Cálculo del equilibrio líquido-vapor de una mezcla de gas de síntesis y amoníaco líquido a alta presión.
Se calcula el dew point y la composición del líquido, dada la composición en fase gas .

Se utiliza la ecuación de Redlich-Kwong modificada por De Santis & al. Ind. Eng. Chem. Proc. Des. Dev. 13, 1974
según el artículo Calculation of Vapor-Liquid Equilibria for the system NH3-N2-H2-A-CH4
C.G..Alesandrini, S. Lynn, J.M. Prausnitz, Ind, Eng. Chem. Proc. Des. Dev. 11, 1972.

*P = R*T/(v-b) - a(T)/T^1/2/v/(v+b)*

	b_i	a_{ii}	P_c (atm)	T_c (K)
NH3	24,33		111,3	405,5
CH4		45,8		190,7
H2	20,2/(1+44,2/2,016/T)	43,6/(1+21,8/2,016/T)	quantum effects	
N2	0,02678	15,462	33,5	126,2
A		48,0	151,2	

*Para amoníaco a(T) = 24,33+0,5017E6*T^(-3/2) y a_0 = 24,33*
*Su derivada es : da/dT = (-3/2*0,5017E6/T^(-5/2))*
Los gases son 1= NH3, 2 = CH4, 3 = H2, 4 = N2, 5 = A

Composición gaseosa

$y_1 = 0{,}08$ *NH3*

$y_2 = 0{,}088$ *CH4*

$y_3 = 0{,}598$ *H2*

$y_4 = 0{,}199$ *N2*

$y_5 = 0{,}035$ *A*

$$b_1 = 0{,}08664 \cdot 0{,}0820597 \cdot \frac{405{,}5}{111{,}3}$$

$$b_2 = 0{,}08664 \cdot 0{,}0820597 \cdot \frac{190{,}7}{45{,}8}$$

$$b_3 = 0{,}08664 \cdot 0{,}0820597 \cdot \left[\frac{\dfrac{43{,}6}{1 + \dfrac{21{,}8}{2{,}016 \cdot T}}}{\dfrac{20{,}2}{1 + \dfrac{44{,}2}{2{,}016 \cdot T}}} \right]$$

$b_4 = 0{,}02678$

$$b_5 = 0{,}08664 \cdot 0{,}0820597 \cdot \frac{151{,}2}{48}$$

$$b_M = y_1 \cdot b_1 + y_2 \cdot b_2 + y_3 \cdot b_3 + y_4 \cdot b_4 + y_5 \cdot b_5$$

$$a_1 = \frac{501700}{T^{1{,}5}}$$

$$a_2 = 0{,}4275 \cdot 0{,}0820597^2 \cdot \frac{190{,}7^{2{,}5}}{45{,}8}$$

$$a_3 = 0{,}4275 \cdot 0{,}0820597^{2} \cdot \left[\frac{\left(\frac{43{,}6}{1 + \frac{21{,}8}{2{,}016 \cdot T}} \right)^{2{,}5}}{\frac{20{,}2}{1 + \frac{44{,}2}{2{,}016 \cdot T}}} \right]$$

$$a_4 = 15{,}462$$

$$a_5 = 0{,}4275 \cdot 0{,}0820597^{2} \cdot \frac{151{,}2^{2{,}5}}{48}$$

$R = 0{,}0820597$ [atm-m^3/kmol-K]

$$a_M = \left[y_1 \cdot 24{,}33^{0{,}5} + y_2 \cdot a_2^{0{,}5} + y_3 \cdot a_3^{0{,}5} + y_4 \cdot a_4^{0{,}5} + y_5 \cdot a_5^{0{,}5} \right]^2 + y_1^{2} \cdot a_1$$

$$DT = \frac{-3}{2} \cdot \frac{501700}{T^{\left[\frac{-5}{2}\right]}} \cdot y_1^{2}$$

$$P = R \cdot \left[\frac{T}{v - b_M} \right] - \left[\frac{\frac{a_M}{v}}{\frac{v + b_M}{T^{0{,}5}}} \right]$$

$$\Delta h = \left[P \cdot v - R \cdot T - \left(\left[\frac{1{,}5 \cdot \frac{a_M}{\sqrt{T}} - DT \cdot \sqrt{T}}{b_M} \right] \cdot \ln\left[\frac{v + b_M}{v} \right] \right) \right] \cdot \left| 101{,}325 \cdot \frac{J/kmol}{atm*l/kmol} \right|$$

$$\ln\left[\nu_1\right] = \ln\left[\frac{v}{v - b_M} \right] + \frac{b_1}{v - b_M} - \left[\frac{\frac{2}{R}}{T^{1{,}5} \cdot b_M} \cdot \left(y_1 \cdot \left[24{,}33 + a_1 \right] + y_2 \cdot \left[24{,}33 \cdot a_2 \right]^{0{,}5} + y_3 \right.\right.$$

