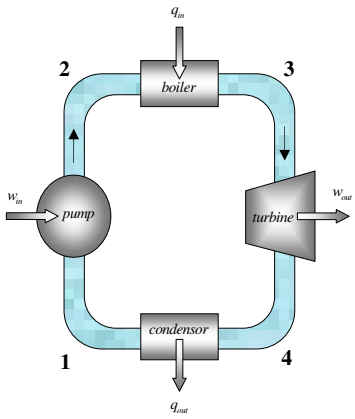
سیکل رانکین

(1820 – 1872)

چرخه نیروگاه بخار - که سیال به طور متناوب در آن بخار و کنداس می شود

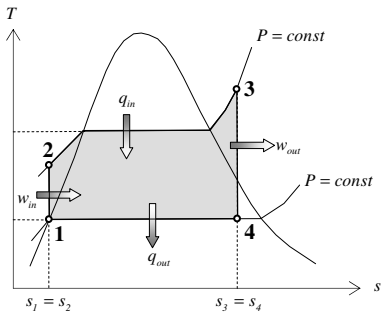


موازنه انرژی برای دستگاه های جریان درا :

$$\overbrace{q_{in}-q_{out}}^{q_{net\,in}}-\overbrace{\left(w_{out}-w_{in}\right)}^{w_{net\,out}}=h_e-h_i$$

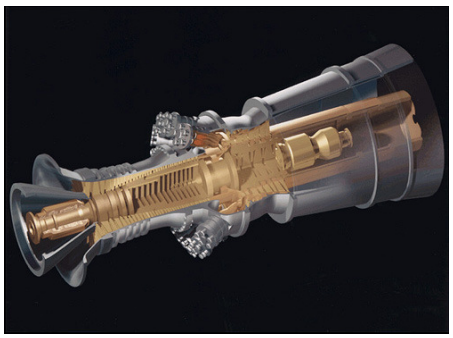
$$q_{in}-q_{out}-w_{out}+w_{in}=h_e-h_i$$

سیکل ایده آل رانکین

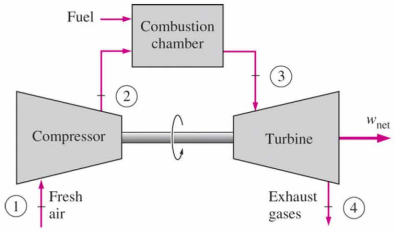


		سیال تراکم ناپذیر		
$1 \rightarrow 2$ Pump:	$w_{in}=h_2-h_1$	$w_{in}=v_1\left(P_2-P_1\right)$	$v_1=v_{f@P_1}$	$h_1=h_{f@P_1}$
		$\Downarrow$		
$2 \rightarrow 3$ Boiler:	$q_{in}=h_3-h_2$	$h_2=h_1+w_{in}$		
$3 \rightarrow 4$ Turbine:	$-w_{out}=h_4-h_3$			
$4 \rightarrow 1$ Condenser:	$-q_{out}=h_1-h_4$			

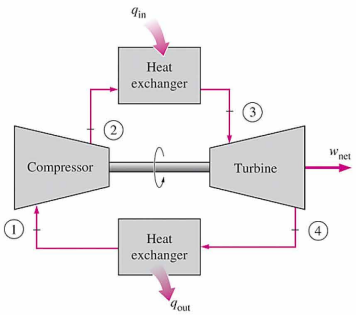
$$\eta_{th}=\frac{w_{net}}{q_{in}}=1-\frac{q_{out}}{q_{in}}=1-\frac{h_4-h_1}{h_3-h_2}$$



