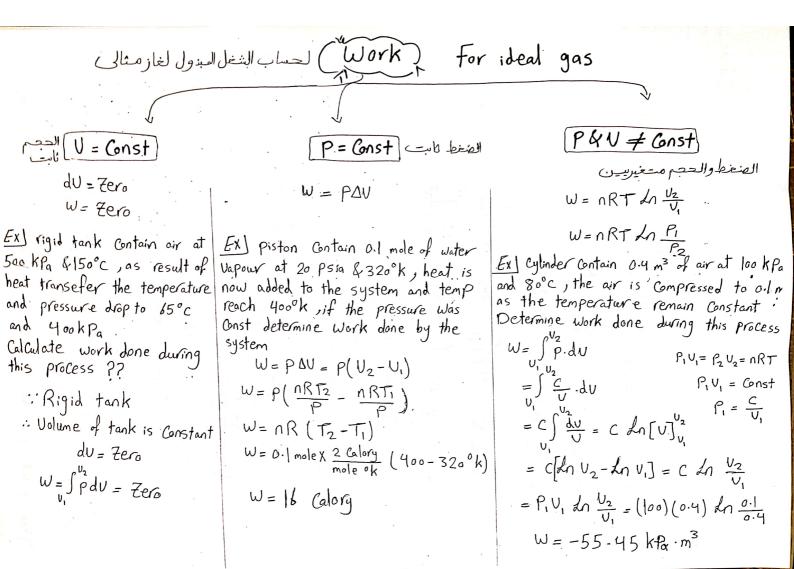
سنتر فيوتشر

Subject:	رادي	ای ای)
Chapter:	ς,	نزمه	

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(Work done by real gas) (Desired by real gas)

to Calculate the work done by real gas that obey Vander Vall equation when expand at const temperature from Volume U, to final Volume U2

$$(P + \frac{\alpha n^2}{V^2})(V - nb) = nRT \rightarrow \text{Uander uall equation}$$
As $\alpha \& b$ Constant
$$P = \frac{nRT}{V - nb} - \frac{\alpha n^2}{V^2}$$

$$W = \int_{V_1}^{V_2} P \cdot dV = \int_{V_1}^{V_2} \left(\frac{nRT}{V - nb} - \frac{\alpha n^2}{V^2}\right) \cdot dV$$

$$= \int_{V_1}^{V_2} \frac{nRT}{V - nb} \cdot dV - \int_{V_2}^{V_2} \frac{\alpha n^2}{V^2} \cdot dV$$

$$= nRT \int_{U_{1}}^{U_{2}} \frac{dU}{U-nb} - an^{2} \int_{U_{1}}^{U_{2}} U^{-2} dU$$

$$= nRT \ln \left[v - nb \right]_{v_1}^{v_2} - an^2 \left[\frac{v^{-2+1}}{-2+1} \right]_{v_1}^{v_2}$$

$$= nRT dn \left[U - nb \right]_{U_1}^{U_2} - an^2 \left[\frac{U^{-1}}{-1} \right]_{U_2}^{U_2}$$

=
$$nRT dn[U-nb]_{U_1}^{V_2} + an^2(-\frac{1}{U})_{U_2}^{V_2}$$

$$= n RT \left[2n \left(V_2 - nb \right) - 2n \left(V_1 - nb \right) \right] + an^2 \left(\frac{1}{V_2} - \frac{1}{V_1} \right)$$

$$W = nRT \ln \frac{U_2 - nb}{U_1 - nb} + \alpha n^2 \left(\frac{1}{U_2} - \frac{1}{U_1}\right)$$
 For real gas

Example I find work done by 1 mole of chlorine when expands at Const temperature 50°C from volume 1 L to final volume 50 L

1) if the chlorine act as ideal gas

2) if the chlorine act as real gas a= 6.493 b=0.05

Solution

Dif the chlorine act as ideal gas

$$W = nRT Ln \frac{V2}{V_1}$$

$$W = (1)[0.082 \frac{l \cdot atm}{mole \cdot k}] (50 + 273)^{\circ} k \ln \frac{50}{1}$$

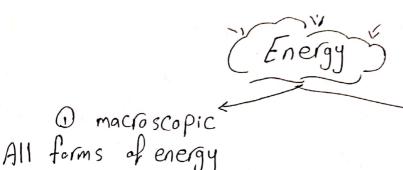
W = 103.6 L.atm

2 if the chlorine act as real gas

$$W = nRT \ln \left(\frac{V_2 - nb}{V_1 - nb} \right) + an^2 \left(\frac{1}{V_2} - \frac{1}{V_1} \right)$$

$$= (1 \text{ mole})(0.082 \frac{1.\text{ atm}}{\text{mole ok}}) (50+273 \text{ k}) \ln (\frac{50-1(0.05)}{1-1(0.05)}) + 6.493 (\frac{1}{50} - \frac{1}{1})$$