$$\left. \cdot \left[24{,}33 \cdot a_3 \right]^{0{,}5} + y_4 \cdot \left[24{,}33 \cdot a_4 \right]^{0{,}5} + y_5 \cdot \left[24{,}33 \cdot a_5 \right]^{0{,}5} \right) \cdot \ln\left(\frac{v + b_M}{v} \right) \Bigg] + a_M \cdot \frac{\frac{b_1}{R}}{\frac{T^{1{,}5}}{b_M^{2}}}$$

$$\cdot \left[\ln\left(\frac{v + b_M}{v} \right) - \left(\frac{b_M}{v + b_M} \right) \right] - \ln\left[P \cdot \frac{v}{R \cdot T} \right]$$

$$\ln\left[\nu_2\right] = \ln\left[\frac{v}{v - b_M} \right] + \frac{b_2}{v - b_M} - \left[\frac{\frac{2}{R}}{T^{1{,}5} \cdot b_M} \cdot \left(y_1 \cdot \left[a_2 \cdot 24{,}33 \right]^{0{,}5} + y_2 \cdot a_2 + y_3 \cdot \left[a_2 \cdot a_3 \right]^{0{,}5} \right.\right.$$

$$\left. + y_4 \cdot \left[a_2 \cdot a_4 \right]^{0{,}5} + y_5 \cdot \left[a_2 \cdot a_5 \right]^{0{,}5} \right) \cdot \ln\left(\frac{v + b_M}{v} \right) \Bigg] + a_M \cdot \frac{\frac{b_2}{R}}{\frac{T^{1{,}5}}{b_M^{2}}} \cdot \left[\ln\left(\frac{v + b_M}{v} \right) - \left(\frac{b_M}{v + b_M} \right) \right]$$

$$- \ln\left[P \cdot \frac{v}{R \cdot T} \right]$$

$$\ln[\nu_3] = \ln\left[\frac{v}{v - b_M}\right] + \frac{b_3}{v - b_M} - \left[\frac{\frac{2}{R}}{T^{1,5} \cdot b_M} \cdot (y_1 \cdot [a_3 \cdot 24{,}33]^{0,5} + y_2 \cdot [a_3 \cdot a_2]^{0,5} + y_3 \cdot a_3 + y_4 \cdot [a_3 \cdot a_4]^{0,5} + y_5 \cdot [a_3 \cdot a_5]^{0,5}) \cdot \ln\left(\frac{v + b_M}{v}\right)\right] + a_M \cdot \frac{\frac{b_3}{R}}{\frac{T^{1,5}}{b_M{}^2}} \cdot \left[\ln\left(\frac{v + b_M}{v}\right) - \left(\frac{b_M}{v + b_M}\right)\right] - \ln\left[P \cdot \frac{v}{R \cdot T}\right]$$

$$\ln[\nu_4] = \ln\left[\frac{v}{v - b_M}\right] + \frac{b_4}{v - b_M} - \left[\frac{\frac{2}{R}}{T^{1,5} \cdot b_M} \cdot (y_1 \cdot [a_4 \cdot 24{,}33]^{0,5} + y_2 \cdot [a_4 \cdot a_2]^{0,5} + y_3 \cdot [a_4 \cdot a_3]^{0,5} + y_4 \cdot a_4 + y_5 \cdot [a_4 \cdot a_5]^{0,5}) \cdot \ln\left(\frac{v + b_M}{v}\right)\right] + a_M \cdot \frac{\frac{b_4}{R}}{\frac{T^{1,5}}{b_M{}^2}} \cdot \left[\ln\left(\frac{v + b_M}{v}\right) - \left(\frac{b_M}{v + b_M}\right)\right] - \ln\left[P \cdot \frac{v}{R \cdot T}\right]$$

$$\ln[\nu_5] = \ln\left[\frac{v}{v - b_M}\right] + \frac{b_5}{v - b_M} - \left[\frac{\frac{2}{R}}{T^{1,5} \cdot b_M} \cdot (y_1 \cdot [a_5 \cdot 24{,}33]^{0,5} + y_2 \cdot [a_5 \cdot a_2]^{0,5} + y_3 \cdot [a_5 \cdot a_3]^{0,5} + y_4 \cdot [a_5 \cdot a_4]^{0,5} + y_5 \cdot a_5) \cdot \ln\left(\frac{v + b_M}{v}\right)\right] + a_M \cdot \frac{\frac{b_5}{R}}{\frac{T^{1,5}}{b_M{}^2}} \cdot \left[\ln\left(\frac{v + b_M}{v}\right) - \left(\frac{b_M}{v + b_M}\right)\right] - \ln\left[P \cdot \frac{v}{R \cdot T}\right]$$