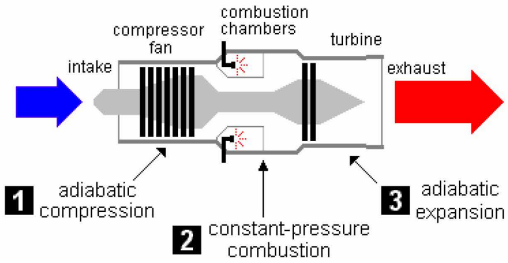
سیکل برایتون

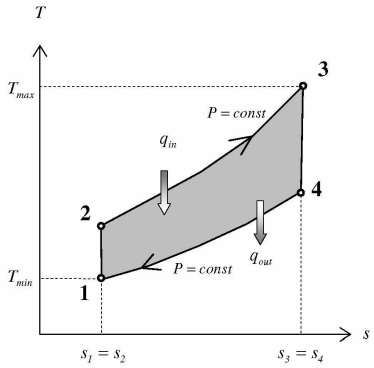


Open Cycle



Closed Cycle

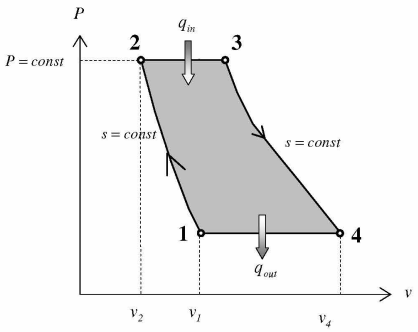




$$q_{in} = h_3 - h_2 = c_p\left(T_3 - T_2\right)$$

$$q_{out} = h_4 - h_1 = c_p\left(T_4 - T_1\right)$$

$$\eta_B = \frac{w_{net,out}}{q_{in}} = 1 - \frac{q_{out}}{q_{in}} = 1 - \frac{T_4 - T_1}{T_3 - T_2} = 1 - \frac{T_1\left(\frac{T_4}{T_1} - 1\right)}{T_2\left(\frac{T_3}{T_2} - 1\right)}$$



داریم۴ به ۳ و ۲به ۱برای فرآیند های آیزونتروپیک :

$$\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{\frac{k-1}{k}} = r_P^{\frac{k-1}{k}} = \left(\frac{P_3}{P_4}\right)^{\frac{k-1}{k}} = \frac{T_3}{T_4}$$

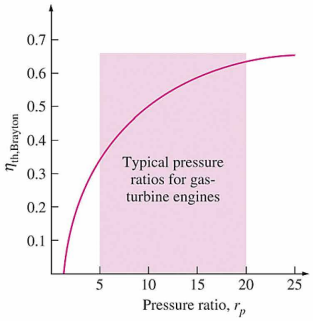
$$r_P = \frac{P_2}{P_1} = \frac{P_3}{P_4} \quad \textit{pressure ratio}$$

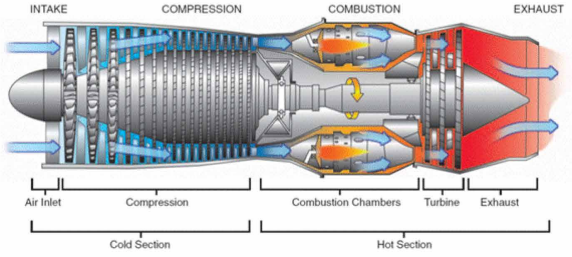
$$\Downarrow$$

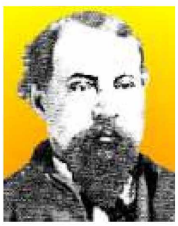
$$\frac{T_4}{T_1} = \frac{T_3}{T_2}$$

بازده حرارتی چرخه برایتون :

$$\eta_B = 1 - \frac{1}{r_P^{\frac{k-1}{k}}}$$





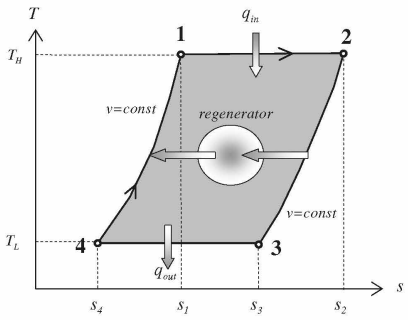


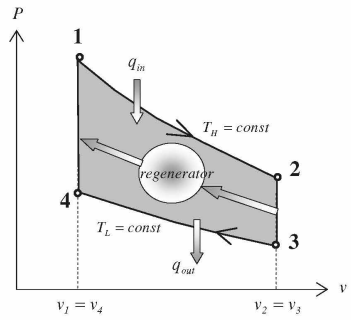
George Brayton
(1830 – 1892)

