# Equilibrium in Hydrogen Sulfide–Monoethanolamine–Water System

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**Vapor-liquid equilibrium in the hydrogen sulfide–monoethanolamine–water system was measured for two normalities (2.5 and 5.0 N) at temperatures of 25, 40, 60, 80, 100, and 120 °C. Partial pressures of $H_2S$ ranged from 0.15 to 2317 kPa.**

The partial pressure of hydrogen sulfide over aqueous monoethanolamine (MEA) solutions has been measured by a number of workers. However, most of the data are restricted to low partial pressures and to a relatively few normalities. Riegger et al. (*8*) used seven MEA solutions ranging from 0.5 to 4.0 N at 25, 45, and 60 °C; partial pressures of $H_2S$ varied between 3.3 and 93 kPa. Atwood et al. (*1*) presented a small amount of data for 0.83, 2.5, 3.3, and 5.0 N MEA solutions at temperatures between 80 and 160 °F; partial pressures of $H_2S$ reached 780 kPa. Leibush and Shneerson (*6*) measured the partial pressures of $H_2S$ over 0.93 and 2.5 N MEA solutions at 15, 25, and 50 °C; partial pressures of $H_2S$ were less than 46 kPa. Muhlbauer and Monaghan (*7*) measured the solubility of $H_2S$ in a 2.5 N MEA solution at 25 and 100 °C at partial pressures of $H_2S$ below 133 kPa. Jones et al. (*2*) determined the solubility of $H_2S$ in a 2.5 N MEA solution at six temperatures between 40 and 120 °C at partial pressures of $H_2S$ up to 113 kPa.

Recently, in this laboratory (*5*), the partial pressure of $H_2S$ over 2.5 and 5.0 N MEA solutions at 40 and 100 °C was measured. Partial pressures of hydrogen sulfide ranged between 2.1 and 4480 kPa. The present work was undertaken to extend the data to other temperatures in the range of interest of industrial processes involving the absorption of $H_2S$ by MEA solutions.

## Experimental

The MEA solutions were prepared from distilled water and commercially available MEA and charged to a windowed equilibrium cell. Equilibrium was reached by the recirculation of the vapor using a magnetic pump. Samples of the vapor and liquid were withdrawn for analysis. The equipment and methods of analysis are essentially the same as those employed in our previous studies of solubility in amine solutions (*3–5*).

## Results and Discussion

The equilibrium solubility of $H_2S$ in 2.5 and 5.0 N MEA solutions was measured at 25, 40, 60, 80, 100, and 120 °C. Partial pressures of $H_2S$ ranged between 0.15 and 2370 kPa. Table I presents the experimental data. The results for the 2.5 N solution are plotted in Figure 1 for comparison with previous work. The present data are in good agreement with published data, except for the data of Riegger et al. (*8*). Comparisons at 40 and 100 °C which were made in the previous work on this system (*5*) also agreed well with literature data except in the region around 100 kPa $H_2S$ partial pressure. Smoothed values for the solubility of $H_2S$ in 2.5 and 5.0 N solutions are presented in Table II.

