

// TERMODINAMİK I //

Sys 73

2. Soru

ilk hal

$$T_1 = 400^\circ\text{C}$$

$$P_1 = 400 \text{ kPa}$$

$$m_1 = 0,04 \text{ kg}$$

$$v_1 = v_2 \times 2$$

Ara hal

$$T_2 = ?$$

$$P_2 = P_1 = 400 \text{ kPa}$$

$$m_2 = 0,04 \text{ kg}$$

$$v_2 = \frac{v_1}{2}$$

Son hal

$$P_3 = 140 \text{ kPa}$$

$$T_3 = ?$$

$$m = 0,04 \text{ kg}$$

$$v_2 = v_3 \Rightarrow 0,00565 \text{ m}^3$$

$$P_1 v_1 = m R T_1$$

$$① \Rightarrow 400 \cdot v_1 = 0,04 \times 0,287 \times 673,15 \Rightarrow v_1 = 0,0193 \text{ m}^3 \Rightarrow 0,00565 = v_2 //$$

$$② \Rightarrow 400 \times 0,00565 = 0,04 \times 0,287 \times T_2 \Rightarrow T_2 = 336,236 \text{ K} //$$

$$③ \Rightarrow 140 \times 0,00565 = 0,04 \times 0,287 \times T_3 \Rightarrow T_3 = 117,682 \text{ K} //$$

Sys 72

Soru

1. hal

$$P_1 = 100 \text{ kPa}$$

$$T_1 = 25^\circ\text{C}$$

$$m_1 = 2 \text{ kg su}$$

2. hal

$$P_1 = P_2 = 100 \text{ kPa}$$

$$T_2 = 25^\circ\text{C} = 99,632^\circ\text{C}$$

$$m_2 = 2 \text{ kg}$$

3. hal

$$P_3 = ? \rightarrow 8592,7 \text{ kPa Table}$$

$$T_3 = 300^\circ\text{C}$$

$$m_3 = 2 \text{ kg}$$

$$V = 0,4 \text{ m}^3 \Rightarrow V = m \times v \Rightarrow 0,4 = 2 \times v \Rightarrow v = 0,2$$

İBB

$$x_2 = 0,117 //$$

$$② \Rightarrow T_d = 99,632^\circ\text{C} \Rightarrow 0,2 = 1,0434 \times 10^{-3} + x \cdot \frac{(1,694 - 1,0434 \times 10^{-3})}{1,692}$$

$$x = 0,117 //$$

Sys 41
Scn 17

1. hcl

$$T_1 = 300^\circ\text{C}$$

$$P_1 = 100 \text{ kPa}$$

$$M_1 = 0,5 \text{ kg}$$

$$V_1 = ? \quad 0,822 \text{ m}^3$$

Scn hcl

$$T_2 = ? \Rightarrow 286,411 \text{ K} = \underline{\underline{13,25^\circ\text{C}}}$$

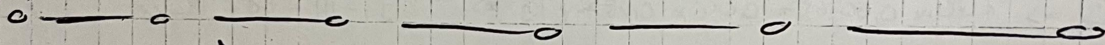
$$V_1 = 2 \times V_2$$

$$P_2 = 100 \text{ kPa}$$

$$M_2 = 0,5 \text{ kg}$$

$$P_1 V_1 = M_1 R_1 T_1 \Rightarrow 100 \times V_1 = 0,5 \times 0,287 \times 573,15 \Rightarrow \underline{\underline{V_1 = 0,822 \text{ m}^3 \text{ kg}}}$$

$$100 \times 0,411 = 0,5 \times 0,287 \times T_2 \Rightarrow \underline{\underline{T_2 = 286,411 \text{ K}}}$$



Sys 58
Scn 28

3. hcl

1. hcl

$$T_1 = 600^\circ\text{C}$$

$$P_1 = 200 \text{ kPa}$$

$$M_1 = 0,05 \text{ kg}$$

$$V_1 = ?$$

2. hcl

$$V_1 = 2 \times V_2$$

$$P_1 = P_2 = 200 \text{ kPa}$$

$$T_2 = ? \quad 432,055 \text{ K}$$

3. hcl

$$P_3 = 150 \text{ kPa}$$

$$T_3 = ?$$

$$V_2 = V_3 \Rightarrow 0,031 \text{ m}^3$$

$$P_1 V_1 = M_1 R_1 T_1 \Rightarrow 200 \times V_1 = 0,05 \times 0,287 \times 873,15 \Rightarrow \underline{\underline{V_1 = 0,062 \text{ m}^3 \text{ kg}}}$$

$$V_2 = 0,031 \text{ m}^3 \text{ kg} = V_1 / 2$$

$$P_2 V_2 = M_2 R_2 T_2 \Rightarrow 200 \times 0,031 = 0,05 \times 0,287 \times T_2 \Rightarrow \underline{\underline{T_2 = 432,055 \text{ K}}}$$

$$P_3 V_3 = M_3 R_3 T_3 \Rightarrow 150 \times 0,031 = 0,05 \times 0,287 \times T_3 \Rightarrow \underline{\underline{T_3 = 324,041 \text{ K}}}$$

$$W_{12} = P_1 (V_2 - V_1) = 200 (0,031 - 0,062) \Rightarrow \underline{\underline{-94,32 \text{ kJ}}}$$

$$W_{23} = 0 \text{ 'olur' } \text{sonlu hclm "scbit"} \quad W_t = -94,32 \text{ kJ}$$

Suf 81
Öm 3.2

İlk hal

$$P_1 = 100 \text{ kPa}$$

$$T_1 = 25^\circ\text{C}$$

$$V_1 = 0,05 \text{ m}^3 \text{ hava}$$

Son hal

$$P_1 = P_2 = 100 \text{ kPa}$$

$$T_2 = ?$$

$$V_2 = 0,01 \text{ m}^3$$

$$\Rightarrow 100 \times 0,05 = m_1 \times 0,287 \times 298,15 \Rightarrow m_1 = 0,058 \text{ kg}$$

$$\Rightarrow 100 \times 0,11 = 0,058 \times 0,287 \times T_2 \Rightarrow T_2 = 556,3 \text{ K}$$

$$\Rightarrow W_{12} = P_1 (V_2 - V_1) \Rightarrow 100 \times (0,1 - 0,05) \Rightarrow \underline{\underline{5 \text{ kJ}}} = W_{12}$$

Suf 82
Öm 3.3

İlk hal

$$P_1 = 100 \text{ kPa}$$

$$T_1 = 25^\circ\text{C}$$

$$V_1 = 0,05 \text{ m}^3$$

Son hal

$$P_2 = 25 \text{ kPa}$$

$$T_2 = T_1 = 25^\circ\text{C}$$

$$V_2 = ?$$

$$W_{12} = ?$$

$$\textcircled{1} \Rightarrow 100 \times 0,05 = m_1 \times 0,287 \times 298,15 \Rightarrow m_1 = 0,058 \text{ kg}$$

$$\textcircled{2} \Rightarrow 25 \times V_2 = 0,058 \times 0,287 \times 298,15 \Rightarrow V_2 = 0,066 \text{ m}^3$$

$$\textcircled{3} \Rightarrow W_{12} = P_1 \cdot V_1 \ln \frac{V_2}{V_1} \Rightarrow 100 \times 0,05 \times \ln \frac{0,066}{0,05} \Rightarrow \underline{\underline{1,388 \text{ kJ}}}$$

Öm 3.4
Suf 84

İlk hal

$$P_1 = 160 \text{ kPa}$$

$$T_1 = 30^\circ\text{C}$$

$$V_1 = 0,5 \text{ m}^3$$

$$m = 0,919 \text{ kg}$$

$$n = 1,5$$

Son hal

$$P_2 = 600 \text{ kPa}$$

$$P_1 V_1^n = P_2 V_2^n$$

$$\Rightarrow \frac{160 \times 0,5^{1,5}}{56,568} = 600 \times V_2^{1,5}$$

$$\Rightarrow V_2^{1,5} = 0,09428 \Rightarrow V_2 = 0,2071 \text{ m}^3$$

$$100 \times 0,2071 = 0,919 \times 0,287 \times T_2$$

$$\Rightarrow \frac{600 \times 0,2071 - 160 \times 0,5}{1 - 1,5} = -88,52 \text{ kJ} \quad T_2 = 471,12 \text{ K}$$

8.8.88
0m: 3,5

11 k hal

2 hal

$$P_1 = 100 \text{ kPa}$$

$$T_2 = 100^\circ\text{C}$$

$$T_1 = 0^\circ\text{C}$$

$$P_2 = ?$$

$$U_1 = 1,5 \text{ m/s}$$

$$U_2 = ?$$

$$\textcircled{1} \Rightarrow 1 \text{ m}^3 + 0,5 \text{ m}^3 \Rightarrow \underline{1,5 \text{ m}^3} = \text{haem}$$

$$m = \frac{P_1 \cdot U_1}{R \cdot T_1} \Rightarrow m = \frac{100 \times 1,5}{0,287 \times 273,15} = \underline{1,91 \text{ kg}}$$

$$\textcircled{2} \Rightarrow P_2 \cdot U_2 = m \cdot R \cdot T_2 \Rightarrow P_2 \cdot U_2 = 1,91 \times 0,287 \times 373,15 \Rightarrow \underline{P_2 \cdot U_2 = 204,54}$$

$$U_2 = \frac{204,54}{P_2} \quad \xrightarrow{\text{hurdelen}} \Rightarrow \frac{P_1}{P_2} = \frac{U_1}{U_2} \Rightarrow \frac{100}{P_2} = \frac{1,5}{\frac{204,54}{P_2}}$$

$$\Rightarrow P_2^2 = \frac{100 \times 204,54}{1,5} = \underline{136,36 \text{ kPa}}$$

$$\parallel U_2 = 1,751 \text{ m/s} \parallel$$

$$U_{12} = \frac{(P_1 + P_2)}{2} \cdot (U_2 - U_1)$$

$$\Rightarrow W_{12} = \frac{(100 + 136,36)}{2} \cdot (1,751 - 1,5) = \underline{27,20 \text{ kJ}}$$

$$W_{\text{ave}} = P_{\text{atm}}(U_2 - U_1) \Rightarrow 101,325 \cdot (1,751 - 1,5) \Rightarrow W_{\text{ave}} = \underline{25,43 \text{ kJ}}$$

$$W_{\text{uden}} = W_{12} - W_{\text{ave}} = 27,20 - 25,43 = \underline{1,77 \text{ kJ}}$$

0m: 3,6

0,3,6

ilk hal

$$T_1 = 30^\circ\text{C}$$

$$V_1 = 0,1 \text{ m}^3$$

Son hal

$$V_2 = 0,4 \text{ m}^3$$

mp. g

AP

$$\Rightarrow P_1 = P_{\text{atm}} + P_p + P_g \Rightarrow P_1 = 100 + \frac{9,8 \times 100 \times 10^{-3}}{0,1} = \underline{\underline{109,8 \text{ kPa}}}$$

$$m = \frac{P_1 \cdot V_1}{R \cdot T_1} = \frac{109,8 \times 0,1}{0,287 \times 303,15} = \underline{\underline{0,126 \text{ kg}}}$$

Son halın

$$P_2 = P_{\text{atm}} + P_p + P_{g2} \Rightarrow P_2 = P_1 + \frac{\rho \cdot (V_2 - V_1)}{A^2 p} = 109,8 + \frac{(800) \cdot (0,4 - 0,1)}{(0,1)^2} \times 10^{-3}$$

$$P_2 \cdot V_2 = m \cdot R \cdot T_2 \Rightarrow 133,8 \times 0,4 = 0,126 \times 0,287 \times T_2 \Rightarrow \underline{\underline{133,8 \text{ kPa}}}$$

$$\underline{\underline{T_2 = 1480 \text{ K}}}$$

İş

$$W_{12} = \frac{P_1 + P_2}{2} \cdot (V_2 - V_1) = \frac{109,8 + 133,8}{2} \cdot (0,4 - 0,1) = \underline{\underline{36,54 \text{ kJ}}}$$

