Equation	G^{ex}/RT
Symmetrical	Ax_1x_2
Margules	$x_1x_2(A_{21}x_1 + A_{12}x_2)$
van Laar	$1/(1/A_{12}x_1 + 1/A_{21}x_2)$
Wilson	$-x_1 \ln(x_1 + \Lambda_{12}x_2) - x_2 \ln(\Lambda_{21}x_1 + x_2)$
T-K-Wilson	$x_1 \ln \dfrac{x_1 + V_2x_2/V_1}{x_1 + \Lambda_{12}x_2} + x_2 \ln \dfrac{V_1x_1/V_2 + x_2}{\Lambda_{21}x_1 + x_2}$
NRTL	$x_1x_2 \left[\dfrac{\tau_{21}G_{21}}{x_1 + G_{21}x_2} + \dfrac{\tau_{12}G_{12}}{G_{12}x_1 + x_2}\right]$
UNIQUAC	$x_1 \left[\ln \dfrac{\phi_1}{x_1} + \dfrac{q_1z}{2} \ln \dfrac{\theta_1}{\phi_1} - q_1 \ln(\theta_1 + \theta_2\tau_{21})\right]$
	$+ x_2 \left[\ln \dfrac{\phi_2}{x_2} + \dfrac{q_2z}{2} \ln \dfrac{\theta_2}{\phi_2} - q_2 \ln(\theta_1\tau_{12} + \theta_2)\right]$
Scatchard-Hildebrand	$\dfrac{(\delta_1 - \delta_2)^2}{RT\left(\dfrac{1}{V_1x_1} + \dfrac{1}{V_2x_2}\right)}$

Table 4.4. Equations of Activity Coefficients of Binary Mixtures

Name	Parameters	$\ln \gamma_1$ and γ_2	
Symmetrical	A	Ax_2^2	(1)
		Ax_1^2	(2)
Scatchard-Hildebrand	δ_1, δ_2	$\dfrac{V_1}{RT}(1-\phi_1)^2(\delta_1 - \delta_2)^2$	(3)
		$\dfrac{V_2}{RT}\phi_1^2(\delta_1 - \delta_2)^2$	(4)
	$\phi_1 = V_1x_1/(V_1x_1 + V_2x_2)$		(5)
Margules	A_{12}	$[A_{12} + 2(A_{21} - A_{12})x_1]\, x_2^2$	(6)
	A_{21}	$[A_{21} + 2(A_{12} - A_{21})x_2]\, x_1^2$	(7)
van Laar	A_{12}	$A_{12} \left(\dfrac{A_{21}x_2}{A_{12}x_1 + A_{21}x_2}\right)^2$	(8)
	A_{21}	$A_{21} \left(\dfrac{A_{12}x_1}{A_{12}x_1 + A_{21}x_2}\right)^2$	(9)
Wilson	λ_{12}	$-\ln(x_1 + \Lambda_{12}x_2) + x_2 \left(\dfrac{\Lambda_{12}}{x_1 + \Lambda_{12}x_2} - \dfrac{\Lambda_{21}}{\Lambda_{21}x_1 + x_2}\right)$	(10)
	$\lambda_{21} - \lambda_{22}$	$-\ln(x_2 + \Lambda_{21}x_1) - x_1 \left(\dfrac{\Lambda_{12}}{x_1 + \Lambda_{12}x_2} - \dfrac{\Lambda_{21}}{\Lambda_{21}x_1 + x_2}\right)$	(11)
	$\Lambda_{12} = \dfrac{V_2^L}{V_1^L} \exp\left(-\dfrac{\lambda_{12}}{RT}\right)$	$\Lambda_{21} = \dfrac{V_1^L}{V_2^L} \exp\left(-\dfrac{\lambda_{21}}{RT}\right)$	(12, 13)
	V_i^L molar volume of pure liquid component i.		
T-K-Wilson (Tsuboka-Katayama-Wilson)	$a_{12} - a_{11} = \lambda_{12}$ $a_{21} - a_{22} = \lambda_{21}$	$\ln \dfrac{x_1 + V_2x_2/V_1}{x_1 + \Lambda_{12}x_2} + (\beta - \beta_v)x_2$	(14)
		$\ln \dfrac{V_1x_1/V_2 + x_2}{\Lambda_{21}x_1 + x_2} - (\beta - \beta_v)x_1$	(15)
	$\beta_v = \dfrac{V_2/V_1}{x_1 + V_2x_2/V_1} - \dfrac{V_1/V_2}{V_1x_1/V_2 + x_2}$,	$\beta = \dfrac{\Lambda_{12}}{x_1 + \Lambda_{12}x_2} - \dfrac{\Lambda_{21}}{\Lambda_{21}x_1 + x_2}$	(16)
	Λ_{12} and Λ_{21} as for the Wilson equation.		

