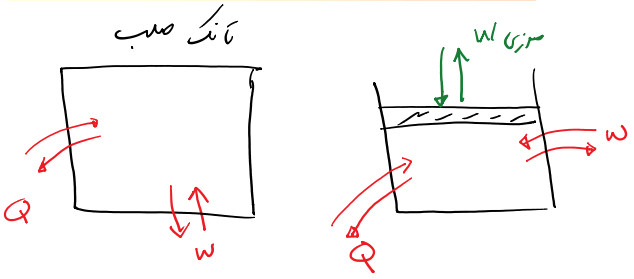
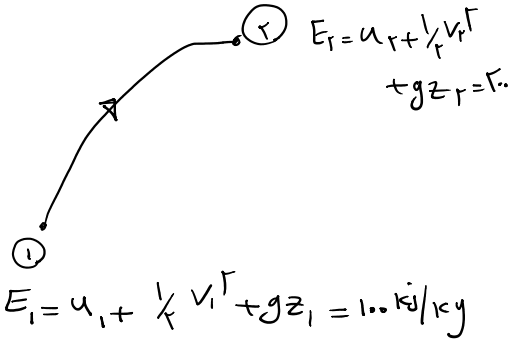
Meeting_012

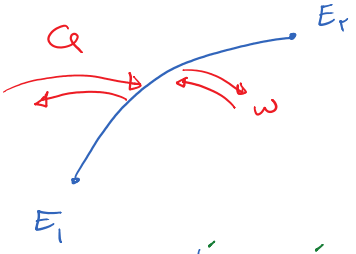
Monday, April 19, 2021 8:01 AM

Chapter 4

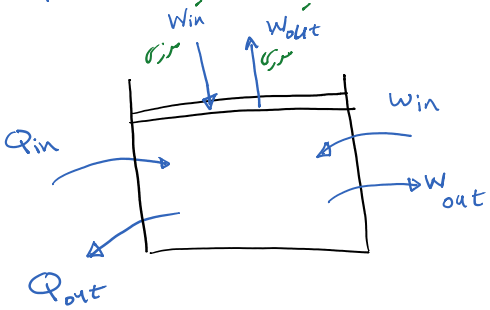
ENERGY ANALYSIS OF CLOSED SYSTEMS



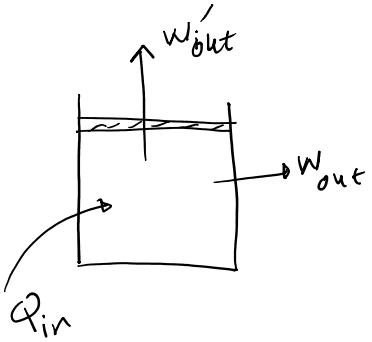




$$\Delta E = E_2 - E_1$$



$$\left[Q_{in} + W_{in} + W'_{in\ مرزی}\right] - \left[Q_{out} + W_{out} + W'_{out}\right] = E_2 - E_1$$



قرارداد: گرمای ورودی به سیستم مثبت در نظر گرفته می‌شود

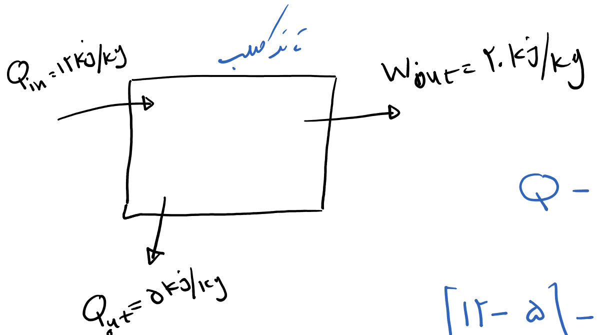
" خروجی از " منفی " "