Havanın atm ile piston

$$W_{12, \text{atm}} = W_{\text{atm}, p12} = P_1 \cdot (V_2 - V_1) = 109,8 \cdot (0,4 - 0,1) = \underline{\underline{32,94 \text{ kJ}}}$$

$$W_{y12} = \frac{P_2 - P_1}{2} \cdot (V_2 - V_1) = \frac{133,8 - 109,8}{2} \cdot (0,4 - 0,1) = \underline{\underline{3,6 \text{ kJ}}}$$

$$W_{12} = W_{\text{atm}, p12} + W_{y12} = 32,94 + 3,6 = \underline{\underline{36,54 \text{ kJ}}}$$

Örnek 3.9

İlk hal
 $T_{A1} = 25^\circ\text{C}$

Akt (moleg)

$$P_{A1} = P_{B1} = P_1 \Rightarrow 198,54 \text{ kPa}$$

$$V_{A1} = 0,1 \text{ m}^3$$

(Soğukluk)

$$T_{B1} = 120^\circ\text{C}$$

$$x_{B1} = 0,2$$

$$V_{B1} = 0,1 \text{ m}^3$$

T=56+

Son hal

$$T_{A2} = T_{A1} = 25^\circ\text{C}$$

$$P_{A2} = P_{B2} = P_2$$

$$V_{A2} = 0,05 \text{ m}^3$$

$$V_{B2} = 0,15 \text{ m}^3$$

$$P_{B2} = 400 \text{ kPa}$$

$$\Rightarrow T_{B1} = 120^\circ\text{C} \Rightarrow P_1 = 198,54 \text{ kPa} = P_{B1}$$

$$\Rightarrow P_{A1} = P_{B1} = 198,54 \text{ kPa}$$

$$v_s = 0,0010606 \text{ m}^3/\text{kg}$$

$$v_b = 0,8915 \text{ m}^3/\text{kg}$$

$$V_{B1} = v_s + x \cdot (v_b - v_s) = 0,12915 \text{ m}^3/\text{kg}$$

$$\frac{V_{B1}}{v_{B1}} = m_b = \underline{\underline{0,558 \text{ kg}}}$$

A bölümü: $\Rightarrow T_{\text{soğukluk}} \text{ hal d.}$

$$\boxed{T_{\text{soğukluk}} \Rightarrow P_1 \cdot V_1 = P_2 \cdot V_2}$$

$$\Rightarrow P_{A1} \cdot V_{A1} = P_{A2} \cdot V_{A2} \Rightarrow 198,54 \times 0,1 = P_{A2} \times 0,05 \Rightarrow P_{A2} = \underline{\underline{2,00 \text{ kPa}}}$$

İs alması

$$\boxed{W_{A12} = P_{A1} \cdot V_{A1} \cdot \ln \frac{V_{A2}}{V_{A1}}} = 198,54 \times 0,1 \times \ln \frac{0,05}{0,1} = \underline{\underline{-13,96 \text{ kJ}}}$$

B bölümü: (kütlenin b. b.)

$$x = 0,2 \Rightarrow \text{İstatik b. b.}$$

$$\text{Son halde denge kütlesi} \Rightarrow P_{A2} = P_{B2} = \underline{\underline{400 \text{ kPa}}}$$

$$\boxed{v_{B2} = \frac{V_{B2}}{m_b}} = 0,2687 \text{ m}^3/\text{kg}$$

$$P_{B2} = 400 \text{ kPa}$$

$$v_{B2} = 0,2687 \text{ m}^3/\text{kg}$$

$$v_b = 0,8922$$

$$v_s = 1,0528 \times 10^{-3}$$

İstatik b. b. bölümü

$$\boxed{x_{B2} = \frac{v_{B2} - v_s}{v_b - v_s}} = \frac{0,2687 - 1,0528 \times 10^{-3}}{0,8922 - 1,0528 \times 10^{-3}} = x_{B2}$$

$$\boxed{x_{B2} = 0,58}$$

Ornek 3.8

Freon-12

Ses model

ilk hal

$$T_1 = 40^\circ\text{C}$$

$$x_1 = 0,0 \text{ (doğrus sıvı halinde)}$$

$$V_1 = \text{bilinmiyor}$$

Son hal

$$x_2 = 0,8$$

$$P_2 = P_k = \underline{\underline{150 \text{ kPa}}}$$

Çöz

1-2 dengeli hal değişimi:

$$V_1 = A_p \times h = 20 \times 10^{-4} \times 5 \times 10^{-2} = 0,0001 \text{ m}^3$$

$$T_1 = 40^\circ\text{C}$$

$$x_1 = 0,0$$

$$v_s = 0,799 \times 10^{-3} \text{ m}^3/\text{kg} = v_1$$

Freon 12

$$m = \frac{V_1}{v_1} = \frac{0,0001}{0,799 \times 10^{-3}} = 0,12512 \text{ kg}$$

Son halde sistemin dengeli halinde:

$$P_2 = P_k \Rightarrow P_{\text{atm}} + \frac{m \cdot g}{A_p} = 100 + \frac{0,12512 \times 9,81}{20 \times 10^{-4}} \times 10^{-3} = 150 \text{ kPa} = P_k$$

$$P_2 = 150 \text{ kPa}$$

$$x_2 = 0,8$$

İBB

$$v_g = 0,685 \times 10^{-3} \text{ m}^3/\text{kg}$$

$$v_b = 0,11004 \text{ m}^3/\text{kg}$$

$$v_2 = v_s + x_2 (v_b - v_s) = 0,08816 \text{ m}^3/\text{kg}$$

$$V_2 = m \cdot v_2 = 0,12512 \times 0,08816 = 0,011034 \text{ m}^3$$

İS

$$W_{1,2} = P_k (V_2 - V_1) \Rightarrow 150 \times (0,011034 - 0,0001) = \underline{\underline{1,6402 \text{ kJ}}}$$

3.6 Balonla ilgili Sorular

Örnek 1 Doğrusal süreç $x = 0,0$
 $P_1 = 100 \text{ kPa}$ $\xrightarrow{P}$

$$m_1 = 0,5 \text{ kg}$$

$$T_1 = 100^\circ\text{C}$$

$$V_1$$

$$u_1 = u_s$$

$$\text{Tablodan} \Rightarrow u_1 = 1,0434 \times 10^{-3}$$

İş alıs veriş: önce önce hacim sabit.

$$\frac{u-s}{T} = 1,40$$

$$u = ?$$

$$w_{12} = ?$$

Örnek 2 1. hal

$$T_1 = 160^\circ\text{C}$$

$$m = 2 \text{ kg}$$

$$x_1 = 1,0$$

$$u_b = u$$

2. hal

$$T_2 = 20^\circ\text{C}$$

İş alıs veriş: önce önce hacim değişir

$$u_b = 0,5085 \text{ m}^3/\text{kg}$$

Örnek 3

İlk hal

$$P_1 = 600 \text{ kPa}$$

$$T_1 = 300^\circ\text{C}$$

$$m_1 = 0,2 \text{ kg}$$

$$V_1 = ?$$

İkinci hal

$$V_1 = \frac{V_2}{3}$$

$$P_2 = 600 \text{ kPa}$$

$$T_2 = ?$$

$$m_2 = 0,2 \text{ kg}$$

3. hal

$$V_2 = V_3 \Rightarrow 0,1644 \text{ m}^3$$

$$P_3 = \frac{P_1}{2} = 300 \text{ kPa}$$

$$T_3 = ?$$

$$m_3 = 0,2 \text{ kg}$$

$$\textcircled{1} \Rightarrow 600 \times V_1 = 0,2 \times 0,287 \times 573,15 \Rightarrow V_1 = 0,0548 \text{ m}^3 //$$

$$\textcircled{2} \Rightarrow V_2 = V_1 \times 3 \Rightarrow V_2 = 0,1644 \text{ m}^3 // V_2 = V_3 //$$

$$\textcircled{2} \Rightarrow 600 \times 0,1644 = 0,2 \times 0,287 \times T_2 \Rightarrow T_2 = 1718,466 \text{ K} //$$

$$\textcircled{3} \Rightarrow 300 \times 0,1644 = 0,2 \times 0,287 \times T_3 \Rightarrow T_3 = 859,233 \text{ K} //$$

$$w_{12} = P_1 (V_2 - V_1) = 600 (0,1644 - 0,0548) \Rightarrow w_{12} = 65,76 \text{ kJ} //$$

$$w_{23} = P_2 (V_3 - V_2) = \text{Hacim sabit} \Rightarrow w_{23} = 0 //$$

$$w_{\text{net}} = w_{12} + w_{23} = 65,76 \text{ kJ} //$$

Ornek 4

1. hal	2. hal	3. hal	4. hal
$P_1 = 600 \text{ kPa}$	$P_2 = 600 \text{ kPa}$	$V_2 = V_3 \Rightarrow 0,04815$	$V_4 = V_1$
$T_1 = 400^\circ \text{C}$	$V_1 = \frac{V_2}{1,5}$	$P_3 = 300 \text{ kPa}$	$T_3 = T_4 = 503,31$
$m_1 = 0,1 \text{ kg}$	$T_2 = ?$	$T_2 = ? - 503,31$	$P_4 = ?$
$V_1 = ?$ $0,0321 \text{ m}^3$	$m_2 = 0,1 \text{ kg}$	$m_3 = 0,1 \text{ kg}$	

$$① \Rightarrow 600 \times V_1 = 0,1 \times 0,287 \times 673,15 \Rightarrow V_1 = 0,0321 \text{ m}^3 //$$

$$② \Rightarrow 0,0321 \times 1,5 = V_2 \Rightarrow V_2 = 0,04815 \text{ m}^3 //$$

$$② \Rightarrow 600 \times 0,04815 = 0,1 \times 0,287 \times T_2 \Rightarrow T_2 = 1006,62 \text{ K} //$$

$$①, ② \Rightarrow W_{12} = P_1 \cdot (V_2 - V_1) \Rightarrow 600 \cdot (0,04815 - 0,0321) \Rightarrow W_{12} = 9,63 \text{ kJ} //$$

$$③ \Rightarrow 300 \times 0,04815 = 0,1 \times 0,287 \times T_3 \Rightarrow T_3 = 503,31 \text{ K} //$$

$$③, ② \Rightarrow W_{23} = V_{\text{sabit}} \Rightarrow \text{izotik} \Rightarrow W_{23} = 0 // (\text{Hacim sabit})$$

$$④ \Rightarrow V_4 = V_1 = 0,0321 \text{ m}^3 \Rightarrow P_4 \times 0,0321 = 0,1 \times 0,287 \times 503,31 \Rightarrow P_4 = 449,99 \text{ kPa}$$

$$③, ④ \Rightarrow W_{34} = T_{\text{sabit}} \Rightarrow W_{34} = P_3 \times V_3 \times \ln \frac{V_4}{V_3} \quad P_4 \approx 450 \text{ kPa}$$

$$\Rightarrow W_{34} = 300 \times 0,04815 \times \ln \left(\frac{0,0321}{0,04815} \right) \Rightarrow W_{34} = -5,856 \text{ kJ} //$$

$$⑥, ① \Rightarrow W_{41} \Rightarrow V_{\text{sabit}} \Rightarrow W_{41} = 0 //$$

$$W_{\text{net}} = W_{12} + W_{23} + W_{34} + W_{41} = 9,63 - 5,856 = 3,774 \text{ kJ} = W_{\text{net}} //$$

