b/V_a)}$$

$$\left.\begin{aligned} T_1 V_b^{\gamma-1} &= T_2 V_c^{\gamma-1} \\ T_1 V_a^{\gamma-1} &= T_2 V_d^{\gamma-1} \end{aligned}\right\} \quad \frac{V_b}{V_a} = \frac{V_c}{V_d}$$



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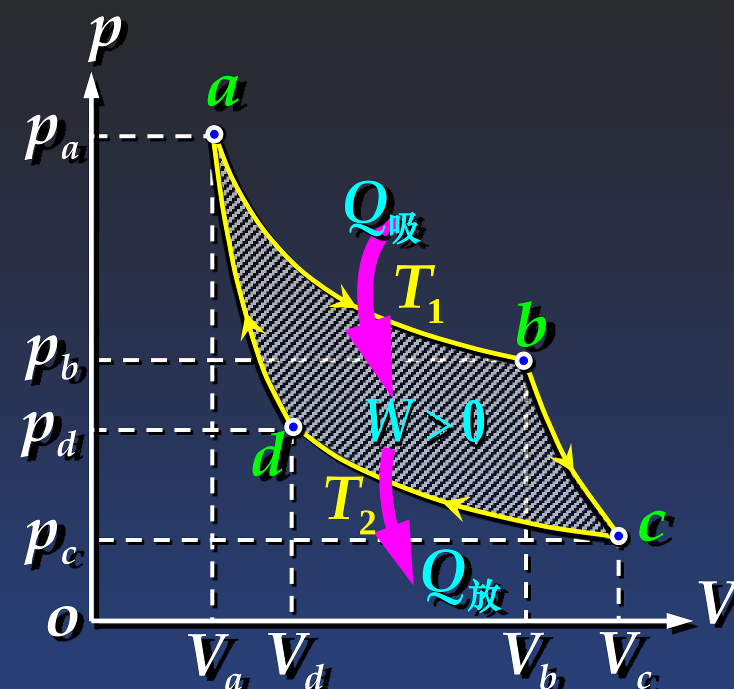
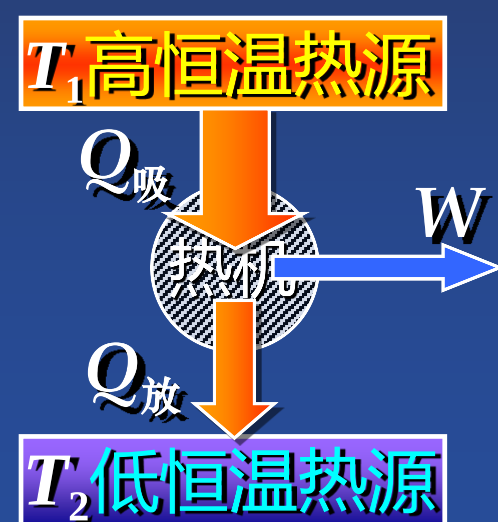


$$\left.\begin{aligned}T_1V_b^{\gamma-1}&=T_2V_c^{\gamma-1}\\T_1V_a^{\gamma-1}&=T_2V_d^{\gamma-1}\end{aligned}\right\}\quad \frac{V_b}{V_a}=\frac{V_c}{V_d}$$

