Meeting_012

Monday, April 26, 2021 10:34 AM

برای گاز کامل

$$s_2 - s_1 = c_{v,\text{avg}} \ln \frac{T_2}{T_1} + R \ln \frac{v_2}{v_1} \qquad (\text{kJ/kg}\cdot\text{K}) \qquad \textbf{(7–33)}$$

$$s_2 - s_1 = c_{p,\text{avg}} \ln \frac{T_2}{T_1} - R \ln \frac{P_2}{P_1} \qquad (\text{kJ/kg}\cdot\text{K}) \qquad \textbf{(7–34)}$$

$$s_2 - s_1 = c_{\text{avg}} \ln \frac{T_2}{T_1} \longrightarrow$$ تک آنتروپی $\longrightarrow s_2 = s_1 \longrightarrow T_1 = T_2 = T$ برای جامدات و مایعات

$$s = f(T)$$

فرآیند تک آنتروپی برای گاز کامل

$$s_2 = s_1 = s \longrightarrow \Delta s = s_2 - s_1 = 0$$

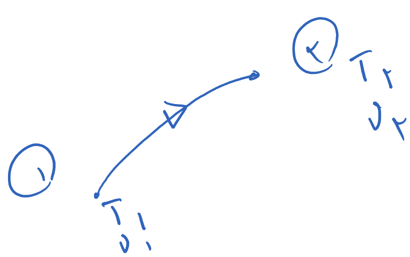
$$c_{v,\text{ave}} \ln \frac{T_2}{T_1} + R \ln \frac{v_2}{v_1} = 0 \Longrightarrow c_{v,\text{ave}} \ln \frac{T_2}{T_1} = -R \ln \frac{v_2}{v_1}$$

$$k = c_p / c_v$$

$$\Longrightarrow \left(\frac{T_2}{T_1}\right)_{s=\text{const.}} = \left(\frac{v_1}{v_2}\right)^{k-1} \qquad \text{(ideal gas)}$$

برگشت‌پذیر آدیاباتیک

تک آنتروپی



$$\left(\frac{T_2}{T_1}\right)_{s=\text{const.}} = \left(\frac{P_2}{P_1}\right)^{(k-1)/k} \qquad \text{(ideal gas)} \qquad \textbf{(7–43)}$$

The *third isentropic relation* is obtained by substituting Eq. 7–43 into Eq. 7–42 and simplifying:

$$\left(\frac{P_2}{P_1}\right)_{s=\text{const.}} = \left(\frac{v_1}{v_2}\right)^{k} \qquad \text{(ideal gas)} \qquad \textbf{(7–44)}$$

رابطه بین T و P برای گاز کامل
در فرآیند آنتروپی ثابت

$$\left(\frac{T_2}{T_1}\right)_{s=\text{const.}} = \left(\frac{P_2}{P_1}\right)^{(k-1)/k} = \left(\frac{v_1}{v_2}\right)^{k-1}$$

VALID FOR
- *ideal gas
- *isentropic process
- *constant specific heats

EXAMPLE 7–10 Isentropic Compression of Air in a Car Engine

Air is compressed in a car engine from 22°C and 95 kPa in a reversible and adiabatic manner. If the compression ratio V_1/V_2 of this engine is 8, determine the final temperature of the air.

آنتروپی ثابت

$T_1 = 22°C + 273 = 295\ K$

$P_1 = 95\ kPa$

$\frac{v_1}{v_2} = \frac{V_1}{V_2} = 8$

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

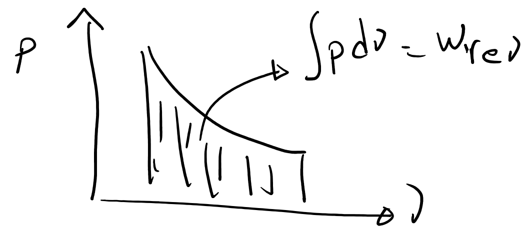
$$\frac{T_2}{295} = (8)^{1.4-1} \Longrightarrow T_2 = 295(8)^{0.4} = 677\ K$$