Ornek 4

Übung 5

1. hal	2. hal	3. hal
$T_1 = 140^\circ\text{C}$	$P_1 = P_2 = ? \Rightarrow 361,4 \text{ kPa}$	$V_2 = V_3 = 6,69 \text{ m}^3$
$x_1 = 0,5$	$T_2 = 200^\circ\text{C}$	$T_3 = 24^\circ\text{C}$
$m_1 = 10 \text{ kg}$	$m_2 = 10 \text{ kg}$	$P_3 = 2,982 \text{ kPa} = P_d$
$P_1 = ? 361$	$V_2 = ? = 6,69 \text{ m}^3$	$x_3 = ?$
$V_1 = ? = 2,54 \text{ m}^3$	$x_2 = ?$	$m_3 = 40 \text{ kg}$

$$P_d = 361,4 \text{ kPa}$$

$$v_s = 1,0801 \times 10^{-3}$$

$$v_b = 0,5085$$

①

$$V_1^* = v_s + x_1(v_b - v_s) \Rightarrow 1,0801 \times 10^{-3} + 0,5 \times (0,5085 - 1,0801 \times 10^{-3}) = v_1 = 0,254 \text{ m}^3/\text{kg}$$

$$m = \frac{V_1}{v_1} \Rightarrow 10 = \frac{V_1}{0,254} \Rightarrow V_1 = 2,54 \text{ m}^3 //$$

② $v_s = 1,1900 \times 10^{-3}$, $v_b = 0,08604$

$$\text{Entropiesystem} \Rightarrow \frac{400 - 361,4}{400 - 200} = \frac{0,5589 - v_2}{0,5589 - 1,1280} \Rightarrow v_2 = -0,1109 = 0,5589 - v_2$$

$$v_2 = 0,6698 \text{ m}^3/\text{kg} //$$

$$m = \frac{V_2}{v_2} \Rightarrow V_2 = m \times v_2 = 10 \times 0,6698 = 6,69 \text{ m}^3 = V_2 //$$

③ $P_{d,1} = P_{d,2} = P_{d,3} //$

④ $V_4 = 2,54 \text{ m}^3 //$

$$w_{12} = P_1(v_2 - v_1) \Rightarrow 361(6,69 - 2,54) = 1498,15 \text{ kJ} //$$

$$w_{23} = v_{schl} \Rightarrow w_{23} = 0 //$$

$$w_{34} = \frac{P_{d,1}v_1 - P_{d,2}v_2}{1-n} = -4502,7 \text{ kJ}$$

Orak 6

Wacana
Sol

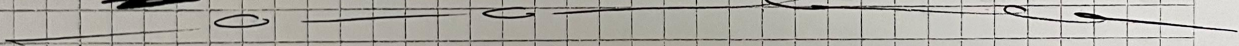
<u>1 kg hel</u>	<u>Ser hel</u>	$W_2 = ?$
$P_1 = 300 \text{ kPa}$	$T_2 = 100^\circ\text{C}$	
$T_1 = 300^\circ\text{C}$	$P_2 = ?$	
$m_1 = 1 \text{ kg}$	$M = 1 \text{ kg}$	$\Rightarrow v_2 = 0,5 \text{ m}^3/\text{kg}$
$V_1 = ? \Rightarrow 0,9855 \text{ m}^3$	$V_2 = ? \Rightarrow 0,5 \text{ m}^3$	

① $\Rightarrow$ Enkapsyoni $\Rightarrow \frac{400 - 300}{400 - 200} = \frac{0,6545 - v_1}{0,6545 - 1,3162} \Rightarrow -0,33065 = 0,6545 - v_1$
 $\Rightarrow v_1 = 0,9855$

$\Rightarrow m = \frac{V_1}{v_1} \Rightarrow 1 = \frac{V_1}{0,9855} \Rightarrow V_1 = 0,9855 \text{ m}^3$

② $\Rightarrow$ 2 hel Isok bar Isotermik $\Rightarrow P_2 = P_1 = 101,33 \text{ kPa}$

③ $\Rightarrow W_2 =$



Frage 7

1. hal

$$P_1 = 200 \text{ kPa}$$

$$x_1 = 0,5 \quad T_d$$

$$m_1 = 10 \text{ kg} \quad \text{degress starr-bahn}$$

$$V_1 = ? \quad // 4,43 \text{ m}^3 //$$

$$T_1 = T_d = 120,23^\circ \text{C}$$

2. hal

$$P_2 = 400 \text{ kPa}$$

$$V_2 = V_1 \times 2 \quad \Rightarrow // V_2 = 8,86 \text{ m}^3 //$$

$$m_1 = 10 \text{ kg}$$

$$v_2 = 0,886 \text{ m}^3/\text{kg}$$

$$T_2 \approx \underline{\underline{500^\circ \text{C}}}$$

kein
Boden
Boden

$$\textcircled{1} \Rightarrow v_5 = 1,0608 \times 10^{-3}, \quad v_6 = 0,8854$$

$$\Rightarrow v_1 = 1,0608 \times 10^{-3} + 0,5 \cdot (0,8854 - 0,0010608) \Rightarrow v_1 = 0,443 \text{ m}^3/\text{kg}$$

$$\Rightarrow V_1 = v_1 \cdot m \Rightarrow // V_1 = 4,43 \text{ m}^3 //$$

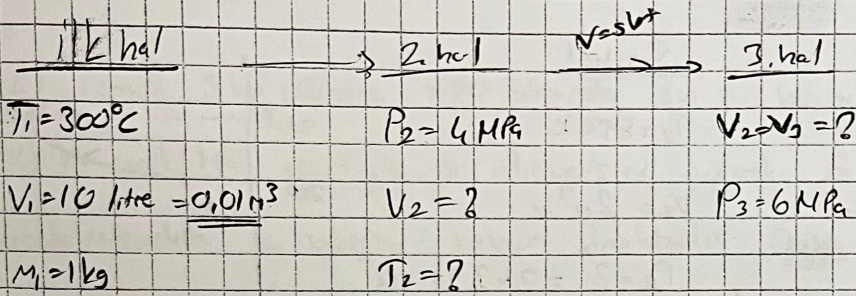
$$\textcircled{2} \Rightarrow T_2 \approx 500^\circ \text{C}, \quad v_2 = 0,886 \text{ m}^3/\text{kg}$$

$$\textcircled{3} \Rightarrow w_{12} = ? \Rightarrow$$

$$\kappa = 10^5$$

$$P_{atm} = 1 \text{ bar} = 100 \text{ kPa}$$

Ques 2



$$\textcircled{1} \Rightarrow P_1 = \cancel{P_p} + P_{atm} + P_{y1}$$

$$P_1 = 100 + P_{y1} \Rightarrow P_{y1} = 8492.7 \text{ kPa}$$

8492.7 kPa

$$\textcircled{2} P_2 = P_{atm} + \cancel{P_p} + P_{y2} \Rightarrow 6000 = 100 + P_{y2} \Rightarrow P_{y2} = 5900 \text{ kPa}$$

$$P_{y2} = \frac{F_{y2}}{A_p} \Rightarrow \frac{\kappa \cdot (V_2 - V_1)}{A_p} \quad \begin{matrix} 7.77 \\ 0.01 \end{matrix}$$

Übung 9

il/hal

$$P_1 = 200 \text{ kPa}$$

$$T_1 = 60^\circ\text{C}$$

$$m = 2 \text{ kg}$$

$$V_1 = ? \text{ 0,95 m}^3$$

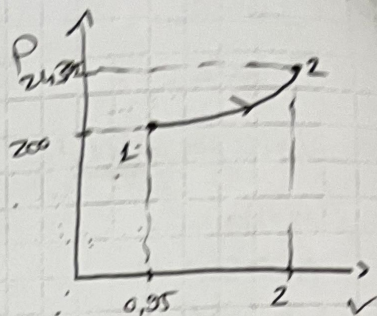
Sen hal

$$T_2 = 850^\circ\text{C}$$

$$V_2 = 2 \text{ m}^3 //$$

$$P_2 = ? = 243,95 \text{ kPa}$$

$$m = 2 \text{ kg}$$



$$\textcircled{1} \Rightarrow 200 \times V_1 = 2 \times 0,287 \times 333,15 \Rightarrow V_1 = 0,95 \text{ m}^3$$

$$\textcircled{2} \Rightarrow P_2 \times 2 = 2 \times 0,287 \times 850 \Rightarrow P_2 = 243,95 \text{ kPa} //$$

$$\textcircled{3} \Rightarrow W_{12} = \frac{(P_1 + P_2)}{2} \cdot (V_2 - V_1) \Rightarrow \frac{(243,95 + 200)}{2} \cdot (2 - 0,95) = 233,07 \text{ kJ} //$$

Übung 10

il/hal

$$P_1 = 100 \text{ kPa}$$

$$T_1 = 120^\circ\text{C}$$

$$m = 2 \text{ kg}$$

$$V_1 = ? = 3,586$$

Sen hal

$$V_2 = V_1 \times 2 \Rightarrow V_2 = 7,172 \text{ m}^3 //$$

$$P_2 = ? = 70,7105 \text{ kPa}$$

$$T_2 = ? = 883,511$$

$$m = 2 \text{ kg}$$

$P \cdot V^{0,5} = \text{const}$

KBB.

// kriegst bisher
Begegnung //

Tabellen

$$\Rightarrow V_1 = 1,793 \Rightarrow V_1 = v_1 \times m_1 \Rightarrow V_1 = 1,793 \times 2 = 3,586 \text{ m}^3$$

$$\Rightarrow P_1 \cdot V_1^{0,5} = P_2 \cdot V_2^{0,5} \Rightarrow \frac{100 \times 3,586^{0,5}}{1,793} = P_2 \times 7,172^{0,5} \Rightarrow P_2 = 70,7105 \text{ kPa} //$$

$$\Rightarrow 70,7105 \times 7,172 = 2 \times 0,287 \times T_2 \Rightarrow T_2 = 883,511 \text{ K} \Rightarrow 610^\circ\text{C}$$

$$\Rightarrow W_{12} = \frac{P_2 \cdot V_2 - P_1 \cdot V_1}{1 - 0,5} = \frac{(70,7105 \times 7,172) - (100 \times 3,586)}{1 - 0,5} = 297,07 \text{ kJ}$$

Hoca Okulda, Çimeler 7. Hafta

1) 1 litre 5 bar basıncıta 480 oranında su bu buharı, piston silindiri
 dişi 1000 K sıcaklıkta suyla ısı alışverişini yapacak Politrópik ($n=1$) hal
 den gerçekleştirilecek ve basıncı 10 bar olacaktır. Daha sonra sabit sıcaklıkta
 hal değişimi ile basıncı 5 barı gelir ve son olarak sabit basıncıta hal alır.
 olarak bu süreçte haline denerek soruları çözünüz.

a) Birim kg için yapılan ısı ve iş alışverişini bulunuz.

b) Sistemin ısı verimini hesaplayınız.

c) Hal değişim P-V diyagramı?

