GASES IDEALES Y REALES

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Gases ideales y Factor de Compresibilidad

Ideales

$Si\ P \to 0 \quad \Rightarrow \quad \frac{PV}{T} \to R$

$Si\ T \uparrow \quad \Rightarrow \quad Ideal$

$Si\ P \uparrow \quad \Rightarrow \quad Real$

Ideal
Traslación azarosa de las moléculas.
Moléculas con volumen nulo
Moléculas sin atracción entre sí
Gases en su mayoría son diatómicos: N_2, O_2, Cl_2, F_2
Ggases triatómicos: O_3
Gases moleculares: CO_2, CH_4, NO_x SO_x

Real
Considera tamaño de partículas
Interacción de las partículas
Estados fuera de equilibrio
Disociación molecular
Puede considerar reacciones

$$PV = nRT$$

$$P = \frac{n}{V} \cdot N_A \cdot \frac{RT}{N_A}$$

$$P = NkT$$

$N = \#\,total\ moléculas\ /\ unidad\ volumen$

Van der Waals

$$\left[P + a\left(\frac{n}{V}\right)^2\right](V - nb) = nRT$$

$$a = \frac{27(RT_c)^2}{64P_c}, \quad b = \frac{RT_c}{8P_c}$$

Boyle (isotermas)

$$V \propto \frac{1}{P} \quad VP = cte$$

Charles (Ley expansión) (isobaras)

$$V \propto T \quad \frac{V}{T} = cte$$

Gay-Lussac (isocoras)

$$P \propto T \quad \frac{P}{T} = cte$$

Avogadro (isopletas)*

$$V \propto n$$

* Composición constante

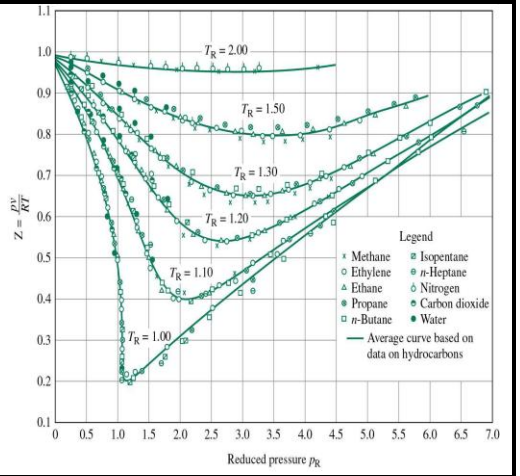
Datos / Modelos Gases Reales

Valores R:
atm L / (mol K): 0.08206
atm cm^3 / (mol K): 82.0575
J / (mol K): 8.314462
kPa m^3 / (kmol.K): 8.314462
psi pie^3 / (lbmol ^oR): 10.73
bar L / (mol K): 0.08314472
Btu / (lbmol ^oR): 1.9859
(kg/cm^2) L / (mol K): 0.0847
mmHg/ (mol K): 62.364
plgHg pie^3/ (lbmol ^oR) 21.85
°C = (°F − 32) ÷ 1.8
°F = (°C × 1.8) + 32
°C = K − 273.15
°R = °F + 459.67

R $_{aire}$ = 0.287 kJ / (kg K)
R $_{bióxido\ carbono}$ = 0.187
R $_{nitrógeno}$ =.2968
Volumen molar (V_m) = 22.414 L STP
IUPAC (STP) NIST, ISO, EEA, ICAO: 273 K, 1atm
Número Avogadro (N_A):
$6.02214129 \times 10^{23}$
Constante Boltzmann (k)

$$k = \frac{R}{N_A} \quad \begin{matrix} 1.3806504(24)\times10^{-23}\,\mathrm{J\,K^{-1}} \\ 8.617343(15)\times10^{-5}\,\mathrm{eV\,K^{-1}} \\ 0.00831447\,\mathrm{kJmol^{-1}K^{-1}} \end{matrix}$$

1 atm = 760 mmHg= 760 torr = 1.01325 bar= 14.696 psi = 0.7037 at
1cm H_2O = 98.064 Pa @ 4°C