محاسبه کار برگشت پذیر

$$w_{rev} = \int P\,dv$$

$P \uparrow \longrightarrow \int P\,dv = w_{rev}$

$w_{rev} = \int p\,dv$



$$\boxed{q - w = dh + \Delta pe + \Delta ke}$$ قانون اول ترمودینامیک برای

سیستم باز

$$\begin{cases} \delta q = T\,ds \\ \delta q_{rev} = T\,ds \quad \text{(Eq. 7–16)} \\ T\,ds = dh - v\,dP \quad \text{(Eq. 7–24)} \end{cases}$$

$$\delta q_{rev} = dh - v\,dP$$

$dpe \quad dke$

$$\delta q - \delta w = dh + \Delta pe + \Delta ke$$

$$dh - v\,dp - \delta w = dh + \Delta pe + \Delta ke$$

$$\Rightarrow -\delta w_{rev} = v\,dp + \Delta pe + \Delta ke$$

$$\Rightarrow \boxed{\delta w_{rev} = -\left[v\,dp + \Delta pe + \Delta ke\right]}$$

$$\left.\begin{array}{l} \Delta ke = 0 \\ \Delta pe = 0 \end{array}\right\} \longrightarrow \delta w_{rev} = -v\,dp$$

$$w_{rev} = -\int v\,dp$$

rev J

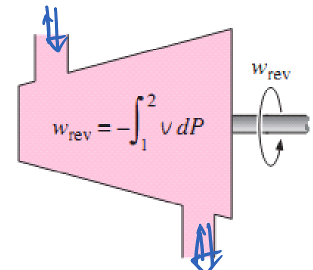
$$W_{مرزی} = \int p\, dv$$ → برای سیستم های بسته

$$W_{rev} = -\int v\, dp$$ → کار برگشت پذیر برای سیستم های باز

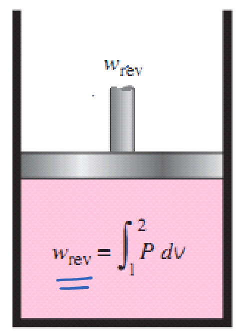
سیستم توربین

i kinetic and potential energies are ne

$$w_{rev} = -\int_1^2 v\, dP \qquad \text{(kJ/kg)}$$



(*a*) Steady-flow system



(*b*) Closed system

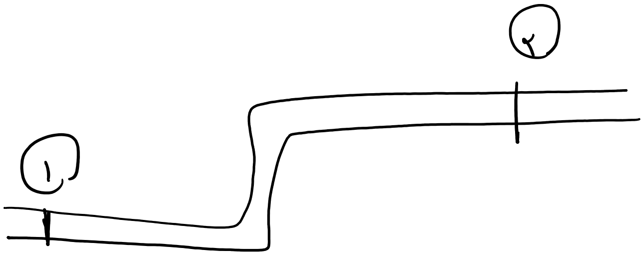
$$* \; W_{rev} = -\left[\int v\,dp + \Delta ke + \Delta pe\right]$$

اگر سیال تراکم ناپذیر باشد ($v =$ ثابت) (مایعات)

$$W_{rev} = -\left[v\int_1^2 dp + \Delta pe + \Delta ke\right]$$

$$W_{rev} = -\left[v(P_2 - P_1) + \Delta pe + \Delta ke\right]$$

اگر سیال تراکم ناپذیر باشد W_{rev}



مکانیک سیالات

$$\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + z_2$$

kJ/kg

$$0 = +v(P_2 - P_1) + g(z_2 - z_1) + \frac{1}{2}(V_2^2 - V_1^2)$$

$\frac{1}{\rho}$

$$\Rightarrow vP_2 + g z_2 + \frac{1}{2} V_2^2 = vP_1 + g z_1 + \frac{1}{2} V_1^2 \quad (kJ/kg)$$

$$\frac{P_2}{\rho g}_{\gamma} + z_2 + \frac{1}{2g} V_1^2 = \frac{P_1}{\rho g}_{\gamma} + z_2 + \frac{1}{2g} V_2^2$$

معادله برنولی برای سیالات تراکم ناپذیر است و پایا.