$$\Rightarrow \frac{1 \text{ hal}}{P_1 V_1^{n=1}} \rightarrow \frac{2 \text{ hal}}{P_2 V_2^{n=1}} \rightarrow \frac{3 \text{ hal}}{P_3 V_3^{n=1}} \rightarrow \text{Ekstrüzyon olur}$$

$$\begin{array}{l}
 P_1 = 5 \text{ bar} \quad P_2 = 10 \text{ bar} \quad P_3 = 5 \text{ bar} \\
 m_s = 0.8 \quad T_2 = ? \quad T_3 = T_2 = 773.15 \text{ K} \\
 m_b = 0.2 \quad T_3 > T_2 \quad \text{KBB}
 \end{array}$$

$$x_1 = \frac{m_b}{m_t} = \frac{0.2}{1} = 0.2$$

$$u_1 = (u_s + x_1(u_b - u_s))$$

$$\Rightarrow u_1 = 0.096 \text{ m}^3/\text{kg}$$

$$h_1 = 1061.6 \text{ kJ/kg}$$

$$u_1 = 1023.6 \text{ kJ/kg}$$

$$P_1 V_1^n = P_2 V_2^n \Rightarrow 500 \times 0.096 = 1000 \times V_2$$

$$\Rightarrow V_2 = 0.152 \text{ m}^3/\text{kg}$$

$$\Rightarrow T_2 = T_3 = 773.15 \text{ K}$$

$$u_2 = u_s + x_2(u_b - u_s)$$

$$x_2 = 0.78$$

$$h_2 = 2332 \text{ kJ/kg}$$

$$s_2 = 5.605 \text{ kJ/kg}$$

$$u_2 = h_2 - P_2 V_2$$

$$u_2 = 2180 \text{ kJ/kg}$$

$$u_s = 2609.15 \text{ kJ/kg}$$

$$u_b = 0.4045 \text{ m}^3/\text{kg}$$

$$s_s = 6.9442 \text{ kJ/kg}$$

$$h_s = 2811.4 \text{ kJ/kg}$$

1-2 arası

$$w_{12} = \frac{P_2 \dot{U}_2 - P_1 \dot{U}_1}{1-n} = \frac{1000 \cdot 0,152 - 500 \cdot 0,046}{2} = \underline{\underline{57 \text{ kJ}}}$$

$$q_{12} = w_{12} = U_2 - U_1$$

$$q_{12} - 57 = 2180 - 1023,6 \Rightarrow q_{12} = 1213,4 \text{ kJ/kg}$$

2-3 arası

$$q_{23} = T(s_3 - s_2)$$

$$q_{23} = (179 + 173,15) \cdot (6,9667 - 5,605)$$

$$q_{23} = 615 \text{ kJ/kg}$$

$$q_{23} - w_{23} = U_3 - U_2$$

$$615 - w_{23} = 2609 - 2180$$

$$w_{23} = 186 \text{ kJ/kg}$$

3-1 arası

$$w_{31} = P(\dot{V}_1 - \dot{V}_3)$$

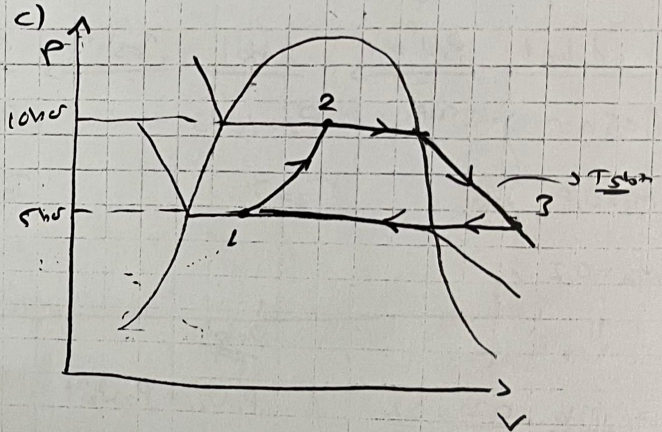
$$w_{31} = 500(0,026 - 0,4015)$$

$$w_{31} = -162,25 \text{ kJ/kg}$$

$$q_{31} - w_{31} = U_1 - U_3$$

$$q_{31} - (-162,25) = 1023 - 2609$$

$$q_{31} = -1769,8 \text{ kJ/kg}$$



$$b) \eta_{\text{net}} = \frac{w_{\text{net}}}{q_{\text{gen}}} = \frac{57 + 186 - 164}{1213 + 615} = \underline{\underline{0,04}}$$

Örnek 2

Pistolu bir silindirik iletken $0,7 \text{ MPa}$, 320°C sıcaklıkta bulunan $0,1 \text{ kg}$ Argon gazındaki serbest enerji hal değişimiyle bir çevrim meydana getirmektedir;

$$\gamma = \beta = 0,20813$$

1-2 : $PV = \text{sabit}$ sıcaklık ile hacim değişimi izlenmektedir.

2-3 : $P = \text{sabit}$ hacim ile basınç değişimi izlenmektedir.

3-1 : $V = \text{sabit}$ sıcaklık ile basınç değişimi izlenmektedir.

Buna göre :

a) Çevrim $P-V$ ve $T-V$ diyagramlarında gösteriniz.

b) Çevrim boyunca yapılan iş ve ısı hesaplayınız.

c) Çevrimin ısı ve entalpi değişimleri.

1. hal	2. hal	3. hal
$P_1 = 700 \text{ kPa}$	$V_2 = V_1 \Rightarrow 0,00881 \text{ m}^3$	$V_1 = V_3 = ? \Rightarrow 0,017 \text{ m}^3$
$T_1 = 320^\circ\text{C}$	$P_2 = ? \quad 1401,27 \text{ kPa}$	$P_3 = P_2 = ? \quad 1401,27 \text{ kPa}$
$m = 0,1 \text{ kg}$	$m = 0,1 \text{ kg}$	$T_3 = ? \Rightarrow 1144,55 \text{ K} \Rightarrow 871,4^\circ\text{C}$
$V_1 = ? = V_3 = 0,017 \text{ m}^3$	$T_2 = 320^\circ\text{C}$	

$$1) \Rightarrow P_1 V_1 = m R T_1 \Rightarrow 700 \times V_1 = 0,1 \times 0,20813 \times 593,15 \Rightarrow V_1 = 0,017 \text{ m}^3$$

$$2) \Rightarrow V_2 = \frac{V_1}{2} \Rightarrow V_2 = 0,00881 \text{ m}^3$$

$$3) \Rightarrow P_2 \times 0,00881 = 0,1 \times 0,20813 \times 593,15 \Rightarrow P_2 = 1401,27 \text{ kPa}$$

$$4) \Rightarrow 1401,27 \times 0,017 = 0,1 \times 0,20813 \times T_3 \Rightarrow T_3 = 1144,55 \text{ K}$$

$$b) \Rightarrow 1-2 \Rightarrow W_{12} = P_1 V_1 \ln \frac{V_2}{V_1} \Rightarrow 700 \times 0,017 \times \ln \left(\frac{0,00881}{0,017} \right) \Rightarrow -7,82 \text{ kJ}$$

$$Q_{12} - W_{12} = m C_v (T_2 - T_1) \Rightarrow Q_{12} = -7,82 \text{ kJ}$$

2-3 aşısı

$$W_{23} = P_2 (V_3 - V_2) \Rightarrow 1401,27 (0,017 - 0,00881) \Rightarrow W_{23} = \boxed{11,47 \text{ kJ}}$$

$$Q_{23} = m \cdot c_{p0} \cdot (T_3 - T_2) = 0,1 \times 0,5203 \times (871,4 - 320) = \boxed{28,68 \text{ kJ}} \quad Q_{23}$$

3-1 aşısı

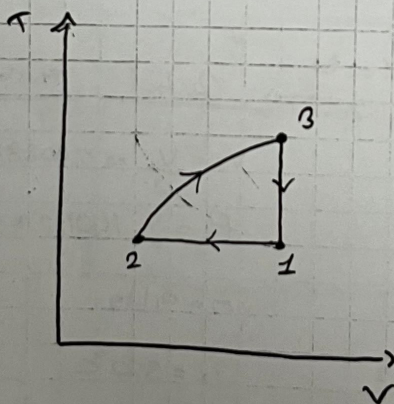
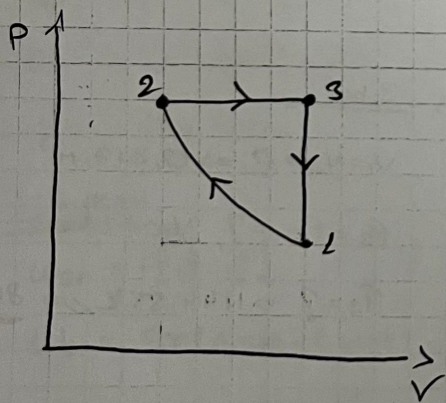
$$W_{31} = 0 \quad \text{Nispet}$$

$$Q_{31} = m \cdot c_{v0} (T_1 - T_3) \Rightarrow 0,1 \times 0,3122 (320 - 871,4) = \boxed{-17,21 \text{ kJ}}$$

$$W_{\text{net}} = 11,47 + 0 - 7,82 = \underline{\underline{3,65 \text{ kJ}}}$$

$$\eta_{\text{is,1}} = \frac{3,65}{28,68} = \underline{\underline{0,127}}$$

$$Q_{\text{giren}} = \underline{\underline{28,68}}$$



Hoca Örnek Soru Çözümü 7. Hafta 10.

① Hacmi $1,8 \text{ m}^3$ olan rijit bir tank içinde 220°C sıcaklıkta ıslak su-buhar bulunmaktadır. ıslak su buharının hacminin $\frac{1}{3}$ 'ü suyun içinde kalan kısmıdır.

Buna göre buharlık: ıslak buharın

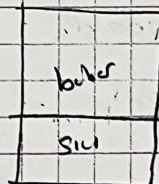
a) Buzluluğu

$$V = 1,8 \text{ m}^3$$

b) Kuruluk derecesini

$$T = 220^\circ\text{C}$$

c) Yığınların kütlesini



ıslak buhar

$$T = 220^\circ\text{C}$$

$$V_g = \frac{1}{3} V \Rightarrow V_g = 0,6 \text{ m}^3$$

$$P = ? \Rightarrow P = 2319,8 \text{ kPa}$$

$$V_b = 1,2 \text{ m}^3$$

$$v_g = 0,001190 \text{ m}^3/\text{kg} \Rightarrow \text{E8.4}$$

$$v_g = \frac{V_g}{m_g} \Rightarrow 0,001190 = \frac{0,6}{m_g}$$

$$x = ?$$

$$m_g = 504,2 \text{ kg}$$

$$f = ?$$

$$v_b = 0,086094 \text{ m}^3/\text{kg} \Rightarrow \text{E8.1}$$

$$v_b = \frac{V_b}{m_b} \Rightarrow 0,086094 = \frac{1,2}{m_b}$$

$$m_b = 13,93 \text{ kg}$$

$$x = \frac{m_b}{m_{\text{toplam}}} = \frac{13,93}{518,3} = 0,026$$

$$f = \frac{m_g}{V_t} = \frac{518,3}{1,8} = 287,94$$

② Hacmi 2 m^3 den bir buhar kazanında 200 kPa basıncıta ısıtık su buharı bulunmaktadır kazan hacminin $4/20$ 'sının suyu ve kalan buhar ddt. bitirilmeye gane ısıtık su buharının sıcaklığını kuruluk dere. ve özgül hacmi hesaplayınız.

$$P = 200\text{ kPa}$$

$$V = 2\text{ m}^3 \rightarrow 2 \times \frac{2}{10} = 0,4 = \text{suyu} \quad 1,6 = \text{gca. (buhar)}$$

$$P = 200\text{ kPa}$$

$$T_s = T_d = 120,23^\circ\text{C}$$

$$v_s = 1,0608 \times 10^{-3}$$

$$v_b = 0,8854$$

$$m_s = \frac{V_s}{v_s} = m_b = \frac{0,4}{1,0608 \times 10^{-3}} = 377,09\text{ kg}$$

$$m_t = 378,89$$

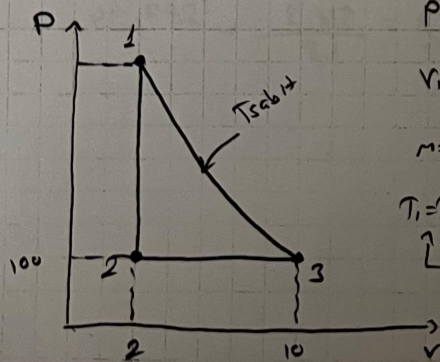
$$m_b = \frac{V_b}{v_b} = \frac{1,6}{0,8854} = 1,807\text{ kg}$$

$$x = \frac{m_b}{m_t} = \frac{1,807}{378,89} = x = 0,004769$$

$$v_t = v_s + x(v_b - v_s) \Rightarrow v_t = 1,0608 \times 10^{-3} + 0,004769(0,8854 - 1,0608 \times 10^{-3})$$

$$v_t = 0,00527\text{ m}^3/\text{kg}$$

③ 2 kg havalı asfırdaki sıcaklık görüldüğü gibi sürekli değişen bir şekilde bir çevrim düsturundadır. Her bir havalı değ. nede yapılan işleri ve ısı alışverişini ayrı ayrı hesaplayınız. Çevrimi $T-v$ diyagramlarında göstermek ve varsa ısı verimini bulunuz