$$\longrightarrow\quad \eta_{卡诺}=1-\frac{T_2}{T_1}$$

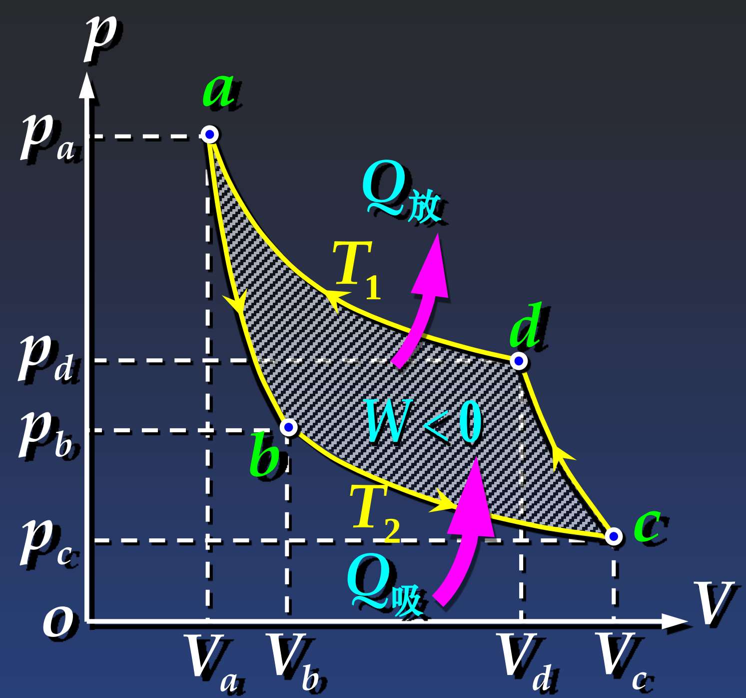


注意

- 卡诺热机效率只与高、低温热源的温度有关，与工质无关！

二、卡诺逆循环

$$w_{卡诺}=\frac{Q_{吸}}{W'}=\frac{T_2}{T_1-T_2}$$

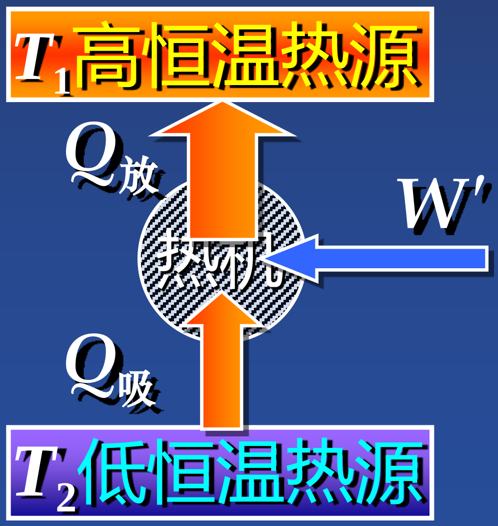


例 保持冰箱内温度为 −3℃，则由于：

$$T_2=273-3=270(\mathrm{K})$$

$$T_1=273+27=300(\mathrm{K})$$

$$w_{卡诺}=\frac{T_2}{T_1-T_2}=9$$

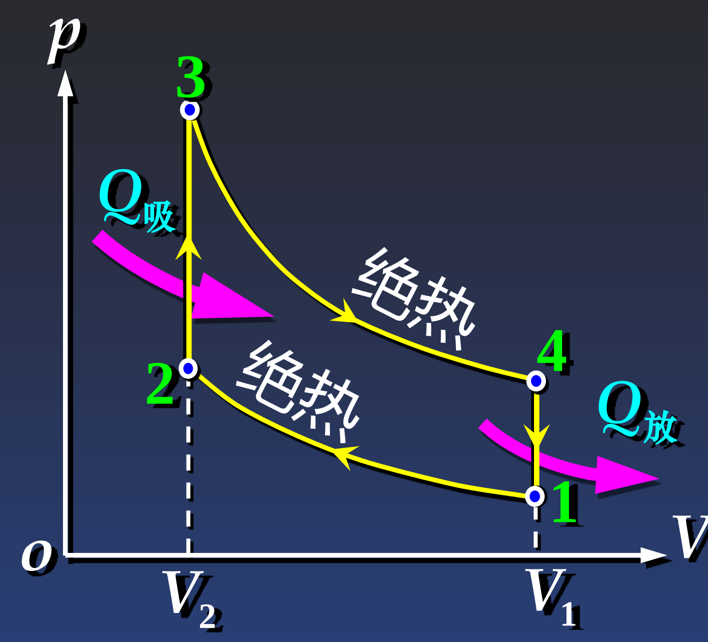


三、其他循环

- 奥托循环 (Otto cycle):