العازالمال الشغل السنول في حالة الغاز الحقيقي أقل من حالة الغاز المالي Work in Case of real gas >> Work decrease



U macroscopic
All forms of energy
outside the system
ملاطاقات خارج النظام

2) microscopic related to structure of molecules forming system

الطاقة الداخلية الداخلية الماقة الداخلية الماقة الداخلية على Internal energy (u) على الطاقة الداخلية على الطاقة الدرسطة بـ structure وانتقال عن مستوى الأفر وهكذا

** kinetic energy (k.E) = J=1 = $\frac{1}{2}$ | $\frac{1}{2$

The energy result of it's elevation in gravitional field as levation of it's elevation of it's elevation present the present as levation in gravitional field as levation in gravition in gra

Total energy = internal energy + kinetic energy + Potential energy $E = U + k \cdot E + P \cdot E$ $\Delta E = \Delta U + \Delta k \cdot E + \Delta P \cdot E$

* First Law of thermodynamics has three forms 1- Energy Can't be created or destroyed but it can transeter from one form to another. قانون بقاء الطاقة ولاتست عن العدم ولذن يمكن تحويله امن مرورة 2-Total amount of energy of system & surrounding are Constant and energy of system & surrounding 3- During the interaction between System & surrounding energy gained by = (energy lost by the system) = the surrounding)

The system = Ildles lbin and a lbin = lbin a speed a lbin a DE = Q ± W As معدارالطاقة المكتسبة heat gained or heat lost معدارالطاقة المكتسبة المحافظة المحافظ But DE = Du + Dk.E + DP.E neglect change in kinetic energy & Potential energy $AE = \Delta 4$ LDU = Q + W

First Law of thermodynamics (DE = Q + W) $\Delta E = Q + W$ $\Delta E = Q - W$ Q >+Ue "gained heat 5/1/2/1"

" افقد حراح " loss heat " أفقد حراح " loss heat " ا

W -ve "work done on system" -ve system

-ve "work done by system"

Ex A rigid tank Contains hot fluid that is cooled while being stirred by a paddle wheel. The initial internal energy of the fluid is 800 kJ during the Cooling process, the fluid losses 500 kJ of heat, and the paddle wheel does looky at work on fluid Determine the final internal energy of the fluid ?? Neglect the energy stored in the paddle wheel

U, = Sooky Q = -500kT W = + 100 kg $U_2 = ??$

DE=Q+W Δ = -500 + 100 = -400 kg DE = DU + DKE + DPE neglect energy stored in Paddle Wheel $\Delta E = \Delta U = U_2 - U_1$ -400 = 42 - 800U2 = -400+800 Uz = +400 KJ

Net heat transefer at Constant Volume DE = 9 - W But $\Delta E = \Delta u + \Delta k E + \Delta p E$: DE = DU Δu= 9-W But w= Sp.du at Const Volume du= Fero W = Zero $u_2 - u_1 \leftarrow 0$: $\Delta u = 9_V$ Net change in internal energy = heat transefer at const volume كمية العرارة المنتقلة عند صعرات = محصلة الدغييري الطاقة الداخلية The state of internal energy Wet heat transefer at constant pressure $\Delta E = 9 - \omega$ W=PAU at Const pressure $9 = \Delta E + W$ DE = QU (PAV + PAV = م9) عند بثوب الضغط 9p = (Uz-U1) + P(U2-U1) 9p = u2 -u1 + PU2 -PU1 $9_p = u_2 + pv_2 - (u_1 + pv_1)$ 2p = H2 - H, $9_p = \Delta H$ net change in enthalpy = net change in heat transeter at كعية العرارة المنتقلة عند منغط كابت = محصلة التغيير في المحتوى العراري about of heat content

المصنوى العرارى (H) -: Enthalpy: is thermodynamic quantity equivalent to heat content of system وى كمية وموديناميكية مكافئة للمحتى العرارى للنظام > change in enthalpy associated to particular chemical process التعنيرفي المحتوى العراري مرسبط جزئياً بالعملية الكيميائية * Relation between 9p & 9v 00 $q_{p} = \Delta u + p \Delta v$ $q_p = \Delta u + W \implies q_p = q_v + W$ Sep 7 9 9p is larger than 9, by work ا ملعوظة هامة مرآة at const volume the increase in heat transefer of to increase in internal energy qu - at Const pressure the increase in heat transefer C> go to Work

> 90 to increase in internal energy

 $Q_{\rho} = \Delta u + w$