کار: کار خروجی مثبت و کار ورودی منفی در نظر گرفته می‌شود

$$Q - \left[W + W_{مرزی}\right] = E_2 - E_1$$

$$Q - \left[W + W_{مرزی}\right] = (u_2 - u_1) + \frac{1}{2000}\left(V_2^2 - V_1^2\right) + \frac{g}{1000}(z_2 - z_1)$$

kJ/kg



تغییرات انرژی این سیستم را محاسبه کنید

$$Q - [W + W_{\text{مرزی}}] = E_2 - E_1$$

$$[12 - 5] - [+20 + 0] = E_2 - E_1$$

$$7 - 20 = E_2 - E_1 \rightarrow E_2 - E_1 = -13\ kJ/kg$$

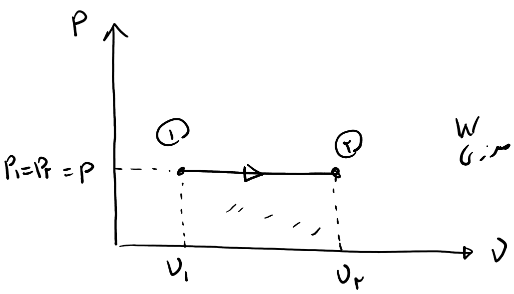
$\Delta Pe = 0$
$\Delta Ke = 0$

روابط مربوط به موازنه انرژی برای سیستم های بسته

$$\Delta V = 0 \rightarrow W_{\text{مرزی}} = 0 \rightarrow Q - W = u_2 - u_1$$

$$\Delta V \neq 0 \rightarrow W_{\text{مرزی}} \neq 0 \rightarrow Q - [W + W_{\text{مرزی}}] = u_2 - u_1$$

$$\Rightarrow Q - w = h_2 - h_1$$



$$W_{\text{مرزی}} = P(v_2 - v_1) = P_2 v_2 - P_1 v_1$$

$$h = u + Pv$$ تعریف آنتالپی

$$\Rightarrow h_2 - h_1 = (u_2 + P_2 v_2) - (u_1 + P_1 v_1) = \underbrace{(u_2 - u_1)}_{\Delta u} + \underbrace{(P_2 v_2 - P_1 v_1)}_{\text{کار مرزی}}$$

EXAMPLE 4–5 Electric Heating of a Gas at Constant Pressure

A piston–cylinder device contains 25 g of saturated water vapor that is maintained at a constant pressure of 300 kPa. A resistance heater within the cylinder is turned on and passes a current of 0.2 A for 5 min from a 120-V source. At the same time, a heat loss of 3.7 kJ occurs. (*a*) Show that for a closed system the boundary work W_b and the change in internal energy ΔU in the first-law relation can be combined into one term, ΔH, for a constant-pressure process. (*b*) Determine the final temperature of the steam.

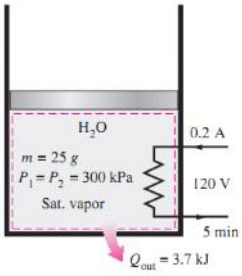
$m = 25\,g$

بخار اشباع ← فازش

فشار ثابت $P = 300\,kPa$

مشخصات برقی $\begin{cases} I = 0.2\,A \\ \Delta t = 5\,min \\ V = 120\,V \end{cases}$

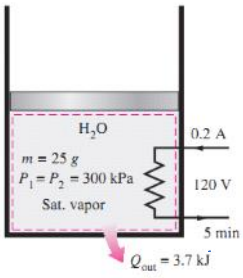
مقدار گرمای تلف شده $Q_{out} = 3.7\,kJ$



① $\begin{cases} P_1 = 300\,kPa \\ \text{فازش: بخار اشباع} \end{cases} \Rightarrow \begin{cases} v_1 = v_g = 0.606 \\ u_1 = u_g = 2543 \\ h_1 = h_g = 2725.9 \\ s_1 = 6.9919 \\ T_1 = T_{sat} = 133.52 \end{cases}$