$$P = 200 \quad [atm]$$

$$\beta_1 = \frac{\mathbf{v}_{Crit}['Ammonia']}{R} \cdot \left[1 - 0{,}89 \cdot \mathbf{AcentricFactor}^{0,5}('Ammonia')\right] \cdot \exp\left[6{,}9547 - 76{,}2853 \cdot \frac{T}{\mathbf{T}_{Crit}('Ammonia')} + 191{,}306 \cdot \left(\frac{T}{\mathbf{T}_{Crit}['Ammonia']}\right)^2 - 203{,}5472 \cdot \left(\frac{T}{\mathbf{T}_{Crit}['Ammonia']}\right)^3 + 82{,}7631 \cdot \left(\frac{T}{\mathbf{T}_{Crit}['Ammonia']}\right)^4\right]$$

$$F = x_1 \cdot \mathbf{v}_{Crit}['Ammonia'] + x_2 \cdot \mathbf{v}_{Crit}['CH4'] + x_3 \cdot \mathbf{v}_{Crit}['H2'] + x_4 \cdot \mathbf{v}_{Crit}['N2'] + x_5 \cdot \mathbf{v}_{Crit}['Argon']$$

$$G = R \cdot \left[x_1 \cdot \mathbf{T}_{Crit}(\text{'Ammonia'}) + x_2 \cdot \mathbf{T}_{Crit}(\text{'CH4'}) + x_3 \cdot \mathbf{T}_{Crit}(\text{'H2'}) + x_4 \cdot \mathbf{T}_{Crit}(\text{'N2'}) + x_5 \cdot \mathbf{T}_{Crit}(\text{'Argon'}) \right]$$

$$H = 1 - 0{,}89 \cdot \left[x_1 \cdot \mathbf{AcentricFactor}(\text{'Ammonia'}) + x_2 \cdot \mathbf{AcentricFactor}(\text{'CH4'}) + x_3 \cdot \mathbf{AcentricFactor}(\text{'H2'}) + x_4 \cdot \mathbf{AcentricFactor}(\text{'N2'}) + x_5 \cdot \mathbf{AcentricFactor}(\text{'Argon'}) \right]^{0,5}$$

$$J = \mathbf{exp}\left[6{,}9547 - 72{,}2853 \cdot T \cdot \frac{R}{G} + 191{,}306 \cdot \left(T \cdot \frac{R}{G} \right)^2 - 203{,}5472 \cdot \left(T \cdot \frac{R}{G} \right)^3 + 82{,}7631 \cdot \left(T \cdot \frac{R}{G} \right)^4 \right]$$

$$J2 = \mathbf{exp}\left[6{,}9547 - 72{,}2853 \cdot T \cdot \left(\frac{R}{G - R \cdot x_2 \cdot \mathbf{T}_{Crit}[\text{'CH4'}] + 191{,}306 \cdot \left[T \cdot \left(\frac{R}{G - R \cdot x_2 \cdot \mathbf{T}_{Crit}[\text{'CH4'}]} \right) \right]^2 - 203{,}5472 \cdot \left[T \cdot \left(\frac{R}{G - R \cdot x_2 \cdot \mathbf{T}_{C} \dots} \right. \right. \dots} \right. \right.$$

$$H2 = 1 - 0{,}89 \cdot \left[x_1 \cdot \mathbf{AcentricFactor}(\text{'Ammonia'}) + x_3 \cdot \mathbf{AcentricFactor}(\text{'H2'}) + x_4 \cdot \mathbf{AcentricFactor}(\text{'N2'}) + x_5 \cdot \mathbf{AcentricFactor}(\text{'Argon'}) \right]^{0,5}$$

$$DJ2 = J2 \cdot \left[-72{,}2853 \cdot T \cdot \left(\frac{R}{G - R \cdot x_2 \cdot \mathbf{T}_{Crit}[\text{'CH4'}]} - \mathbf{T}_{Crit}[\text{'CH4'}] \cdot \left[\frac{R}{G - R \cdot x_2 \cdot \mathbf{T}_{Crit}(\text{'CH4'})} \right]^2 \right) + 191{,}306 \cdot T^2 \cdot \left(2 \cdot \left[\frac{R}{G - R \cdot x_2 \cdot \mathbf{T}_{Crit}(\text{'CH4'})} \right]^2 - 2 \cdot \mathbf{T}_{Crit}[\text{'CH4'}] \cdot \left[\frac{R}{G - R \cdot x_2 \cdot \mathbf{T}_{Crit}(\text{'CH4'})} \right]^3 \right) - 203{,}5472 \cdot T^3 \cdot \left(3 \cdot \left[\frac{R}{G - R \cdot x_2 \cdot \mathbf{T}_{Crit}(\text{'CH4'})} \right]^3 - 3 \cdot \mathbf{T}_{Crit}[\text{'CH4'}] \cdot \left[\frac{R}{G - R \cdot x_2 \cdot \mathbf{T}_{Crit}(\text{'CH4'})} \right]^4 \right) + 82{,}7631 \cdot T^4 \cdot \left(4 \cdot \left[\frac{R}{G - R \cdot x_2 \cdot \mathbf{T}_{Crit}(\text{'CH4'})} \right]^4 - 4 \cdot \mathbf{T}_{Crit}[\text{'CH4'}] \cdot \left[\frac{R}{G - R \cdot x_2 \cdot \mathbf{T}_{Crit}(\text{'CH4'})} \right]^5 \right) \right]$$