1. havalı v_{sabit}

$$P_1 = 500\text{ kPa}$$

$$V_1 = 2\text{ m}^3$$

$$m = 2\text{ kg}$$

$$T_1 = T_2 = ? \rightarrow 1742,16\text{ K}$$

2. havalı P_{sabit}

$$P_2 = 100\text{ kPa}$$

$$V_2 = 2\text{ m}^3$$

$$m = 2\text{ kg}$$

$$T_2 = ? \rightarrow 346,43\text{ K}$$

3. havalı

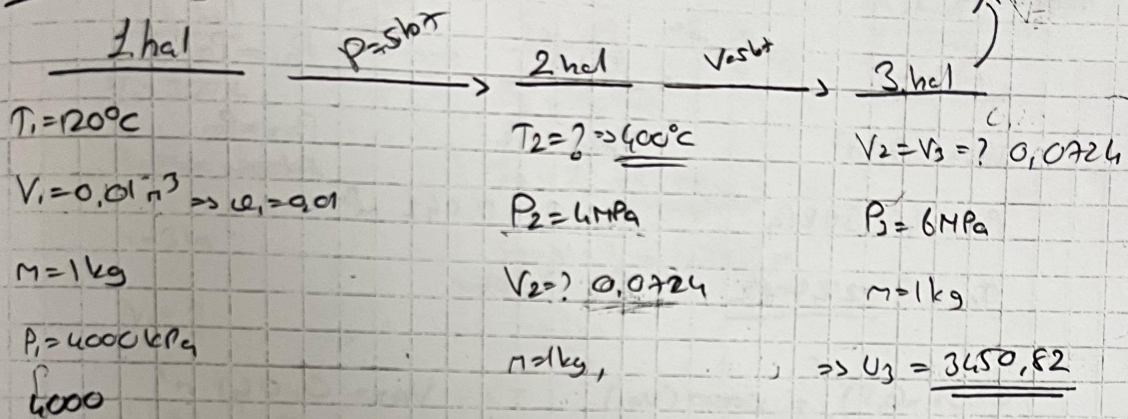
$$V_3 = 10\text{ m}^3$$

$$P_3 = 100\text{ kPa}$$

$$T_3 = T_1 = ? \rightarrow 1742,16\text{ K}$$

$$m = 2\text{ kg}$$

19. Soru



$$P_2 = P_{\text{atm}} + P_{g2} = 100 + \frac{10^5 \cdot (V_2 - a_1)}{(0,04)^2} \times 10^{-3} = 0,0724 \text{ m}^3/\text{kg}$$

$$P_1 = 100 + P_{g1} \Rightarrow 100 + \frac{10^5 \cdot (0,0724 - 0,01)}{(0,04)^2} \times 10^{-3} \Rightarrow P_1 = 4000 \text{ kPa}$$

$$U_2 = 2922,18 \quad h_2 =$$

$$0,01 = 1,2521 \times 10^{-3} + x_1 (0,04975 - 1,2521 \times 10^{-3}) \Rightarrow x_1 = 0,18$$

$$U_1 = 1082,35 + 0,18 \times (2601,3 - 1082,35) = U_1 = 1355,79$$

$$W_{12} = P_1 \cdot (V_2 - V_1) \Rightarrow 4000 \times (0,0724 - 0,01) = W_{12} = 249,6 \text{ kJ}$$

$$Q_{12} = m \cdot (u_2 - u_1) \Rightarrow 1 \cdot (2922,18 - 1355,79) = 1566,39$$

$$W_{23} = 0 \quad Q_{23} = m \cdot (u_3 - u_2) = 1 \cdot (3450,82 - 2922,18) = 528,64 \text{ kJ}$$

1, 2, 3, 4

Soru 12

1.1.1.1
A kolu

1.1.1.1
2.1.1.1

$$V_{A1} = ? \text{ m}^3$$

$$P_{A1} = 47,36 \text{ kPa}$$

$$T_{A1} = ? \text{ K}$$

$$T_{A2} = 150^\circ\text{C}$$

$$V_{A2} = ? \Rightarrow 0,041 \text{ m}^3$$

$$P_{A2} = ? \text{ kPa}$$

$$V_{A1} + V_{B1} = 1 \text{ m}^3 = V_T$$

$$V_{A2} + V_{B2} = 1 \text{ m}^3 = V_T$$

$$V = 1,4$$

$$P_{A1} = P_{B1}$$

$$P_{A2} = P_{B2}$$

$$47,36 \times (0,5)^{1,5} = 2000 (V_{A2})^{1,5} \Rightarrow V_{A2} = 0,041 \text{ m}^3$$

$$2000 \times 0,041 = m_A \times 0,2968 \times 423,15 \Rightarrow m_A = 0,65 \text{ kg}$$

$$47,36 \times 0,5 = 0,65 \times 0,2968 \times T_{A1} \Rightarrow T_{A1} = 122,74 \text{ K}$$

1.1.1.1
B kolu

1.1.1.1
2.1.1.1

$$V_{B1} = ? \text{ m}^3$$

$$T_{B1} = 80^\circ\text{C}$$

$$m_{B1} = 50 \text{ kg}$$

$$U_{B1} = 0,01 \text{ m}^3/\text{kg} \Rightarrow 10 \text{ m}^3$$

$$P_{B1} = ? \Rightarrow 47,36 \text{ kPa}$$

2.1.1.1

$$P_{B2} = 2000 \text{ kPa}$$

$$V_{B2} = ? \Rightarrow 0,96 \text{ m}^3$$

$$m_{B2} = 50 \text{ kg}$$

$$U_{B2} = 0,0192 \text{ m}^3/\text{kg} \Rightarrow 0,96 \text{ m}^3$$

$$T_{B2} = 212,33^\circ\text{C}$$

$$0,040 + V_{B2} = 1 \text{ m}^3$$

$$V_{B2} = 0,96 \text{ m}^3$$

$$0,01 = 1,0292 \times 10^{-3} + x (3,409 - 1,0292 \times 10^{-3})$$

$$U_{B1} =$$

$$x = 0,002$$

$$U_{B1} = 334,9 + 0,002 (2482,3 - 334,9)$$

$$U_{B1} = 339,19$$

$$0,0192 = 1,1766 \times 10^{-3} + x (0,05554 - 1,1766 \times 10^{-3})$$

$$x = 0,183$$

$$U_{B2} = 906,23 + 0,183 (2555,12 - 906,23)$$

$$U_{B2} = 1215,84$$

$$W_{A2} = \frac{m_A P_A (T_{A2} - T_{A1})}{1 - n} = \frac{0,65 \times 0,2968 \times (423,15 - 122,74)}{-0,5} = -115,91 \text{ kJ}$$

$$Q_{A12} = 0$$

$$Q_{B12} = m_B (1215,84 - 339,19) \Rightarrow 43832,5 \text{ kJ}$$

13. Seru

1 kg hel $\xrightarrow{V=567}$ Sen hel

$$Q_{12} = -150 \text{ kJ}$$

$$T_1 = 300 \text{ K}$$

$$P_2 = 1000 \text{ kPa}$$

$$P_1 = 260 = 200 \text{ kPa}$$

$$T_2 = ? \Rightarrow 1500 \text{ K}$$

$$m = 3 \text{ kg}$$

$$V_2 = V_1 = ? \Rightarrow 1,2915 \text{ m}^3$$

$$V_1 = ?$$

$$m = 3 \text{ kg}$$

$$\textcircled{1} \Rightarrow 200 \times V_1 = 3 \times 0,287 \times 300 \Rightarrow V_1 = 1,2915 \text{ m}^3$$

$$\textcircled{2} \Rightarrow 1000 \times 1,2915 = 3 \times 0,287 \times T_2 \Rightarrow T_2 = 1500 \text{ K}$$

$$W_{12} = 0 //$$

$$-150 - Q_{12} - W_{12} = m \cdot c_{v,0} \cdot (T_2 - T_1) \Rightarrow$$

$$-150 - Q_{12} = 3 \times 0,7165 \times (1500 - 300) \Rightarrow Q_{12} = -2729,4 \text{ kJ}$$

10. Seru

1 kg hel $\xrightarrow{V=567}$ 2 hel $\xrightarrow{P=567}$ 3 hel

$$P_1 = 1000 \text{ kPa}$$

$$P_2 = 200 \text{ kPa}$$

$$P_3 = 200 \text{ kPa}$$

$$\left. \begin{array}{l} M_b = 6 \text{ kg} \\ m_s = 4 \text{ kg} \end{array} \right\} m_{\text{total}}$$

$$V_2 = ? \underline{10,16 \text{ m}^3}$$

$$V_2 \times 1,2 = V_3 \Rightarrow \underline{12,192 \text{ m}^3}$$

$$u_2 = 1,016 \text{ m}^3/\text{kg}$$

$$\underline{1,016 \text{ m}^3/\text{kg}}$$

$$\underline{1,016 \text{ m}^3/\text{kg}}$$

$$\rightarrow u_2 = 1,016 \approx 1,0804$$

$$x = \frac{6}{10} = \underline{0,6} \text{ 13B}$$

$$T_1 = T_d = 99,632^\circ \text{C}$$

$$\Rightarrow T_2 = 200^\circ \text{C}$$

$$u_1 = 313,17 + 0,6 \times (2006 - 313,17) \quad x = \ominus$$

$$u_1 = 1628,864$$

$$u_1 = 1,0434 \times 10^3 + 0,6 \times (1,084 - 1,0434 \times 10^3)$$

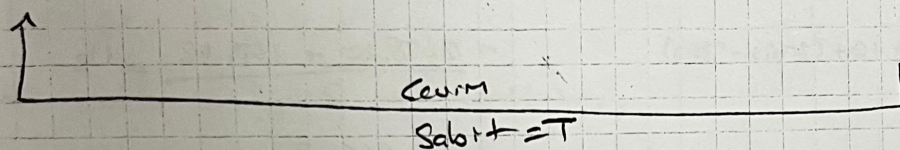
$$\underline{u_1 = 1,016 \text{ m}^3/\text{kg}}$$

$$V_1 = 1,016 \times 10 = \underline{10,16 \text{ m}^3}$$

100
SOL

(Azet)

1 hel	$V \rightarrow$	2 hel	$n \rightarrow$	3 hel	$p \rightarrow$	4 hel
$P_1 = 1000 \text{ kPa}$		$V_1 = V_2 = ?$	$n = 1,4$	$P_3 = 100 \text{ kPa}$		$P_3 = P_4 = 100 \text{ kPa}$
$T_1 = 300 \text{ K}$		$P_2 = 6000 \text{ kPa}$		$T_3 = ? \text{ 558,50 K}$		$T_4 = 300 \text{ K}$
$m = 15 \text{ kg}$		$T_2 = ? \text{ 1799,15}$		$V_3 = ?$		$V_4 = ?$
$V_1 = ?$		$m = 15 \text{ kg}$		$m = 15 \text{ kg}$		$m = 15 \text{ kg}$



$$① \Rightarrow 1000 \times V_1 = 15 \times 0,29680 \times 300 \Rightarrow \underline{V_1 = 1,335 \text{ m}^3}$$

$$② \Rightarrow V_1 = V_2 = 1,335 \Rightarrow 6000 \times 1,335 = 15 \times 0,29680 \times T_2 \Rightarrow \underline{T_2 = 1799,15 \text{ K}}$$

$$A_{\text{Zot}} = k = \frac{C_p}{C_v} \Rightarrow \underline{1,4}$$

$$③ \Rightarrow \frac{T_3}{T_2} = \left[\frac{P_3}{P_2} \right]^{\frac{1}{1,4}} \Rightarrow \underline{T_3 = 558,50 \text{ K}}$$

$$④ \Rightarrow 100 \times V_3 = 15 \times 0,29680 \times 558,50 \Rightarrow \underline{V_3 = 24,86 \text{ m}^3}$$

$$⑤ \Rightarrow 100 \times V_4 = 15 \times 0,29680 \times 300 \Rightarrow \underline{V_4 = 13,356 \text{ m}^3}$$

$$W_{12} = 0 \quad Q_{12} = m \cdot C_v \cdot (T_2 - T_1) \Rightarrow 15 \times 0,7448 \times (1799,15 - 300) \Rightarrow \underline{Q_{12} = 16748,95}$$

$$W_{23} = \frac{P_2 V_2 - P_3 V_3}{1 - 1,4} \Rightarrow \frac{(6000 \times 1,335) - (100 \times 24,86)}{1 - 1,4} = \underline{13810}$$

$$Q_{23} = 0$$

$$W_{34} = P_3 \cdot (V_4 - V_3) = 100 \times (13,356 - 24,86) = \underline{-1130,4}$$

$$Q_{34} = m \cdot C_p \cdot (T_4 - T_3) = 15 \times 1,0416 \times (300 - 558,50) = \underline{-4038,804 \text{ kJ}}$$

$$W_{41} = P_{41} V_{41} \ln \frac{V_1}{V_4} \Rightarrow 100 \times 13,356 \times \ln \frac{1,335}{13,356} \Rightarrow \underline{-3075,93 \text{ kJ}}$$

$$Q_{41} = W_{41} \Rightarrow \underline{-3075,93 \text{ kJ}}$$

2023 ②

A tank (s.)