561.43 2163.5 2724.9

② $\begin{cases} P_1 = P_2 = 300\,kPa = 0.3\,MPa \longrightarrow h_f = 561.43 \quad h_g = 2725 \\ h_2 = 2854 \longrightarrow h_2 > h_g \longrightarrow \text{بخار فوق گرم} \longrightarrow \begin{cases} v_2 = \\ u_2 = \\ T_2 = \\ s_2 = \end{cases} \end{cases}$



یک سیستم بسته ، $W_b \neq 0$ ، $\Delta ke = 0$ ، $\Delta p = 0$

kJ/kg kJ/kg kJ/kg

$q - w = h_2 - h_1$

$Q - W = m(h_2 - h_1)$ ✓ ✓

$(-3.7) - [0 - 1.2] = \frac{25}{1000}(h_2 - 2725)$

$Q_{in} = 0$

$Q_{out} = 3.7\,kJ$

$W_{out} = 0$

$-3.7 + 1.2 = \frac{25}{1000}(h_2 - 2725)$

$W_{in} = \dot{W} \cdot \Delta t = \frac{VI}{1000} \cdot \Delta t = \frac{120 \times 0.2 \times [5 \times 60]}{1000} = 1.2\,kJ$

$3.5 = \frac{25}{1000}(h_2 - 2725) \Rightarrow \frac{3.5 \times 1000}{25} = h_2 - 2725$

$$Q_{12} = \frac{25}{1000}(h_2 - 2733) \Rightarrow \frac{-3125 \times 1000}{25} = h_2 - 2733$$

$$-140 = h_2 - 2733$$

$$\Rightarrow h_2 = -140 + 2733 = 2593 \ kJ/kg$$

$$h_2 = 2593 \simeq 2589.9$$

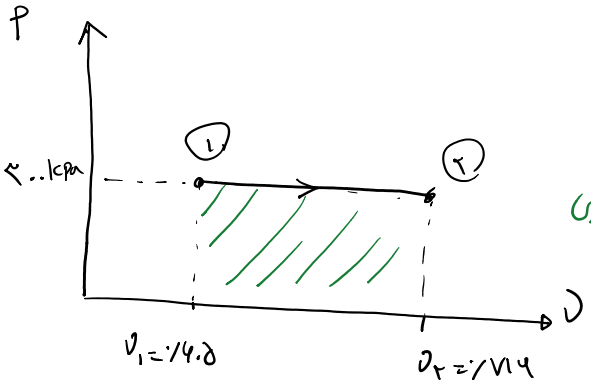
T	P = 0.20 MPa (120.21°C)				P = 0.30 MPa (133.52°C)			
	v	u	h	s	v	u	h	s
Sat.	0.88578	2529.1	2706.3	7.1270	0.60582	2543.2	2724.9	6.9917
150	0.95986	2577.1	2769.1	7.2810	0.63402	2571.0	2761.2	7.0792
200	1.08049	2654.6	2870.7	7.5081	0.71643	2651.0	2865.9	7.3132
250	1.19890	2731.4	2971.2	7.7100	0.79645	2728.9	2967.9	7.5180
300	1.31623	2808.8	3072.1	7.8941	0.87535	2807.0	3069.6	7.7037
400	1.54934	2967.2	3277.0	8.2236	1.03155	2966.0	3275.5	8.0347
500	1.78142	3131.4	3487.7	8.5153	1.18672	3130.6	3486.6	8.3271
600	2.01302	3302.2	3704.8	8.7793	1.34139	3301.6	3704.0	8.5915
700	2.24434	3479.9	3928.8	9.0221	1.49580	3479.5	3928.2	8.8345
800	2.47550	3664.7	4159.8	9.2479	1.65004	3664.3	4159.3	9.0605
900	2.70656	3856.3	4397.7	9.4598	1.80417	3856.0	4397.3	9.2725
1000	2.93755	4054.8	4642.3	9.6599	1.95824	4054.5	4642.0	9.4726
1100	3.16848	4259.6	4893.3	9.8497	2.11226	4259.4	4893.1	9.6624
1200	3.39938	4470.5	5150.4	10.0304	2.26624	4470.3	5150.2	9.8431
1300	3.63026	4687.1	5413.1	10.2029	2.42019	4686.9	5413.0	10.0157