$$\beta_2 = \beta_1 + \left[\frac{\mathbf{v}(\text{'Ammonia'}; T = T; x = 0)}{413{,}88343 - 5{,}3949156 \cdot T + 0{,}029121251 \cdot T^2 - 0{,}000069651858 \cdot T^3 + 6{,}3228243 \times 10^{-8} \cdot T^4} \right] \cdot 1000 \cdot \left[\left(\left([H - x_2 \cdot \mathbf{v}_{Crit}(\text{'CH4'})] \cdot \left[\frac{J2}{G - R \cdot x_2 \cdot \mathbf{T}_{Crit}(\text{'CH4'})} \right] \right) \cdot \mathbf{v}_{Crit}(\text{'CH4'}) - \left([F - x_2 \cdot \mathbf{v}_{Crit}(\text{'CH4'})] \cdot H2 \cdot J2 \cdot R \cdot \frac{\mathbf{T}_{Crit}[\text{'CH4'}]}{[G - R \cdot x_2 \cdot \mathbf{T}_{Crit}(\text{'CH4'})]^2} \right) \right] + [F - x_2 \cdot \mathbf{v}_{Crit}(\text{'CH4'})] \cdot \left[\frac{J2}{G - R \cdot x_2 \cdot \mathbf{T}_{Crit}(\text{'CH4'}) \cdot \frac{-0{,}89}{2} \cdot \mathbf{AcentricFactor}(\text{'CH4'}) \cdot \left(\frac{0{,}89}{1 - H2} \right) + \left([F - x_2 \cdot \mathbf{v}_{Crit}(\text{'CH4'})] \cdot \left[\frac{\dots}{G - R \cdot \dots} \right. \right. \dots} \right. \dots$$

$$J3 = \exp\left[6{,}9547 - 72{,}2853 \cdot T \cdot \left(\frac{R}{G - R \cdot x_3 \cdot \mathbf{T}_{Crit}\left['H2'\right]} + 191{,}306 \cdot \left[T \cdot \left(\frac{R}{G - R \cdot x_3 \cdot \mathbf{T}_{Crit}\left['H2'\right]} \right) \right]^2 - 203{,}5472 \cdot \left[T \cdot \left(\frac{R}{G - R \cdot x_3 \cdot \mathbf{T}_{Crit}\right.\right.\right.\right.$$

$$H3 = 1 - 0{,}89 \cdot \left[x_1 \cdot \mathbf{AcentricFactor}('Ammonia') + x_2 \cdot \mathbf{AcentricFactor}('CH4') + x_4 \cdot \mathbf{AcentricFactor}('N2') + x_5 \cdot \mathbf{AcentricFactor}('Argon') \right]^{0{,}5}$$

$$DJ3 = J3 \cdot \left[-72{,}2853 \cdot T \cdot \left(\frac{R}{G - R \cdot x_3 \cdot \mathbf{T}_{Crit}\left['H2'\right]} - \mathbf{T}_{Crit}\left['H2'\right] \cdot \left[\frac{R}{G - R \cdot x_3 \cdot \mathbf{T}_{Crit}('H2')} \right]^2 \right) + 191{,}306 \cdot T^2 \cdot \left(2 \cdot \left[\frac{R}{G - R \cdot x_3 \cdot \mathbf{T}_{Crit}('H2')} \right]^2 - 2 \cdot \mathbf{T}_{Crit}\left['H2'\right] \cdot \left[\frac{R}{G - R \cdot x_3 \cdot \mathbf{T}_{Crit}('H2')} \right]^3 \right) - 203{,}5472 \cdot T^3 \cdot \left(3 \cdot \left[\frac{R}{G - R \cdot x_3 \cdot \mathbf{T}_{Crit}('H2')} \right]^3 - 3 \cdot \mathbf{T}_{Crit}\left['H2'\right] \cdot \left[\frac{R}{G - R \cdot x_3 \cdot \mathbf{T}_{Crit}('H2')} \right]^4 \right) + 82{,}7631 \cdot T^4 \cdot \left(4 \cdot \left[\frac{R}{G - R \cdot x_3 \cdot \mathbf{T}_{Crit}('H2')} \right]^4 - 4 \cdot \mathbf{T}_{Crit}\left['H2'\right] \cdot \left[\frac{R}{G - R \cdot x_3 \cdot \mathbf{T}_{Crit}('H2')} \right]^5 \right) \right]$$

