Table 9.1-2

SPECIES ACTIVITY BASED ON DIFFERENT CHOICES OF STANDARD STATE ACTIVITY*

From Sandler, Chemical and Engineering Thermodynamics, 2nd Ed

State (All at Temperature T and Pressure P)	Standard State (All at Temperature T and 1 atm Pressure)	General	Simplification for Low and Moderate Pressures
Pure gas	Pure gas $\bar{G}_i^\circ = \underline{G}_i^V(T, P = 1\text{ atm})$	$a_i = \dfrac{f_i^V(T, P)}{f_i^V(T, P = 1\text{ atm})} = \dfrac{P(f/P)}{1\text{ atm}}$	$a_i = \dfrac{P}{1\text{ atm}}$
Species in a gaseous mixture	Pure gas $\bar{G}_i^\circ = \underline{G}_i^V(T, P = 1\text{ atm})$	$a_i = \dfrac{\bar{f}_i^V(T, P, y_i)}{f_i^V(T, P = 1\text{ atm})} = \dfrac{y_iP(\bar{f}_i/y_iP)}{1\text{ atm}} = \dfrac{P_i(\bar{f}_i/y_iP)}{1\text{ atm}}$;	$a_i = \dfrac{y_iP}{1\text{ atm}} = \dfrac{P_i}{1\text{ atm}}$
Pure liquid†	Pure liquid $\bar{G}_i^\circ = \underline{G}_i^L(T, P = 1\text{ atm})$	$a_i = \dfrac{f_i^L(T, P)}{f_i^L(T, P = 1\text{ atm})} = \dfrac{P^{vap}(T)(f/P)_{sat}\exp\{(\underline{V}^L/RT)(P - P^{vap})\}}{P^{vap}(T)(f/P)_{sat}} = \exp\left\{\dfrac{\underline{V}^L}{RT}(P - P^{vap})\right\}$	$a_i = 1$
Species in a liquid mixture†	Pure liquid $\bar{G}_i^\circ = \underline{G}_i^L(T, P = 1\text{ atm})$	$a_i = \dfrac{x_i\gamma_iP^{vap}(f/P)_{sat}\exp\{(\bar{V}_i/RT)(P - P^{vap})\}}{P^{vap}(f/P)_{sat}} = x_i\gamma_i\exp\left\{\dfrac{\bar{V}_i}{RT}(P - P^{vap})\right\}$	$a_i = x_i\gamma_i$ ($\gamma_i \to 1$ as $x_i \to 1$)
	Species in a 1 molal ideal solution $\bar{G}_i^\circ = \bar{G}_i(T, P = 1\text{ atm}, M_i = 1)$; (see Eq. 7.8-15)	$a_i = \dfrac{M_i\mathcal{H}_i(T, P = 1\text{ atm})\gamma_i^\square}{(M_i = 1)\mathcal{H}_i(T, P = 1\text{ atm})}\exp\left\{\dfrac{\bar{V}_i^\infty}{RT}(P - 1\text{ atm})\right\} = \dfrac{M_i\gamma_i^\square}{(M_i = 1)}\exp\left\{\dfrac{\bar{V}_i^\infty}{RT}(P - 1\text{ atm})\right\}$	$a_i = M_i\gamma_i^\square/(M_i = 1)$ ($\gamma_i^\square \to 1$ as $M_i \to 0$)
	Species as a pure liquid with infinite dilution properties $\bar{G}_i^\circ = \bar{G}_i^*(T, P = 1\text{ atm}, x_i = 1)$	$a_i = \dfrac{x_iH_i(T, P = 1\text{ atm})\gamma_i^*}{H_i(T, P = 1\text{ atm})}\exp\left\{\dfrac{\bar{V}_i^\infty}{RT}(P - 1\text{ atm})\right\} = x_i\gamma_i^*\exp\left\{\dfrac{\bar{V}_i^\infty}{RT}(P - 1\text{ atm})\right\}$	$a_i = x_i\gamma_i^*$ ($\gamma_i^* \to 1$ as $x_i \to 0$)
Pure solid	Pure solid $\bar{G}_i^\circ = \underline{G}_i^S(T, P = 1\text{ atm})$	$a_i = \dfrac{f_i^S(T, P)}{f_i^S(T, P = 1\text{ atm})} = \dfrac{P^{sat}(T)(f/P)_{sat}\exp\{(\underline{V}^S/RT)(P - P^{sat})\}}{P^{sat}(T)(f/P)_{sat}} = \exp\left\{\dfrac{\underline{V}^S}{RT}(P - P^{sat})\right\}$	$a_i = 1$
Species in a solid mixture	Pure solid $\bar{G}_i^\circ = \underline{G}_i^S(T, P = 1\text{ atm})$	$a_i = \exp\left\{\dfrac{\underline{V}^S}{RT}(P - 1\text{ atm})\right\}$ as above	$a_i = 1$
Dissolved electrolyte in solution	Dissolved electrolyte, each ion at unit molality in an ideal solution $\bar{G}_i^\circ = \nu_+\bar{G}_A(T, P = 1\text{ atm}, M_A = 1) + \nu_-\bar{G}_B(T, P = 1\text{ atm}, M_B = 1) = \bar{G}_{AB,D}^\square(T, P = 1\text{ atm})$		$a_i = \dfrac{M_A^{\nu_+}M_B^{\nu_-}(\gamma_\pm)^\nu}{(M_\pm = 1)^\nu} = \dfrac{(M_\pm\gamma_\pm)^\nu}{(M_\pm = 1)^\nu}$

*In this table we have neglected the Poynting correction to the pure component standard states; also 1 atm = 1.013 bar.

†If a liquid or liquid mixture is describable by equation of state, the same equations as for gases or gaseous mixtures are used.