Factor Compresibilidad (Z)

$$PV = ZnRT$$

Para mayoría de gases
Z_c=0.2 -0.33

$$P_r = \frac{P}{P_c}, \quad T_r = \frac{T}{T_c}, \quad V_r = \frac{V \cdot P_c}{R \cdot T_c} \qquad r = reducido, \quad c = crítico$$

	Constantes Críticas				Acéntrico	Coeficientes de Van der Waals	
Fórmula	T_c (K)	P_c (MPa)	$10^6 V_c$ (m^3/mol)	Z_c	w	10^3 a (m^6Pa/mol^2)	10^6 b (m^3/mol)
He	5.3	0.229	61.6	0.29	0	3.45	23.7
H_2	3.33	1.30	69.7			24.7	26.6
N_2	126.1	3.39	90.0	0.291	0.040	141	39.1
CO	134.0	3.51	90.0	0.294	0.046	151	39.9
O_2	154.3	5.04	74.4			138	31.8
C_2H_4	282.9	5.16	127.5	0.270	0.087	453	57.1
CO_2	304.2	7.38	94.2	0.274	0.420	365	42.7
NH_3	405.6	11.37	72.0	0.242	0.252	422	37.1
H_2O	647.2	22.06	55.44			553	30.5
Hg	1735.0	105.0	40.1			820	17.0

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Redlich-Kwong

$\bar{v} = volumen\ molar\ (m^3/mol)$

$$P = \frac{RT}{\bar{v} - b} - \frac{a}{\sqrt{T}\bar{v}(\bar{v} + b)} \qquad a = \frac{0.42748R^2T_c^{2.5}}{P_c} \qquad b = \frac{0.08662RT_c}{P_c}$$

Dieterici

$$P = \frac{nRT}{V - nb}e^{\frac{-na}{VRT}} \qquad a = \frac{RT_c}{e^2P_c}, \quad b = \frac{4R^2T_c^2}{e^2P_c}$$

Berthelot

$$P = \frac{nRT}{V - nb} - \frac{n^2a}{TV^2} \qquad a = \frac{27R^2T_c^3}{64P_c}, \quad b = \frac{RT_c}{8P_c}$$

Beattie-Bridgeman

$P \le 0.8P_c$

$$P = \frac{R_uT}{\bar{v}}\left(1 - \frac{c}{\bar{v}T^3}\right)(\bar{v} + B) - \frac{A}{\bar{v}^2}$$

R_u *y* $\bar{v}$ *son referidas a* mol^{-1}

$$A = A_0\left(1 - \frac{a}{\bar{v}}\right) \quad y \quad B = B_0\left(1 - \frac{b}{\bar{v}}\right)$$

Benedict-Webb-Rubin

$P \le 2.5P_c$

$$P = \frac{R_uT}{\bar{v}} + \left(B_0R_uT - A_0 - \frac{C_0}{T^2}\right)\frac{1}{\bar{v}^2} + \frac{bR_uT - a}{\bar{v}^3} + \frac{a\alpha}{\bar{v}^6} + \frac{c}{\bar{v}^3T^2}\left(1 + \frac{\gamma}{\bar{v}^2}\right)e^{\frac{-\gamma}{\bar{v}^2}}$$

Peng-Robinson

$\omega = -\log_{10}(P_r^{sat}) - 1 \quad @ \quad T_r = 0.7$

$$P = \frac{RT}{\bar{v} - b} - \frac{a\alpha}{\bar{v}^2 + 2b\bar{v} - b^2} \qquad a = \frac{0.45724R^2T_c^2}{P_c} \qquad b = \frac{0.07780RT_c}{P_c}$$

$$\alpha = (1 + (0.37464 + 1.54226\omega - 0.26992\omega^2)(1 - T_r^{0.5}))^2; \quad \omega = factor\ acéntrico$$

Ecuación Virial

$$\frac{P\bar{v}}{RT} = 1 + \frac{B}{\bar{v}} + \frac{C}{\bar{v}^2} + \frac{D}{\bar{v}^3} + \ldots; \quad B = -V_c; \quad C = \frac{V_c^2}{3}$$

T es Temperatura de Boyle
Cuando B =0