NRTL	$g_{12} - g_{22}$ $g_{21} - g_{11}$ α_{12}	$x_2^2 \left[\tau_{21} \left(\frac{G_{21}}{x_1 + x_2 G_{21}}\right)^2 + \left(\frac{\tau_{12} G_{12}}{(x_2 + x_1 G_{12})^2}\right)\right]$	(17)
		$x_1^2 \left[\tau_{12} \left(\frac{G_{12}}{x_2 + x_1 G_{12}}\right)^2 + \left(\frac{\tau_{21} G_{21}}{(x_1 + x_2 G_{21})^2}\right)\right]$	(18)

$$\tau_{12} = \frac{g_{12} - g_{22}}{RT} \qquad \tau_{21} = \frac{g_{21} - g_{11}}{RT} \tag{19, 20}$$

$$G_{12} = \exp(-\alpha_{12}\tau_{12}) \qquad G_{21} = \exp(-\alpha_{21}\tau_{21}) \tag{21, 22}$$

Name	*Parameters*	*ln γ_1 and γ_2*	
	g_{ij} parameter for interaction between components i and j; $g_{ij} = g_{ji}$		
	α_{ij} nonrandomness parameter; $\alpha_{ij} = \alpha_{ji}$		
UNIQUAC	$u_{12} - u_{22}$	$\ln \gamma_1^C + \ln \gamma_1^R$[3]	(23)
	$u_{21} - u_{11}$	$\ln \gamma_2^C + \ln \gamma_2^R$	(24)

$$\ln \gamma_1 = \ln \gamma_1^C + \ln \gamma_1^R \tag{25}$$

$$\ln \gamma_1^C = \ln \frac{\varphi_1}{x_1} + \frac{z}{2} q_1 \ln \frac{\vartheta_1}{\varphi_1} + \varphi_2 \left(l_1 - \frac{r_1}{r_2} l_2\right) \tag{26}$$

$$\ln \gamma_1^R = -q_1 \ln(\vartheta_1 + \theta\tau_{21}) + \vartheta_2 q_2 \left(\frac{\tau_{21}}{\vartheta_1 + \vartheta_2\tau_{21}} - \frac{\tau_{12}}{\vartheta_1\tau_{12} + \vartheta_2}\right) \tag{27}$$

$$\ln \gamma_2 = \ln \gamma_2^C + \ln \gamma_2^R \tag{28}$$

$$\ln \gamma_2^C = \ln \frac{\varphi_2}{x_2} + \frac{z}{2} q_2 \ln \frac{\vartheta_2}{\varphi_2} + \varphi_1 \left(l_2 - \frac{r_2}{r_1} l_1\right) \tag{29}$$

$$\ln \gamma_2^R = -q_2 \ln(\vartheta_1\tau_{12} + \vartheta_2) + \vartheta_1 q_2 \left(\frac{\tau_{12}}{\vartheta_1\tau_{12} + \vartheta_2} - \frac{\tau_{21}}{\vartheta_1 + \vartheta_2\tau_{21}}\right) \tag{30}$$

$$l_i = \frac{z}{2}(r_i - q_i) - (r_i - 1) \qquad z = 10 \tag{31}$$

q_i area parameter of component i

r_i volume parameter of component i

u_{ij} parameter of interaction between components i and j; $u_{ij} = u_{ji}$

z coordination number

γ_i^C combinatorial part of activity coefficient of component i

γ_i^R residual part of activity coefficient of component i

$$\vartheta_i = \frac{q_i x_i}{\sum_j q_j x_j} \text{ area fraction of component } i \tag{32}$$

$$\phi_i = \frac{r_i x_i}{\sum_j r_j x_j} \text{ volume fraction of component } i \tag{33}$$

$$\tau_{ji} = \exp\left(-\frac{u_{ji} - u_{ii}}{RT}\right) \tag{34}$$

From: Walas, Phase Equilibrium in Chemical Engineering