$\Delta Pe = 0$

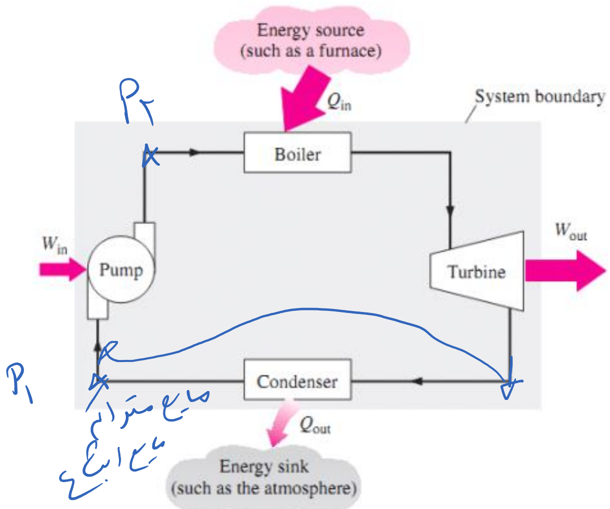
$\Delta Ke = 0$

$$W_{rev} = -\int v \, dp = -v(P_2 - P_1)$$

(برای سیال تراکم ناپذیر)

v ①

dp ②



EXAMPLE 7–12 Compressing a Substance in the Liquid versus Gas Phases

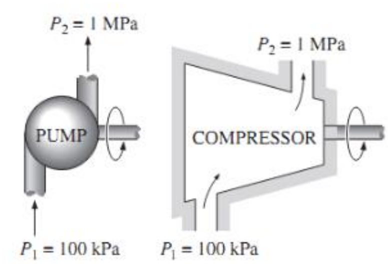
Determine the compressor work input required to compress steam isentropically from 100 kPa to 1 MPa, assuming that the steam exists as (*a*) saturated liquid and (*b*) saturated vapor at the inlet state.

$P_1 = 100\ kPa \longrightarrow P_2 = 1\ MPa$

برای حالت مایع

$$w_{rev} = -\int v\,dp = -v\int_1^2 dp = -v(P_2 - P_1)$$

$$w_{rev} = -0.001\,(1000 - 100) = -0.001\,(900) = -0.9\ kJ/kg$$



(*a*) Compressing a liquid (*b*) Compressing a vapor

P		v_f	v_g
100	99.61	0.001043	1.6941
1000	179.88	0.001127	0.19436

$v_1 = v_{f@\,100\,kPa} = 0.001043\ m^3/kg$ (Table A–5)

بخار ـ از فشار 100kPa تا فشار 1000kPa بصورت فرآیند ایزنتروپی متراکم کنیم.

$q - w = h_2 - h_1$

$$w_{rev,in} = (3194.5 - 2675.0)\ \text{kJ/kg} = \mathbf{519.5\ kJ/kg}$$

							h_f		h_g	s_f		s_g
100	99.61	0.001043	1.6941	417.40	2088.2	2505.6	417.51	2257.5	2675.0	1.3028	6.0562	7.3589

State 1: بخار اشباع
$P_1 = 100$ kPa (sat. vapor) } $h_1 = 2675.0$ kJ/kg, $s_1 = 7.3589$ kJ/kg · K (Table A–5)

State 2:
$P_2 = 1$ MPa, $s_2 = s_1$ } $h_2 = 3194.5$ kJ/kg (Table A–6)

Thus,