$$\eta_{otto} = 1 - q^{1-\gamma}$$

$q = V_1/V_2$：绝热压缩比



$$T_2 = 273 - 3 = 270(\mathrm{K})$$

$$T_1 = 273 + 27 = 300(\mathrm{K})$$

$$w_{卡诺} = \frac{T_2}{T_1 - T_2} = 9$$

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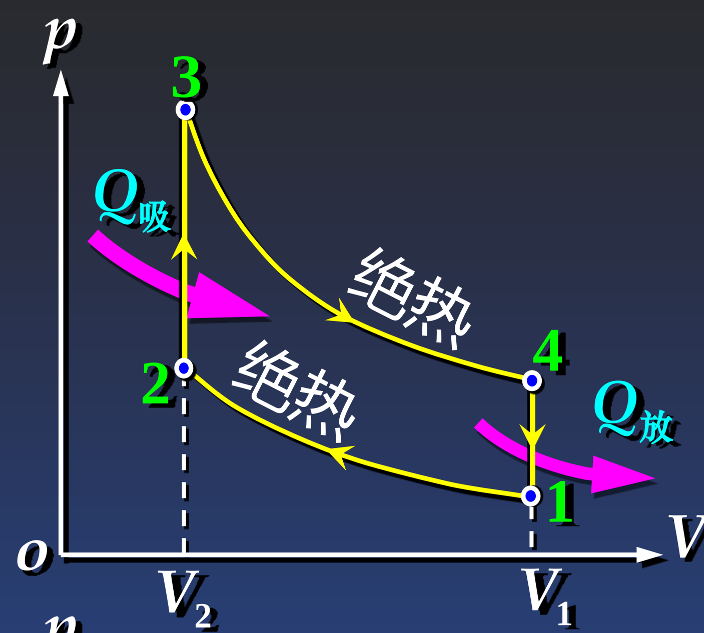
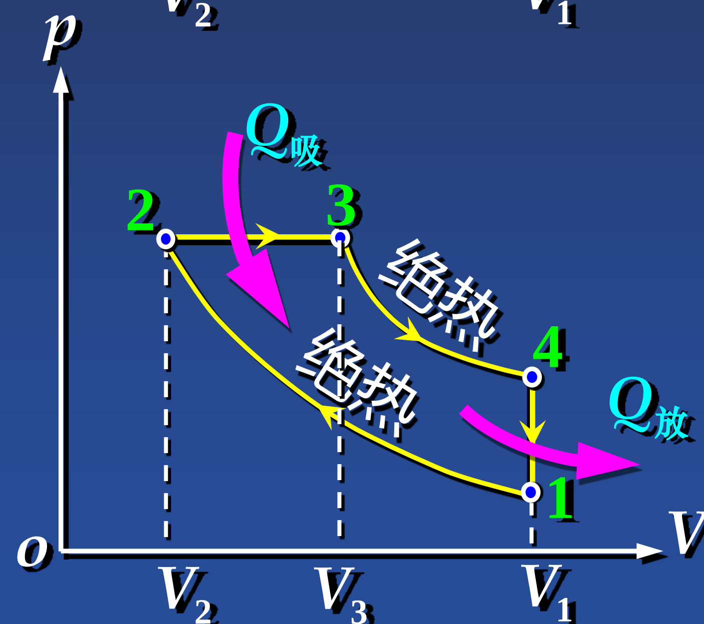


- 狄塞尔循环 (Diesel cycle):

$$\eta_{diesel} = 1 - \frac{1}{\gamma} q^{1-\gamma} \cdot \frac{\beta^{\gamma} - 1}{\beta - 1}$$

$\beta = V_3/V_2$： 定压膨胀比



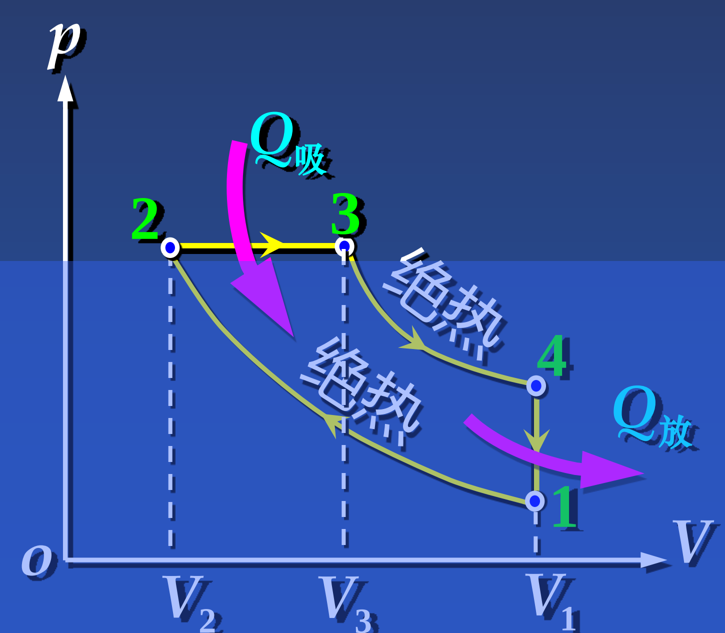
归纳：

☺ $$\eta_{卡诺} = 1 - \frac{|Q_{放}|}{Q_{吸}} = 1 - \frac{T_2}{T_1}$$

☺ $$w_{卡诺} = \frac{T_2}{T_1 - T_2}$$

$$\eta_{diesel} = 1 - \frac{1}{\gamma} q^{1-\gamma} \cdot \frac{\beta^{\gamma} - 1}{\beta - 1}$$

$\beta = V_3/V_2$： 定压膨胀比



归纳：

- $$\eta_{卡诺} = 1 - \frac{|Q_{放}|}{Q_{吸}} = 1 - \frac{T_2}{T_1}$$

- $$w_{卡诺} = \frac{T_2}{T_1 - T_2}$$

- $$\eta \leq \eta_{卡诺} = 1 - T_2 / T_1$$

(The end)