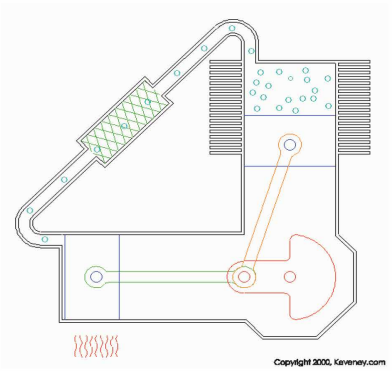
سیکل استرلینگ

موتورهای احتراق خراجی

Reverend Robert Stirling
(1790–1878)

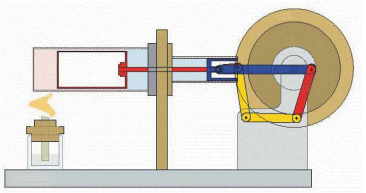






بازده حرارتی چرخه های
کارنو ، استرلینگ واریکسون

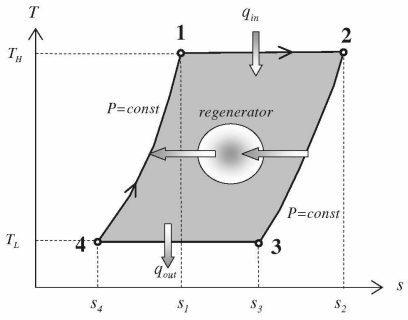
$$\eta_{th} = 1 - \frac{T_L}{T_H}$$

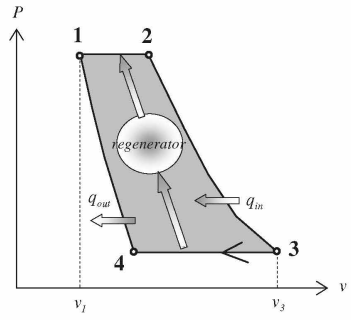


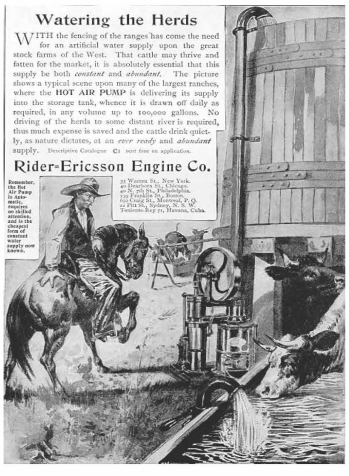
سیکل اریکسون

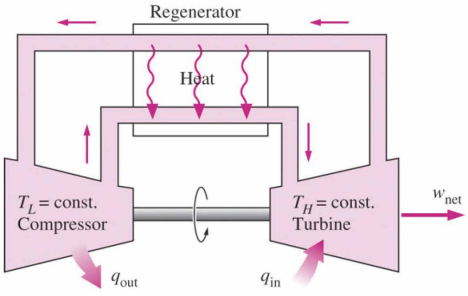
موتور های احتراق خارجی

John Ericsson
(1803–1889)