$v_2 = 0.714$

$u_2 = 2981$

$s_2 = v_1 3132$

$T_2 = 200\ ^\circ C$

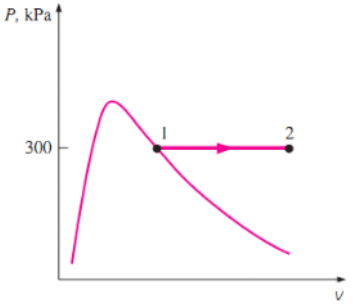


کار مرزی را حساب کنید

$$W_{\text{مرزی}} = P \cdot \Delta V$$

$$= 200\,(v_2 - v_1)$$

$$= 200\,(0.714 - 0.405)\ kJ/kg$$



$$W_{\text{مرزی}} = mP\Delta V$$

$$= \frac{25}{1000}(200)(v_2 - v_1)\ kJ$$

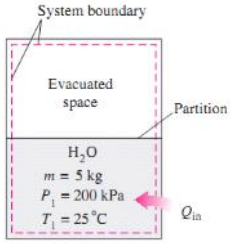
EXAMPLE 4–6 Unrestrained Expansion of Water

A rigid tank is divided into two equal parts by a partition. Initially, one side of the tank contains 5 kg of water at 200 kPa and 25°C, and the other side is evacuated. The partition is then removed, and the water expands into the entire tank. The water is allowed to exchange heat with its surroundings until the temperature in the tank returns to the initial value of 25°C. Determine (*a*) the vol-

یک تانک صلب از وسط با دو قسمت تقسیم شده است. در یک طرف آن آب به حجم 5 kg در فشار 200 kPa و دمای

the tank contains 5 kg of water at 200 kPa and 25°C, and the other side is evacuated. The partition is then removed, and the water expands into the entire tank. The water is allowed to exchange heat with its surroundings until the temperature in the tank returns to the initial value of 25°C. Determine (*a*) the volume of the tank, (*b*) the final pressure, and (*c*) the heat transfer for this process.

سیستم بسته است. در یک طرف آن آب با جرم ۵ kg در فشار ۲۰۰ kPa و دمای ۲۵°C وجود دارد. و سمت دیگر خلا داریم. آگر صفحه جدا کننده را برداریم آب کل فضای مخزن را پر میکند.
سیال و محیط بیرون متبادل گرما دارد تا دمای آن به ۲۵°C برسد. الف) حجم تانک ب) فشارهای ج) میزان انتقال گرما



① $P_1 = ۲۰۰$ kpa $\longrightarrow T_{sat} = ۱۲۰°C$

$T_1 = ۲۵°C$ $\quad T_1 < T_{sat} \longrightarrow$ حالا مشخص

$m = 5kg$

$\longrightarrow T_1 = 25 \longrightarrow$ $v_1 = v_f = ۰/۰۰۱ \longrightarrow V_1 = m v_1 = ۵ \times ۰/۰۰۱ = ۰/۰۰۵ m^3$

$u_1 = u_f = 104.83$

$h_1 = h_f = 104.83$

$s_1 = s_f = ۰/۳۶۷۲$

25	3.1698	0.001003	43.340	104.83	2304.3	2409.1	104.83	2441.7	2546.5	0.3672	8.1895	8.5567

② $V_2 = V_1 = ۲ \times ۰/۰۰۵ = ۰/۰۱ \ m^3$ $\quad v_2 = \frac{V_2}{m} = \frac{۰/۰۱}{۵} = ۰/۰۰۲$

$m = 5kg$

$T_2 = ۲۵ \ ^\circ C \longrightarrow$