$$\beta_3 = \beta_1 + \left[\frac{\mathbf{v}('Ammonia'; T = T; x = 0)}{-203{,}3942 + 2{,}4117042 \cdot T - 0{,}0084697111 \cdot T^2 + 0{,}000010233186 \cdot T^3 + 0 \cdot T^4} \right] \cdot 1000 \cdot \left[\left(\left[H - x_3 \cdot \mathbf{v}_{Crit}('H2') \right] \cdot \left[\frac{J3}{G - R \cdot x_3 \cdot \mathbf{T}_{Crit}('H2')} \right] \right) \cdot \mathbf{v}_{Crit}('H2') - \left(\left[F - x_3 \cdot \mathbf{v}_{Crit}('H2') \right] \cdot H3 \cdot J3 \cdot R \cdot \frac{\mathbf{T}_{Crit}\left['H2'\right]}{\left[G - R \cdot x_3 \cdot \mathbf{T}_{Crit}('H2') \right]^2} \right) \right] + \left[F - x_3 \cdot \mathbf{v}_{Crit}('H2') \right] \cdot \left[G - R \cdot x_3 \cdot \mathbf{T}_{Crit}('H2') \cdot \frac{-0{,}89}{2} \cdot \mathbf{AcentricFactor}('H2') \cdot \left(\frac{J3}{0{,}89} \right) + \left(\left[F - x_3 \cdot \mathbf{v}_{Crit}('H2') \right] \cdot \left[\frac{H3}{G - R \cdot x_3 \cdot} \right. \right. \right.$$

$$J4 = \exp\left[6{,}9547 - 72{,}2853 \cdot T \cdot \left(\frac{R}{G - R \cdot x_4 \cdot \mathbf{T}_{Crit}\left['N2'\right]} + 191{,}306 \cdot \left[T \cdot \left(\frac{R}{G - R \cdot x_4 \cdot \mathbf{T}_{Crit}\left['N2'\right]} \right) \right]^2 - 203{,}5472 \cdot \left[T \cdot \left(\frac{R}{G - R \cdot x_4 \cdot \mathbf{T}_{Crit}\right.\right.\right.\right.$$

$$H4 = 1 - 0{,}89 \cdot \left[x_1 \cdot \mathbf{AcentricFactor}('Ammonia') + x_2 \cdot \mathbf{AcentricFactor}('CH4') + x_3 \cdot \mathbf{AcentricFactor}('H2') + x_5 \cdot \mathbf{AcentricFactor}('Argon') \right]^{0{,}5}$$

$$DJ4 = J4 \cdot \left[-72{,}2853 \cdot T \cdot \left(\frac{R}{G - R \cdot x_4 \cdot \mathbf{T}_{Crit}['N2']} - \mathbf{T}_{Crit}['N2'] \cdot \left[\frac{R}{G - R \cdot x_4 \cdot \mathbf{T}_{Crit}('N2')} \right]^2 \right) + 191{,}306 \cdot T^2 \cdot \left(2 \cdot \left[\frac{R}{G - R \cdot x_4 \cdot \mathbf{T}_{Crit}('N2')} \right]^2 - 2 \cdot \mathbf{T}_{Crit}['N2'] \cdot \left[\frac{R}{G - R \cdot x_4 \cdot \mathbf{T}_{Crit}('N2')} \right]^3 \right) - 203{,}5472 \cdot T^3 \cdot \left(3 \cdot \left[\frac{R}{G - R \cdot x_4 \cdot \mathbf{T}_{Crit}('N2')} \right]^3 - 3 \cdot \mathbf{T}_{Crit}['N2'] \cdot \left[\frac{R}{G - R \cdot x_4 \cdot \mathbf{T}_{Crit}('N2')} \right]^4 \right) + 82{,}7631 \cdot T^4 \cdot \left(4 \cdot \left[\frac{R}{G - R \cdot x_4 \cdot \mathbf{T}_{Crit}('N2')} \right]^4 - 4 \cdot \mathbf{T}_{Crit}['N2'] \cdot \left[\frac{R}{G - R \cdot x_4 \cdot \mathbf{T}_{Crit}('N2')} \right]^5 \right) \right]$$