$$\left. \begin{aligned} P_A &= 350 \text{ kPa} \\ x_A &= 0,7 \\ V_A &= 0,15 \text{ m}^3 \end{aligned} \right\} \text{18 B}$$

$$\rho = \frac{0,15}{0,367} \text{ kg}$$

$$T_A = T_B = 138,87^\circ \text{C}$$

$$U_A = 538,89 + 0,7(2546,2 - 538,89)$$

$$U_A = 1945,4$$

$$w_A = 0,367 \text{ m}^3/\text{kg}$$

A+B tank

$$T_{AB} = 25^\circ \text{C}$$

$$V_{AB} = 0,60 \text{ m}^3$$

$$P_{AB} = P_A = 3,171 \text{ kPa}$$

$$0,226 + 0,40 = 0,626 \text{ kg} = m_A + m_B = m_{AB}$$

$$w_{AB} = \frac{V_{AB}}{m_{AB}} = \frac{0,60}{0,626} = 0,958 \text{ m}^3/\text{kg}$$

$$x_{A2} = \frac{w_2 - w_3}{w_1 - w_3} = \frac{0,958 - 0,0010029}{42,48 - 0,0010029} = 0,020$$

$$U_2 = U_3 + x_2(U_1 - U_3) \Rightarrow 104,75 + 0,020(2409,85 - 104,75) \Rightarrow U_{AB} = 150,850$$

$$Q_{12} - W_{12} = U_{AB} - (U_A + U_B) \Rightarrow m_{AB} \times U_{AB} - m_A \times U_A - m_B \times U_B = Q_{12}$$

$$\Rightarrow (0,626 \times 150,850) - (0,40 \times 1945,4) - (0,226 \times 2656,31) = -1409,32 \text{ kJ}$$

B tank

$$P_B = 159 \text{ kPa}$$

$$T_B = 200^\circ \text{C}$$

$$V_B = 0,45 \text{ m}^3$$

18 B

Table

$$\Rightarrow \frac{2658,20 + 2656,42}{2} = U_B$$

$$U_B = 2656,31$$

$$w_B = \frac{1,0804 + 2,172}{2} = 1,6262 \text{ m}^3/\text{kg}$$

$$m_B = \frac{V_B}{w_B} = \frac{0,45}{1,6262} = 0,276 \text{ kg}$$

★

23 a ①

Sulfa 20 gromer.

$$S_{\text{ulfa}} \text{ haeri} = 6,1 \times 7,62 \times 2,44 = \underline{\underline{113,41 \text{ m}^3}}$$

$$20 \times 110 = 2200 \text{ W isi udig}$$

$$V_{\text{gas}} = 20 \times 0,442 = \underline{\underline{8,84 \text{ m}^3}} \quad \left. \vphantom{V_{\text{gas}} = 20 \times 0,442 = \underline{\underline{8,84 \text{ m}^3}}} \right\} V_{\text{hasil}} = V_{\text{sulfa}} - V_{\text{gas}} = \underline{\underline{104,58 \text{ m}^3}}$$

$$2200 \text{ W} = 1892 \text{ kcal/h}$$

$$1892 \text{ kcal/h} \times \frac{4,184}{\text{kcal}} = 7908,56 \text{ kJ/h}$$

$$15 \text{ dkd} \Rightarrow \frac{7908,56}{4} = \underline{\underline{1977,14 \text{ kJ/s}}}$$

$$P_{\text{u}} = m_1 B T_1 \Rightarrow 100 \times 104,58 = m \times 0,287 \times 294,15$$

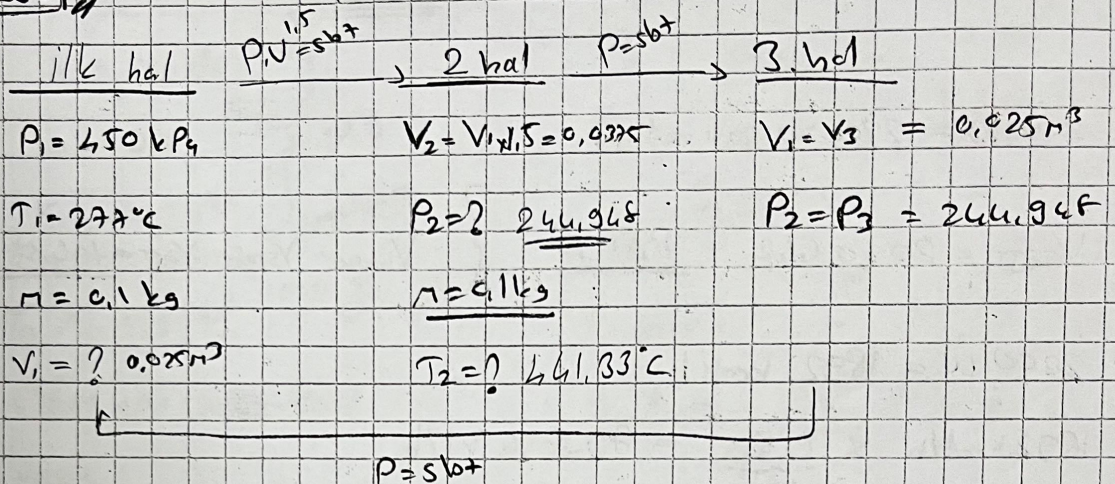
$$m = \underline{\underline{123,8 \text{ kg}}}$$

$$\Rightarrow \underset{1977}{Q_{12}} - \underset{0 (u=50\%)}{W_{12}} = U_2 - U_1 \Rightarrow m c_{\text{uo}} \underbrace{(T_2 - T_1)}_{\Delta T} \Rightarrow 1977 = 123,8 \times 0,7165 \times (\Delta T)$$

$$\Rightarrow \underline{\underline{\Delta T = 22,28^\circ \text{C}}}$$

Çözüm Sorular

4. 15. Soru



$$① \Rightarrow 450 \times V_1 = 0,1 \times 0,20813 \times 550,15 \Rightarrow \underline{V_1 = 0,025 \text{ m}^3}$$

$$② \Rightarrow 0,025 \times 1,5 = \underline{V_2 = 0,0375 \text{ m}^3}$$

$$① \cdot ② \Rightarrow 450 \times (0,025)^{1,5} = P_2 \times (0,0375)^{1,5} \Rightarrow \underline{P_2 = 244,948 \text{ kPa}}$$

$$② \Rightarrow 244,948 \times 0,0375 = 0,1 \times 0,20813 \times T_2 \Rightarrow \underline{T_2 = 441,33^\circ\text{C}}$$

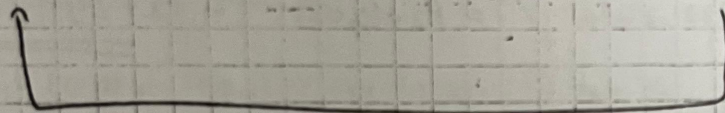
Snow Gears Sinter

$$U_3 = 313,17 + 4,284 \times (2506 - 313,17)$$

$$U_2 = 957,70$$

2023 - ③

<u>ilk hal</u>	<u>Ara hal</u>	<u>Son hal</u>
$P_1 = 500 \text{ kPa}$	$P_2 = 100 \text{ kPa}$	$P_3 = 100 \text{ kPa}$
$V_1 = 0,1 \text{ m}^3$	$V_2 = 0,6 \text{ m}^3$	$V_3 = 0,1 \text{ m}^3$
$m = 0,2 \text{ kg}$	$m = 0,2 \text{ kg}$	$m = 0,2 \text{ kg}$



$$V_1 = m \times u$$

$$\Rightarrow 0,1 = 0,2 \times u$$

$$u_1 = 0,5 \text{ m/s}$$

$$T_1 = 280^\circ\text{C}$$

$$h_1 = 3023,4$$

$$U_1 = 2971,70$$

$$V_2 = m \times u_2$$

$$0,6 = 0,2 \times u_2$$

$$u_2 = 3 \text{ m/s}$$

$$T_2 = 380^\circ\text{C}$$

$$h_2 = 3237 \text{ kJ/kg}$$

$$u_3 = 0,5 \text{ m/s}$$

$$0,5 = 1,043 \times 10^{-2} \times (1,654 - 1,043 \times 10^{-3})$$

$$x = 0,294$$

$$h_3 = h_s + x \cdot (h_b - h_s)$$

$$h_3 = 417,71 + 0,294 \cdot (2675,4 - 417,71)$$

$$h_3 = 1081,32$$

$$W_{23} = P_2(V_3 - V_2) \Rightarrow 100(0,1 - 0,6) \Rightarrow \underline{\underline{-50 \text{ kJ}}}$$

$$Q_{23} = m \cdot (h_2 - h_1) \Rightarrow 0,2(3237 - 3023,4) \Rightarrow \underline{\underline{42,72 \text{ kJ}}}$$

$$W_{31} = 0, Q_{31} = m \cdot (u_3 - u_1) \Rightarrow 0,2(2971,70 - 957,70) \Rightarrow \underline{\underline{362,8 \text{ kJ}}}$$

$$W_{12} = \frac{(P_1 + P_2)}{2} \cdot (V_2 - V_1) \Rightarrow \frac{600}{2} \cdot (0,5) \Rightarrow \underline{\underline{150 \text{ kJ}}}$$

$$Q_{12} - W_{12} = U_2 - U_1 \Rightarrow Q_{12} = U_2 - U_1 + W_{12} \Rightarrow Q_{12} = m \cdot (u_2 - u_1) + W_{12}$$

$$Q_{12} = 182,86 \text{ kJ}$$

$$Q_{\text{net}} = 99,91 \text{ kJ} \approx 100 \text{ kJ} \quad Q_{\text{net}} = 100$$

$$W_{\text{net}} = 100 \text{ kJ} \quad \left. \begin{array}{l} \text{Carnot T. having upper V} \\ \text{P}_{\text{giri}} \quad \text{P}_{\text{dipin}} \end{array} \right\} \quad \eta_{\text{isi}} = \frac{W_{\text{net}}}{P_{\text{giri}} P_{\text{dipin}}} = \frac{100}{100} = \underline{\underline{1}} \quad \eta_{\text{isi}} = 1$$

Örnek 2.11)

(Freon-12)

<u>Ilk hal</u>	$PV^{1.3} = \text{const.}$	<u>Son hal</u>	
$V_1 = 0,01 \text{ m}^3$	$u_1 = 199,5$	$V_2 = 0,02 \text{ m}^3$	$u_3 = 0,000744$
$T_1 = 50^\circ\text{C}$	$v_1 = 0,01428$	$P_2 \rightarrow 1,95,96 \text{ kPa}$	$u_0 = 0,03536$
$x_1 = 40$		$T_2 = T_0 = 15,59^\circ\text{C}$	$u_2 = \frac{V_2}{V_1} = \frac{0,02}{0,01} = 2$
			$x_2 = 0,8$

