Fig. 2. Ratio of standard fugacity of water and its vapor pressure as a function of pressure and temperature.

Fig. 3. Ratio of standard fugacity of ammonia and its vapor pressure as a function of pressure and temperature.

Gamson and Watson (6) proposed the following expression for $v_{m,i}$:

$$v_{m,i} = (v\omega)_i \, (5.7 + 3.0 \, T_{r,i}) \quad (14)$$

where $(v\omega)_i$ is a constant for each component.

The fugacity f_{i,L,p_i} relative to the vapor pressure at the temperature T of the system is calculated by the generalized correlation of Gamson and Watson (5, 6) for determining the fugacity coefficient v_i as a function of reduced temperature and reduced pressure:

$$v_i = \frac{f_{i,L,p_i}}{p_i} \quad (15)$$

Substitution of Equations (14) and (15) into Equation (13) gives the following:

$$\log (f^\circ_{i,L,P}) = \log p_i + \log v_i$$
$$+ \frac{(v\omega)_i(5.7 + 3.0 \cdot Tr)(P - p_i)}{2.303 \, RT} \quad (16)$$

The vapor pressure p_i for ammonia and water is calculated with the Antoine equation and is then converted to atmosphere units:

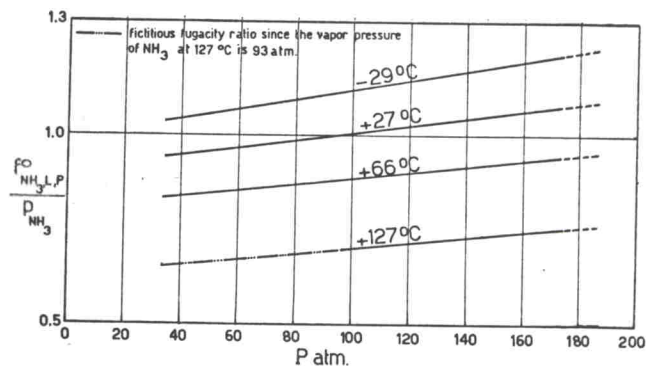$$\log p_i = A - \frac{B}{C + t} \quad (17)$$

The Antoine equation constants have been taken from reference 7:

	A	B	C
Water	8.10765	1750.286	235.000
Ammonia	7.55466	1002.711	247.885

The other constants in Equation (16) are:

$(v\omega)_{NH_3} = 3.10$ cc./g.-mole
$(v\omega)_{H_2O} = 2.28$ cc./g.-mole
$R = 82.057$ (atm.)(cc.)/(g.-mole)(°K.)

Equation (16) has been applied in the pressure range from 20 to 200 atm. and at temperatures from $-29°$ to $+127°C$. In this range $f^\circ_{i,L,P}$ was seen to be substantially a linear function of pressure at constant temperature for ammonia and water. The values calculated at different temperature are presented in Figures 2 and 3.

$f_{i,v}/Py_i$: Ratio Between Fugacities in Vapor Phase at Nonideal and Ideal Conditions

For a component in the mixture of the vapor phase, Equation (12) becomes

$$\left(\frac{\delta \ln f_{i,v}}{\delta P}\right)_T = \frac{\overline{v}_i}{RT} \quad (18)$$

and by integration at constant temperature

$$\ln \frac{f_{i,v}}{Py_i} = -\frac{1}{RT} \int_o^P \left(\frac{RT}{P} - \overline{v}_i\right) dP \quad (19)$$

TABLE 1. COMPARISON OF EXPERIMENTAL POINTS WITH VALUES CALCULATED WITH EQUATIONS (8) AND (9)
Ratio of hydrogen-nitrogen is 2.1/1

No.	t, °C.	P, atm.	x_{NH_3}	$y^s_{NH_3}$	$y^c_{NH_3}$	$y^i_{NH_3}$	$y^s_{H_2O}$	$y^c_{H_2O}$	$y^i_{H_2O}$
1	50	50.5	0.663	—	0.2640	0.2539	0.002464	0.00260	0.00076
2		58.2	—	0.2180	0.2308	0.2177	—	0.00230	0.00065
3		78.6	—	0.1850	0.1803	0.1611	0.002490	0.00188	0.00048
4		98.0	—	—	0.1520	0.1282	0.002365	0.00162	0.000384
5		117.5	—	0.1380	0.1342	0.1078	0.002000	0.00146	0.000321
6		146.6	—	0.1060	0.1150	0.0864	0.001500	0.00131	0.000257
7		170.0	—	—	0.1060	0.07355	0.000871	0.00122	0.00022
8		185.4	—	0.0900	0.0991	0.06832	0.001490	0.00117	0.000203
9	80	58.2	0.663	0.4807	0.4500	0.4400	0.007960	0.0085	0.00252
10		78.5	—	0.3600	0.3525	0.3257	0.006600	0.00699	0.00186
11		98.0	—	0.2768	0.2908	0.2643	0.004600	0.00605	0.00149
12		117.5	—	0.2600	0.2537	0.2179	0.005600	0.00544	0.00125
13		146.6	—	0.2120	0.2175	0.1746	0.004480	0.00486	0.00100
14		170.0	—	0.1885	0.1940	0.1515	0.004500	0.00453	0.000857
15		185.4	—	0.1850	0.1803	0.1381	0.00398	0.00424	0.00079