$$\beta_4 = \beta_1 + \left[\frac{\mathbf{v}('Ammonia'; T = T; x = 0)}{460 - 6{,}0849 \cdot T + 0{,}032672 \cdot T^2 - 0{,}000077657 \cdot T^3 + 6{,}99 \times 10^{-8} \cdot T^4} \right] \cdot 1000 \cdot \left[\left(\left[H - x_4 \cdot \mathbf{v}_{Crit}('N2') \right] \cdot \left[\frac{J4}{G - R \cdot x_4 \cdot \mathbf{T}_{Crit}('N2')} \right] \right) \cdot \mathbf{v}_{Crit}('N2') - \left(\left[F - x_4 \cdot \mathbf{v}_{Crit}('N2') \right] \cdot H4 \cdot J4 \cdot R \cdot \frac{\mathbf{T}_{Crit}['N2']}{\left[G - R \cdot x_4 \cdot \mathbf{T}_{Crit}('N2') \right]^2} \right) \right] + \left[F - x_4 \cdot \mathbf{v}_{Crit}('N2') \right] \cdot \left[G - R \cdot x_4 \cdot \mathbf{T}_{Crit}('N2') \cdot \frac{-0{,}89}{2} \cdot \mathbf{AcentricFactor}('N2') \cdot \left(\frac{0{,}89}{1 - H4} \right) + \left(\left[F - x_4 \cdot \mathbf{v}_{Crit}('N2') \right] \cdot \left[\frac{H4}{G - R \cdot x_4 \cdot} \right. \right. \right.$$

$$J5 = \mathbf{exp}\left[6{,}9547 - 72{,}2853 \cdot T \cdot \left(G - R \cdot x_5 \cdot \mathbf{T}_{Crit}['Argon'] + 191{,}306 \cdot \left[T \cdot \left(\frac{R}{G - R \cdot x_5 \cdot \mathbf{T}_{Crit}['Argon']} \right) \right]^2 - 203{,}5472 \cdot \left[T \cdot \left(\frac{R}{G - R \cdot x_5 \cdot} \right. \right. \right. \right.$$

$$H5 = 1 - 0{,}89 \cdot \left[x_1 \cdot \mathbf{AcentricFactor}('Ammonia') + x_2 \cdot \mathbf{AcentricFactor}('CH4') + x_3 \cdot \mathbf{AcentricFactor}('H2') + x_4 \cdot \mathbf{AcentricFactor}('N2') \right]^{0{,}5}$$

$$DJ5 = J5 \cdot \left[-72{,}2853 \cdot T \cdot \left(\frac{R}{G - R \cdot x_5 \cdot \mathbf{T}_{Crit}['Argon']} - \mathbf{T}_{Crit}['Argon'] \cdot \left[\frac{R}{G - R \cdot x_5 \cdot \mathbf{T}_{Crit}('Argon')} \right]^2 \right) + 191{,}306 \cdot T^2 \cdot \left(2 \cdot \left[\frac{R}{G - R \cdot x_5 \cdot \mathbf{T}_{Crit}('Argon')} \right]^2 - 2 \cdot \mathbf{T}_{Crit}['Argon'] \cdot \left[\frac{R}{G - R \cdot x_5 \cdot \mathbf{T}_{Crit}('Argon')} \right]^3 \right) - 203{,}5472 \cdot T^3 \cdot \left(3 \cdot \left[\frac{R}{G - R \cdot x_5 \cdot \mathbf{T}_{Crit}('Argon')} \right]^3 - 3 \cdot \mathbf{T}_{Crit}['Argon'] \cdot \left[\frac{R}{G - R \cdot x_5 \cdot \mathbf{T}_{Crit}('Argon')} \right]^4 \right) + 82{,}7631 \cdot T^4 \cdot \left(4 \cdot \left[\frac{R}{G - R \cdot x_5 \cdot \mathbf{T}_{Crit}('Argon')} \right]^4 - 4 \cdot \mathbf{T}_{Crit}['Argon'] \cdot \left[\frac{R}{G - R \cdot x_5 \cdot \mathbf{T}_{Crit}('Argon')} \right]^5 \right) \right]$$

$$\beta_5 = \beta_1$$

$$+ \left[\frac{\mathbf{v}(\text{'Ammonia'}; T=T; x=0)}{483{,}54588 - 6{,}4121276 \cdot T + 0{,}034018649 \cdot T^2 - 0{,}000080038523 \cdot T^3 + 7{,}1411916 \times 10^{-8} \cdot T^4} \right]$$

$$\cdot 1000 \cdot \left[\left(\left[H - x_5 \cdot \mathbf{v}_{Crit}(\text{'Argon'}) \right] \cdot \left[\frac{J5}{G - R \cdot x_5 \cdot \mathbf{T}_{Crit}(\text{'Argon'})} \right] \right) \cdot \mathbf{v}_{Crit}(\text{'Argon'}) - \left(\left[F - x_5 \right. \right. \right.$$

$$\left. \left. \cdot \mathbf{v}_{Crit}(\text{'Argon'}) \right] \cdot H5 \cdot J5 \cdot R \cdot \frac{\mathbf{T}_{Crit}[\text{'Argon'}]}{\left[G - R \cdot x_5 \cdot \mathbf{T}_{Crit}(\text{'Argon'}) \right]^2} \right) \Big] + \left[F - x_5 \cdot \mathbf{v}_{Crit}(\text{'Argon'}) \right]$$