$P_1 = P_2 = 1221,2 \text{ kPa}$

$$\Rightarrow P_1 \cdot V_1^{1.3} = P_2 \cdot V_2^{1.3} \Rightarrow 1221,2 \times (0,01)^{1.3} = P_2 \times (0,02)^{1.3} \Rightarrow P_2 = 1,95,96 \text{ kPa}$$

$$\Rightarrow m = \frac{V_1}{v_1} = \frac{0,01}{0,01428} \Rightarrow m = 0,700 \text{ kg}$$

$$w_{12} = \frac{P_2 u_2 - P_1 u_1}{1 - \gamma} = 7,65 \text{ kJ}$$

$$Q_{12} - w_{12} = m(u_2 - u_1) \Rightarrow -19,45 \text{ kJ}$$

4.9

1 kg hel $\xrightarrow{P=5 \text{ bar}}$ 2 hel $\xrightarrow{V=0.02 \text{ m}^3}$ 3. hel

$P_1 = 0.5 \text{ MPa} = 500 \text{ kPa}$
 $x_1 = 0.01$
 $T_1 = T_0 = 151.84^\circ\text{C}$
 $V_1 = ?$
 $m = 0.1 \text{ kg}$

$P_1 = P_2 = 0.5 \text{ MPa}$
 $V_2 = 0.02 \text{ m}^3$
 $x_2 = ?$
 $m = 0.1 \text{ kg}$

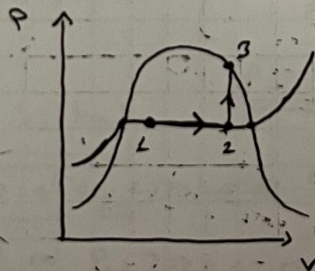
$V_2 = V_3 = 0.02 \text{ m}^3$
 $x_3 = 1.0$
 $m = 0.1 \text{ kg}$
 $v_3 = 0.2 \text{ m}^3/\text{kg}$

$T_2 = T_0 = 151.84^\circ\text{C}$
 $v_1 = 1.0928 \times 10^{-3} + 0.01(0.3742 - 1.0928 \times 10^{-3})$
 $v_1 = 0.00482 \text{ m}^3/\text{kg}$
 $0.00482 \times 0.1 = V_1 = 0.000482 \text{ m}^3$
 $0.02 = 1.0928 \times 10^{-3} + x(0.3742 - 1.0928 \times 10^{-3})$
 $x = 0.532$

3. hel $\Rightarrow$ Tabloda v_3 'ün 0.2 olduğu yere bakılır.

$$T_3 = 177.12^\circ\text{C}$$

$$P_3 = 0.95 \text{ MPa} = 950 \text{ kPa}$$



b) $W_{12} = P_1(v_2 - v_1) \Rightarrow 500 \cdot (0.02 - 0.00482) \Rightarrow W_{12} = 9.759 \text{ kJ}$

$$W_{23} = 0$$

c) $W_{3e} = W_{13e} + W_{per} \Rightarrow (W_{12} + W_{23}) + W_{per} = 9.76 + W_{per} = W_{13e}$

$$Q_{13} - W_{13} = m \cdot (u_3 - u_1) \Rightarrow -9.76 - W_{per} = 0.1 \cdot (2564.6 - 658.8)$$

$$W_{per} = -191.3 \text{ kJ}$$

Örnek 4.6

4 hel
A balımesi
 $P_A = 160 \text{ kPa}$
 $V_A = 0,5 \text{ m}^3$
 $T_A = 30^\circ\text{C}$

2 hel
 $P_B = 600 \text{ kPa}$
 $V_B = ?$
 $0,207 \text{ m}^3$
 $m_B = 0,91$

$$\begin{cases} P_{A1} = P_{B1} \\ P_{A2} = P_{B2} \end{cases}$$

$$160 \times 0,5^{1,5} = 600 \times V_{A2}^{1,5}$$

$$\underline{V_{A2} = 0,207 \text{ m}^3}$$

$$V_T = V_{A1} + V_{B1} \Rightarrow 0,5 + 1,635$$

$$\underline{V_T = 2,135 \text{ m}^3}$$

$$160 \times 0,5 = m_{A1} \times 0,287 \times 303,15 \Rightarrow$$

$$\underline{m_{A1} = 0,91 \text{ kg}}$$

B balıesi:

$$m_B = 3 \text{ kg}$$

$$x_B = 0,5$$

$$W_{B12} = \text{diğer}$$

$$W_p = -3000 \text{ kJ}$$

$$V_{B1} = ? \Rightarrow 1,635 \text{ m}^3$$

$$P_{B1} = 160 \text{ kPa}$$

$$T_{B2} = T_A = 113,32^\circ\text{C}$$

2 hel

$$P_{B2} = 600 \text{ kPa}$$

$$m_B = 3 \text{ kg}$$

$$\frac{T_2}{T_1} = \left(\frac{P_2}{P_1} \right)^{\frac{\gamma-1}{\gamma}} \Rightarrow \frac{T_2}{303,15} = \left(\frac{600}{160} \right)^{\frac{0,5}{1,5}}$$

$$\underline{T_2 = 491 \text{ K}}$$

$$W_{A12} = \frac{P_2 V_2 - P_1 V_1}{1-\gamma} = \frac{(600 \times 0,207) - (160 \times 0,5)}{1-1,5}$$

$$\underline{W_{A12} = -88,4 \text{ kJ}}$$

$$Q_{A12} = W_{A12} = m_{A1} c_{v,A} (T_2 - T_1)$$

$$Q_{A12} = 0,91 \times 0,718 (491 - 303,15) + W_{A12} = -88,4$$

$$\underline{Q_{A12} = 21,04 \text{ kJ}}$$

$$u = 1,0542 \times 10^{-3} + c_{v,T} (1,051 - 1,0522 \times 10^{-3}) \Rightarrow \underline{u_A = 0,545 \text{ m}^3/\text{kg}}$$

$$V_{B1} = u_{B1} \times m \Rightarrow 0,545 \times 3 \Rightarrow \underline{1,635 \text{ m}^3}$$

$$V_{A2} + V_{B2} = V_{A1} + V_{B1} = V_T \Rightarrow V_{B2} + V_{A2} \Rightarrow \underline{V_{B2} = 1,928 \text{ m}^3}$$

$$u_{B2} = \frac{V_{B2}}{m} \Rightarrow \underline{0,642 \text{ m}^3/\text{kg}}$$

$$W_{B12} = -W_{A12} = \underline{88,4 \text{ kJ}}$$

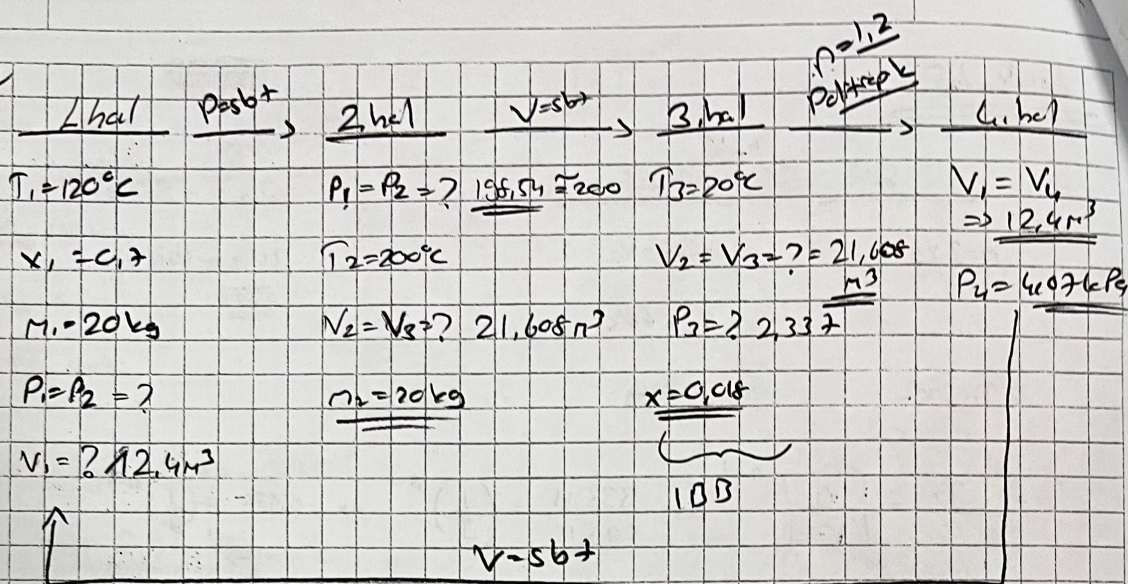
$$600 = P_{B2} \Rightarrow u_{B2} > u_B \text{ (2geni baki)}$$

$$0,642 = u_{B2} \Rightarrow \underline{u_{B2} = 3229,54 \text{ kJ/kg}}$$

$$Q_{B12} - (W_{B12} + W_p) = U_{B2} - U_{B1}$$

$$\Rightarrow Q_{B12} = 3(3229,54 - 1498,43) + 92 - 3000 = \underline{2285,33 \text{ kJ}}$$

Übung 4



$$P_1 = P_2 = \underline{198.54 \text{ kPa}}$$

$$u_1 = 1.0606 \times 10^{-3} + 0.7 \times (0.8515 - 1.0606 \times 10^{-3}) \Rightarrow \underline{u_1 = 0.62 \text{ m}^3/\text{kg}}$$

$$V_1 = m \times u_1 \Rightarrow 20 \times 0.62 = \underline{12.4 \text{ m}^3}$$

$$V_2 = 12.4 \text{ m}^3 = V_1$$

$$u_2 = 1.0804 \text{ m}^3/\text{kg}$$

$$\underline{V_2 = m \times u_2 \Rightarrow 20 \times 1.0804 = 21.608 = \underline{V_2}}$$

$$V_2 = V_3 = 21.608 \text{ m}^3$$

$$u_3 = u_2 = 1.0804$$

$$\Rightarrow u_2 = 1.0804 = 1.0017 \times 10^{-3} + x \cdot (57.84 - 1.0017 \times 10^{-3})$$

$$\underline{x = 0.018}$$

$$P_3 = P_4 = 2.337 \text{ kPa}$$

$$\textcircled{4} \Rightarrow 2.337 \times 21.608 = P_4 \times 12.4 \Rightarrow \underline{P_4 = 4.95 \text{ kPa}}$$