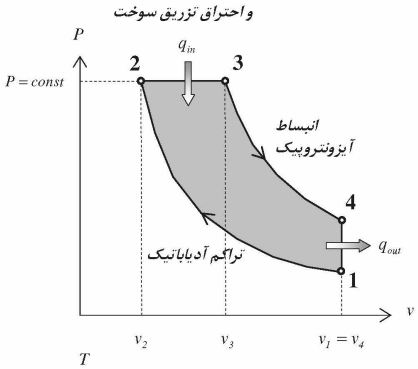


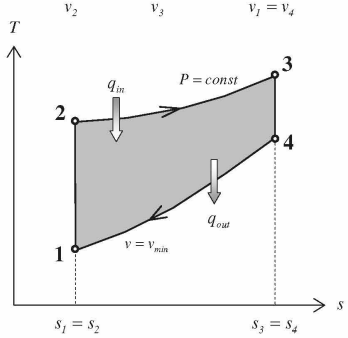


DIESEL سیکل

Rudolf Diesel
(1858 – 1913)

سیکل دیزل در یک سیستم بسته اتفاق می افتد





$3 \rightarrow 2$

$$q_{in} - w_{out} = u_3 - u_2$$

$$q_{in} = w_{out} + u_3 - u_2 \quad = P_2 (v_3 - v_2) + u_3 - u_2$$

$$q_{in} = h_3 - h_2 \quad = c_p (T_3 - T_2)$$

$1 \rightarrow 4$ (انتقال حرارت در حجم ثابت)

$$q_{out} = u_4 - u_1 \quad = c_v (T_4 - T_1)$$

راندمان حرارتی سیکل ایده آل دیزل :

$$\eta_{th} = \frac{w_{net}}{q_{in}} = 1 - \frac{q_{out}}{q_{-n}} = 1 - \frac{c_v (T_4 - T_1)}{c_p (T_3 - T_2)} = 1 - \frac{T_4 - T_1}{k (T_3 - T_2)}$$

$$= 1 - \frac{1}{k} \frac{T_1}{T_2} \frac{\left(\frac{T_4}{T_1} - 1\right)}{\left(\frac{T_3}{T_2} - 1\right)} \quad = 1 - \frac{1}{k} \left(\frac{v_2}{v_1}\right)^{k-1} \frac{\left(\frac{T_4}{T_1} - 1\right)}{\left(\frac{T_3}{T_2} - 1\right)}$$

$$= 1 - \frac{1}{k} \frac{1}{r^{k-1}} \frac{\left(r_c^k - 1\right)}{(r_c - 1)} \quad = 1 - \frac{r^{1-k}}{k} \cdot \frac{\left(r_c^k - 1\right)}{(r_c - 1)}$$

$r = \frac{v_1}{v_2}$ *compression ratio*

$r_c = \frac{v_3}{v_2}$ *cutoff ratio*

راندمان حرارتی سیکل دیزل تحت فرض هوای سرد

$$\eta_{Diesel} = 1 - r^{1-k} \cdot \left[\frac{1}{k} \cdot \frac{\left(r_c^k - 1\right)}{(r_c - 1)}\right]$$

Isentropic processes $1 \rightarrow 2$ and $3 \rightarrow 4$:

$$\frac{T_1}{T_2} = \left(\frac{v_2}{v_1}\right)^{k-1} = \frac{1}{r^{k-1}} \qquad \frac{T_4}{T_3} = \left(\frac{v_3}{v_4}\right)^{k-1} = \left(\frac{v_3}{v_2}\frac{v_2}{v_4}\right)^{k-1} = \left(r_c \frac{1}{r}\right)^{k-1}$$

$$\frac{T_1}{T_2} = \frac{T_4}{T_3} \frac{1}{r_c^{k-1}}$$

$$\frac{T_3}{T_2} r_c^{k-1} = \frac{T_4}{T_1}$$

گاز ایده آل:

$$\frac{P_2 v_2}{T_2} = \frac{P_3 v_3}{T_3} \quad \overset{P_2 = P_3}{\Rightarrow} \quad \frac{v_2}{T_2} = \frac{v_3}{T_3}$$

$$\frac{T_3}{T_2} = \frac{v_3}{v_2} = r_c$$

$$\frac{T_4}{T_1} = \frac{T_3}{T_2} r_c^{k-1} = r_c r_c^{k-1} = r_c^k$$