$$\cdot \left[G - R \cdot x_5 \cdot \mathbf{T}_{Crit}(\text{'Argon'}) \cdot \frac{-0{,}89}{2} \cdot \mathbf{AcentricFactor}(\text{'Argon'}) \cdot \left(\frac{0{,}89}{1 - H5} \right)^{J5} + \left(\left[F - x_5 \cdot \mathbf{v}_{Crit}(\text{'Argon'}) \right] \cdot \left[G - \right. \right. \right.$$

$$\Big]$$

$$f_{1L} = \gamma_1 \cdot x_1 \cdot \mathbf{Fugacity}[\text{'Ammonia'}; T=T; x=0] \cdot \left| 0{,}9869 \cdot \frac{atm}{bar} \right| \cdot \mathbf{exp} \Bigg[\mathbf{v}(\text{'Ammonia'}; T=T; x=0)$$

$$\cdot \left(\frac{1 + 7 \cdot \beta_1 \cdot \left[P - \mathbf{P}_{sat}(\text{'Ammonia'}; T=T) \cdot \left| 0{,}9869 \cdot \frac{atm}{bar} \right| \right]^{[6 / 7]} - 1}{R \cdot T \cdot 6 \cdot \beta_1} \right) \Bigg]$$

$$\mathbf{ln}\left[\frac{\alpha_2}{1000} \right] = -38{,}1649 + \frac{19801{,}2}{T} - \frac{2{,}88498 \times 10^6}{T^2}$$

$$\mathbf{ln}\left[\frac{\alpha_3}{1000} \right] = -9{,}87862 + \frac{2904{,}17}{T} - \frac{177315}{T^2}$$

$$\mathbf{ln}\left[\frac{\alpha_4}{1000} \right] = 4{,}32945 - \frac{5751{,}52}{T} + \frac{1{,}03658 \times 10^6}{T^2}$$

$$\mathbf{ln}\left[\frac{\alpha_5}{1000} \right] = -6{,}43535 + \frac{2602{,}91}{T} - \frac{536723}{T^2}$$

$$\mathbf{ln}[H_2] = -1{,}6701 + \frac{4405{,}58}{T} - \frac{482973}{T^2}$$

$$\mathbf{ln}[H_3] = -2{,}29337 + \frac{5294{,}74}{T} - \frac{521881}{T^2}$$

$$\mathbf{ln}[H_4] = -3{,}68607 + \frac{5967{,}36}{T} - \frac{642828}{T^2}$$

$$\mathbf{ln}[H_5] = -0{,}7941 + \frac{4472{,}47}{T} - \frac{509281}{T^2}$$

$$\phi = \frac{x_2 \cdot \mathbf{v}_{Crit}\left['CH4'\right] \cdot \alpha_2^{0,5} + x_3 \cdot \mathbf{v}_{Crit}\left['H2'\right] \cdot \alpha_3^{0,5} + x_4 \cdot \mathbf{v}_{Crit}\left['N2'\right] \cdot \alpha_4^{0,5} + x_5 \cdot \mathbf{v}_{Crit}\left['Argon'\right] \cdot \alpha_5^{0,5}}{F}$$

$$\mathbf{ln}\left[\gamma_1\right] = \mathbf{v}_{Crit}\left['Ammonia'\right] \cdot \phi^2$$

$$\mathbf{ln}\left[\gamma_2\right] = \mathbf{v}_{Crit}\left['CH4'\right] \cdot \left[\phi^2 - 2 \cdot \alpha_2^{0,5} \cdot \phi\right]$$

$$\mathbf{ln}\left[\gamma_3\right] = \mathbf{v}_{Crit}\left['H2'\right] \cdot \left[\phi^2 - 2 \cdot \alpha_3^{0,5} \cdot \phi\right]$$

$$\mathbf{ln}\left[\gamma_4\right] = \mathbf{v}_{Crit}\left['N2'\right] \cdot \left[\phi^2 - 2 \cdot \alpha_4^{0,5} \cdot \phi\right]$$

$$\mathbf{ln}\left[\gamma_5\right] = \mathbf{v}_{Crit}\left['Argon'\right] \cdot \left[\phi^2 - 2 \cdot \alpha_5^{0,5} \cdot \phi\right]$$

$$f_{2L} = \gamma_2 \cdot x_2 \cdot H_2 \cdot \mathbf{exp}\left[\frac{1}{1000} \cdot \left(413{,}88343 - 5{,}3949156 \cdot T + 0{,}029121251 \cdot T^2 - 0{,}000069651858 \cdot T^3 + 6{,}3228243 \times 10^{-8} \cdot T^4\right) \cdot \left(\frac{1 + 7 \cdot \beta_2 \cdot \left[P - \mathbf{P}_{sat}\left('Ammonia'; T = T\right) \cdot \left|0{,}9869 \cdot \frac{atm}{bar}\right|\right]^{[6/7]} - 1}{R \cdot T \cdot 6 \cdot \beta_2}\right)\right]$$