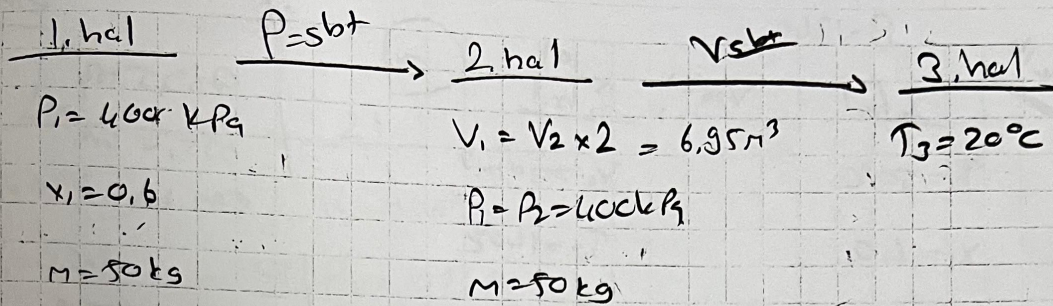
$$w_{12} = P_1 (V_2 - V_1) \Rightarrow 200 \cdot (21.608 - 12.4) = \underline{1841.6 \text{ kJ}}$$

$$w_{23} = 0$$

$$w_{34} = \frac{P_2 V_2 - P_1 V_1}{1 - n}$$

4. Bolam Örnekleme

4. bolam
Örnek 3
V₁
4 m³
4 kPa



$$13,9 \text{ m}^3 \leftarrow V_1 = ? \quad T_1 = ?$$

$$T_1 = T_d = 143,62^\circ\text{C}$$

$$u_1 = 1,0839 \times 10^3 + 0,6 (0,4622 - 1,0839 \times 10^3)$$

$$u_1 = 0,278 \text{ m}^3/\text{kg}$$

$$V_1 = M \times u_1 \Rightarrow 50 \times 0,278 = \underline{\underline{13,9 \text{ m}^3}}$$

$$V_2 = \frac{V_1}{2} \Rightarrow V_2 = \underline{\underline{6,95 \text{ m}^3}} \Rightarrow u_2 = \underline{\underline{0,138}}$$

$$\Rightarrow W_{12} = P_1 (V_2 - V_1) \Rightarrow 400 \times (6,95 - 13,9) \Rightarrow \underline{\underline{-2780 \text{ kJ}}}$$

$$Q_{12} = M \cdot (h_2 - h_1) \Rightarrow$$

$$h_2 = h_s + x \cdot (h_b - h_s) \Rightarrow$$

Örnek 14

B-134g

1. hal

V_{sbt}

2. hal

(a)

$$T_1 = 50^\circ\text{C}$$

$$x_1 = 1.0$$

$$V_1 = 0.01 \text{ m}^3$$

$$m = 0.665 \text{ kg}$$

T_{tab}

$$\Rightarrow P_1 = P_d = 1317.60 \text{ kPa}$$

$$u_1 = 0.01503 \text{ m}^3/\text{kg}$$

$$V_1 = u_1 \times m \Rightarrow 0.01503 \times m = 0.01 \quad m = 0.665 \text{ kg}$$

$$V_2 = 0.01 \text{ m}^3$$

$$T_2 = 140^\circ\text{C}$$

$$P_2 = ?$$

$$W_{12} = ? \text{ " " " "}$$

$$m = 0.665$$

(c)

$$658.8 \text{ kPa}$$

$T = \text{sat}$
entropiyon

$$263.5 \text{ kPa}$$

$$30^\circ\text{C}$$

$$658.8 \text{ kPa}$$

$$T_2$$

$$571 \text{ kPa}$$

$$20^\circ\text{C}$$

$$\frac{263.5 - 658.8}{571 - 571} = \frac{30 - T_2}{30 - 20}$$

$$T_2 = 24.42^\circ\text{C}$$

(a) $W_{12} = 0$ çünkü hacim sabit

$$P_2 = ?$$

(b)

1. hal

P_{sbt}

2. hal

$$T_1 = 50^\circ\text{C}$$

$$P_2 = 1317.60 \text{ kPa}$$

$$P_1 = 1317.60 \text{ kPa}$$

$$T_2 = ?$$

$$m = 0.665$$

$$V_2 = 0.02 \text{ m}^3$$

$$V_1 = 0.01 \text{ m}^3$$

$$m = 0.665$$

$$x_1 = 1.0$$

$$T_2 = 100^\circ\text{C}$$

$$\left. \begin{array}{l} \text{Tablodan } E_{11.2} \\ \Rightarrow T_2 = 100^\circ\text{C} \end{array} \right\}$$

$$(c) W_{12} = P_1 (V_2 - V_1) \Rightarrow 1317.6 (0.02 - 0.01) \Rightarrow 13.176 \text{ kJ}$$

(c)

1. hal

P_{sbt}

2. hal

$$\Rightarrow W_{12} = P_1 \cdot V_1 \cdot \ln \frac{V_2}{V_1} \Rightarrow 1317.60 \times 0.01 \times \ln \frac{0.02}{0.01}$$

$$V_2 = 0.02 \text{ m}^3$$

$$W_{12} = 36.53 \text{ kJ}$$

$$P_2 = 658.8 \text{ kPa}$$

$$y_{ul} = P_1 \cdot V_1 = P_2 \cdot V_2 \Rightarrow 1317.60 \times 0.01 = 0.02 \times P_2$$

$$T_2 = 24.42^\circ\text{C}$$

$$P_2 = 658.8 \text{ kPa}$$

Örnek 13

Table

Smek 13

1 hal

$$T_1 = 40^\circ\text{C}$$

$$V_1 = 0,2 \text{ m}^3$$

$$P_1 = ? \quad \underline{112 \text{ kPa}}$$

$$m_1 = ?$$

2 hal

$$V_2 = 0,4 \text{ m}^3$$

$$P_2 = 132 \text{ kPa}$$

$$m = 0,173 \text{ kg}$$

$$P_i = P_{\text{atm}} + P_p + \cancel{P_g}$$

$$P_i = 100 + \frac{m_p \cdot g}{A_p} \Rightarrow 100 + \frac{9,8 \times 120 \times 10^{-3}}{0,1} = \underline{112 \text{ kPa}} = \underline{P_i}$$

$$\Rightarrow 112 \times 0,2 = m_1 \cdot 0,41195 \times 313,15 \Rightarrow \underline{m = 0,173 \text{ kg}}$$

$$P_i + P_g = 112 + \frac{F_g}{A_p} \Rightarrow P_g = k \frac{(V_2 - V_1)}{(A_p)^2} \Rightarrow 1000 \cdot \frac{(0,4 - 0,2)}{(0,1)^2} \times 10^{-3}$$

$$\underline{P_g = 20 \text{ kPa}}$$

$$P_2 = P_i + P_{g2} \Rightarrow \underline{132 \text{ kPa}} = P_2$$

$$132 \times 0,4 = 0,173 \times 0,41195 \times T_2 \Rightarrow \underline{T_2 = 740,82^\circ\text{C}}$$

$$W_{12} = \frac{(P_1 + P_2)}{2} \cdot (V_2 - V_1) \Rightarrow \frac{(112 + 132)}{2} \cdot (0,2) \Rightarrow \underline{24,4 \text{ kJ}}$$

$$W_{12s} = P_1 (V_2 - V_1) \Rightarrow 112 \times (0,2) = \underline{22,4 \text{ kJ}}$$

$$W_{y12} = \frac{(P_2 - P_1)}{2} (V_2 - V_1) \Rightarrow \frac{132 - 112}{2} \cdot (0,2) \Rightarrow \underline{2 \text{ kJ}}$$

210 Problem

$$① \Rightarrow 0,13 = 0,671 \times 10^{-3} + x \cdot (0,16070 - 0,671 \times 10^{-3}) \Rightarrow x = 0,85$$

$$② \Rightarrow v_{1,82} = 675,47 + x \cdot (2756,7 - 675,47) \Rightarrow x = 0,48$$

$$u = 1,1022 \times 10^{-3} + 0,48 \cdot (0,3068 - 1,1022 \times 10^{-3}) \Rightarrow u = 0,147$$

Örnek 11

A kabi

$$V = 0,3 \text{ m}^3$$

$$P = 300 \text{ kPa}$$

$$T = 300 \text{ K}$$

Argon

$$P \cdot V_1 = n \cdot R \cdot T$$

$$\Rightarrow 300 \times 0,3 = n \times 0,20813 \times 300$$

$$n = 1,44$$

Son halde

$$\text{Sistem dışıdır} \Rightarrow P_2 = P_{1c} = 160 \text{ kPa}$$

$$T_2 = 30^\circ \text{C} \Rightarrow 303,15 \text{ K}$$

$$160 \times V_2 = 1,44 \times 0,20813 \times 303,15$$

$$V_2 = 0,567$$

$$W_{12} = P_c (V_2 - V_1) \Rightarrow 160 \times (0,567 - 0,3)$$

$$W_{12} = 42,72$$

Örnek 12

A kabi

$$P = 1000 \text{ kPa}$$

$$T = 300^\circ \text{C}$$

$$m = 5 \text{ kg}$$

$$V = 1,29 \text{ m}^3$$

$$\left. \begin{array}{l} T_d = 1798,8 \text{ K} \\ \text{KRB} \end{array} \right\}$$

$$v = 0,2580 \Rightarrow V_1 = m \times v \Rightarrow 5 \times 0,2580$$

$$V_1 = 1,29 \text{ m}^3$$

$$V_2 = 0,3 + m \times v_2$$

$$v_2 = 0,06 \quad (133)$$

$$-W_{12} = 5 \times (2808,86 - 2794,10)$$

$$W_{12} = -73,8 \text{ kJ}$$

$$v_2 = v_5 + x \cdot (v_6 - v_5)$$

$$0,06 = 1,0608 \times 10^{-3} + x \cdot (0,8854 - 1,0608 \times 10^{-3})$$

$$x = 0,066$$

Sabah yapilan ank Tablosu

ÖRNEK

T(°C)	P(kPa)	ν (m³/kg)	X	Bölge
50	12,335	7,72	0,64	İBB
120,23	200	0,8854	1	Doğrusal Bölge
250	400	0,5951	—	KBB
110	600	0,5951	—	SSB

0,001053

1. Satır

$$\nu_1 = \nu_s + x, (\nu_b - \nu_s) \Rightarrow 7,72 = 1,0121 \times 10^{-3} + x, (12,05 - 1,0121 \times 10^{-3})$$

$$\underline{x = 0,64}$$

$$\Rightarrow 7,71538 = x, (---)$$

2. satır

$$x = \text{Lidold için } T = T_d = 120,23^\circ\text{C} \quad , \quad \nu = \nu_b \Rightarrow 0,8854$$

3. satır

$$\text{KBB bölgesinde } T > T_d \quad \nu = 0,5951$$

4. satır

$$T = 110^\circ\text{C} \quad P = 600 \text{ kPa} \quad \text{Tablodan Sıvı Olayı} \Rightarrow \nu =$$

$$③ \Rightarrow P_3 V_3 = n R T_3 \Rightarrow 100 \times 10 = 2 \times 0,287 \times T_3 \Rightarrow \underline{T_3 = 1742,16 \text{ K}}$$

$$② \Rightarrow P_2 V_2 = n R T_2 \Rightarrow 100 \times 2 = 2 \times 0,287 \times T_2 \Rightarrow \underline{T_2 = 348,43 \text{ K}}$$

$$① \Rightarrow P_1 V_1 = n R T_1 \Rightarrow P_1 \times 2 = 2 \times 0,287 \times 1742,16 \Rightarrow \underline{P_1 = 500 \text{ kPa}}$$

$$W_{12} = 0 \Rightarrow \underline{V = \text{const}}$$

$$Q_{12} = n C_{v0} (T_2 - T_1) \Rightarrow 2 \times 0,7165 (348,43 - 1742,16) = \underline{Q_{12} = -1997,21 \text{ kJ}}$$

$$W_{23} \Rightarrow P_1 (V_3 - V_2) = 100 \times (10 - 2) \Rightarrow \underline{800 \text{ kJ}}$$

$$Q_{23} \Rightarrow n C_{p0} (T_3 - T_2) \Rightarrow 2 \times 1,0035 \times (1742,16 - 348,43) \Rightarrow \underline{Q_{23} = 2797,21 \text{ kJ}}$$

$$W_{31} \Rightarrow P_3 V_3 \ln \frac{V_1}{V_3} \Rightarrow W_{31} = 100 \times 10 \times \ln \frac{2}{10} \Rightarrow \underline{-1609,44 \text{ kJ}}$$

$$Q_{31} - W_{31} = n C_{v0} (T_1 - T_3) \Rightarrow \underline{Q_{31} = W_{31} = -1609,44 \text{ kJ}}$$

-1609,43

$$Q_{\text{ges}} = Q_{23} = 2797,21$$

$$W_{\text{net}} \Rightarrow 800 - 1609,43 = \underline{-809,43 \text{ kJ}}$$

$$\eta = \frac{W_{\text{net}}}{Q_{\text{ges}}} = \frac{-809,43}{2797,21} = \underline{-0,289}$$

(W_{net} ist dann doch abstrahieren)
 ist vermehrt beibehalten
 $\Rightarrow$ gegeben bei wenn dort u dort
 wenn gegeben.

T-V