$$f_{3L} = \gamma_3 \cdot x_3 \cdot H_3 \cdot \mathbf{exp}\left[\frac{1}{1000} \cdot \left(-203{,}3942 + 2{,}4117042 \cdot T - 0{,}0084697111 \cdot T^2 + 0{,}000010233186 \cdot T^3 + 0 \cdot T^4\right) \cdot \left(\frac{1 + 7 \cdot \beta_3 \cdot \left[P - \mathbf{P}_{sat}\left('Ammonia'; T = T\right) \cdot \left|0{,}9869 \cdot \frac{atm}{bar}\right|\right]^{[6/7]} - 1}{R \cdot T \cdot 6 \cdot \beta_3}\right)\right]$$

$$f_{4L} = \gamma_4 \cdot x_4 \cdot H_4 \cdot \mathbf{exp}\left[\frac{1}{1000} \cdot \left(460 - 6{,}0849 \cdot T + 0{,}032672 \cdot T^2 - 0{,}000077657 \cdot T^3 + 6{,}99 \times 10^{-8} \cdot T^4\right) \cdot \left(\frac{1 + 7 \cdot \beta_4 \cdot \left[P - \mathbf{P}_{sat}\left('Ammonia'; T = T\right) \cdot \left|0{,}9869 \cdot \frac{atm}{bar}\right|\right]^{[6/7]} - 1}{R \cdot T \cdot 6 \cdot \beta_4}\right)\right]$$

$$f_{5L} = \gamma_5 \cdot x_5 \cdot H_5 \cdot \mathbf{exp}\left[\frac{1}{1000} \cdot \left(483{,}54588 - 6{,}4121276 \cdot T + 0{,}034018649 \cdot T^2 - 0{,}000080038523 \cdot T^3 + 7{,}1411916 \times 10^{-8} \cdot T^4\right) \cdot \left(\frac{1 + 7 \cdot \beta_5 \cdot \left[P - \mathbf{P}_{sat}\left('Ammonia'; T = T\right) \cdot \left|0{,}9869 \cdot \frac{atm}{bar}\right|\right]^{[6/7]} - 1}{R \cdot T \cdot 6 \cdot \beta_5}\right)\right]$$

$$f_{1G} = \nu_1 \cdot y_1 \cdot P$$

$$f_{2G} = \nu_2 \cdot y_2 \cdot P$$

$$f_{3G} = \nu_3 \cdot y_3 \cdot P$$

$$f_{4G} = \nu_4 \cdot y_4 \cdot P$$

$$f_{5G} = \nu_5 \cdot y_5 \cdot P$$

$f_{1G} = f_{1L}$

$f_{2G} = f_{2L}$

$f_{3G} = f_{3L}$

$f_{4G} = f_{4L}$

$f_{5G} = f_{5L}$

$$\sigma = \sum_{i=1}^{5} [x_i]$$

$\sigma = 1$

SOLUTION

Unit Settings: [kJ]/[K]/[bar]/[kmol]/[degrees]

a_M = 7,406
b_M = 0,02029
Δh = -9,607E+13
DJ2 = 0,000001288
DJ3 = 0,000002206
DJ4 = 0,000001654
DJ5 = 0,000001487
DT = -7,793E+09
F = 0,07583
f_{1G} = 11,67
f_{1L} = 11,67
f_{2G} = 15,97
f_{2L} = 15,97
f_{3G} = 136,8
f_{3L} = 136,8
f_{4G} = 40,5
f_{4L} = 40,5
f_{5G} = 6,742
f_{5L} = 6,742
G = 32,62
H = 0,5555
H2 = 0,5556
H3 = 0,5555
H4 = 0,5557
H5 = 0,5555
J = 2,321
J2 = 2,838E-07
J3 = 2,775E-07
J4 = 2,790E-07
J5 = 2,765E-07
P = 200 [atm]
ϕ = 0,1869
R = 0,08206 [atm-m^3/kmol-K]
σ = 1
T = 304,5 [K]
v = 0,1335

51 potential unit problems were detected.

Arrays Table

	a_i	α_i	b_i	β_i	γ_i	H_i	v_i	x_i	y_i
1	94,42		0,0259	0,0001221	1,003		0,7293	0,974	0,08
2	31,57	14,25	0,0296	0,0001221	0,8731	1977	0,9074	0,007571	0,088
3	1,757	105	0,01589	0,0001221	0,7756	12916	1,144	0,01183	0,598
4	15,46	34,07	0,02678	0,0001221	0,8253	7927	1,018	0,005137	0,199
5	16,86	25,33	0,0224	0,0001221	0,8714	4452	0,9632	0,001475	0,035