Table I. Experimental Data for Solubility of $H_2S$ in MEA Solutions

$\alpha$, Mole ratio in liquid, $H_2S$/MEA; $p$, partial pressure $H_2S$, kPa

| $T$, °C | $p$ | $\alpha$ | $T$, °C | $p$ | $\alpha$ |
|---|---|---|---|---|---|
| 2.5 N MEA solution | | | 5.0 N MEA solution | | |
| 25 | 1822 | 1.610 | 25 | 604.0 | 1.071 |
| | 870.1 | 1.260 | | 1524 | 1.182 |
| | 353.0 | 1.100 | | 701.2 | 1.058 |
| | 92.39 | 0.990 | | 373.7 | 1.010 |
| | 0.889 | 0.458 | | 373.7 | 1.013 |
| | 3.350 | 0.675 | | 33.09 | 0.845 |
| | 3.206 | 0.672 | | 9.169 | 0.720 |
| | 95.70 | 0.975 | | 0.617 | 0.330 |
| | 20.55 | 0.892 | | 5.894 | 0.682 |
| | 0.152 | 0.206 | | 2.826 | 0.552 |
| | | | | 0.696 | 0.352 |
| 40 | 8.756 | 0.702 | | 0.303 | 0.213 |
| | 2.923 | 0.513 | | 1746 | 1.260 |
| | 912.2 | 1.182 | | 1249 | 1.167 |
| | 148.2 | 0.989 | | | |
| | 28.34 | 0.848 | 40 | 72.39 | 0.866 |
| | | | | 25.03 | 0.716 |
| 60 | 87.56 | 0.862 | | 16.41 | 0.689 |
| | 56.88 | 0.823 | | 7.928 | 0.540 |
| | 93.77 | 0.904 | | 1.785 | 0.351 |
| | 3.199 | 0.329 | | 0.651 | 0.210 |
| | 0.923 | 0.213 | | 1936 | 1.262 |
| | 27.23 | 0.712 | | 1798 | 1.273 |
| | 8.273 | 0.515 | | | |
| | 1669 | 1.260 | 60 | 801.2 | 0.968 |
| | 792.2 | 1.122 | | 166.9 | 0.840 |
| | 406.8 | 1.023 | | 72.39 | 0.715 |
| | | | | 21.72 | 0.550 |
| 80 | 144.6 | 0.820 | | 6.515 | 0.354 |
| | 1296 | 1.168 | | 2.213 | 0.218 |
| | 7.722 | 0.328 | | 0.654 | 0.108 |
| | 3.102 | 0.215 | | 2133 | 1.222 |
| | 55.98 | 0.674 | | | |
| | 21.51 | 0.495 | 80 | 2259 | 1.120 |
| | 1827 | 1.207 | | 924.6 | 0.920 |
| | 855.6 | 1.062 | | 273.0 | 0.800 |
| | 331.6 | 0.965 | | 148.9 | 0.678 |
| | | | | 55.92 | 0.550 |
| 120 | 383 | 0.754 | | 17.65 | 0.350 |
| | 400 | 0.723 | | 6.343 | 0.214 |
| | 1592 | 0.945 | | 1.565 | 0.111 |
| | 47.4 | 0.314 | | 2239 | 1.153 |
| | 18.3 | 0.212 | | 1984 | 1.090 |
| | 115.8 | 0.473 | | | |
| | | | 100 | 1177 | 0.890 |
| | | | | 122.7 | 0.524 |
| | | | | 127.6 | 0.512 |
| | | | | 16.75 | 0.208 |
| | | | | 4.860 | 0.112 |
| | | | | 2164 | 1.042 |
| | | | | 1674 | 0.990 |
| | | | 120 | 2317 | 0.930 |
| | | | | 1421 | 0.835 |
| | | | | 824.6 | 0.726 |
| | | | | 433.7 | 0.580 |
| | | | | 77.2 | 0.302 |
| | | | | 221.3 | 0.477 |
| | | | | 32.2 | 0.207 |
| | | | | 9.65 | 0.113 |
| | | | | 2111 | 0.883 |

Table II. Smoothed Data for Solubility of $H_2S$ in MEA Solutions

| MEA Soln, N | $H_2S$ partial press, kPa | $\alpha$, Mole ratio in liquid, $H_2S$/MEA Temp, °C 25 | 40 | 60 | 80 | 100 | 120 |
|---|---|---|---|---|---|---|---|
| 2.5 | 0.100 | 0.163 | 0.102 | 0.070 | 0.044 | 0.028 | ... |
| | 0.316 | 0.288 | 0.202 | 0.123 | 0.075 | 0.041 | 0.021 |
| | 1.00 | 0.470 | 0.333 | 0.207 | 0.123 | 0.065 | 0.046 |
| | 3.16 | 0.660 | 0.527 | 0.333 | 0.212 | 0.118 | 0.082 |
| | 10.0 | 0.817 | 0.730 | 0.547 | 0.363 | 0.227 | 0.148 |
| | 31.6 | 0.922 | 0.866 | 0.735 | 0.563 | 0.400 | 0.270 |
| | 100 | 0.992 | 0.966 | 0.887 | 0.770 | 0.615 | 0.452 |
| | 316 | 1.090 | 1.056 | 0.990 | 0.932 | 0.853 | 0.675 |
| | 1000 | 1.295 | 1.227 | 1.158 | 1.067 | 0.990 | 0.888 |
| | 2000 | 1.580 | 1.410 | 1.333 | 1.252 | 1.160 | 1.023 |
| 5.0 | 0.316 | 0.230 | 0.117 | 0.071 | ... | ... | ... |
| | 1.00 | 0.402 | 0.237 | 0.138 | 0.088 | 0.043 | ... |
| | 3.16 | 0.573 | 0.392 | 0.253 | 0.152 | 0.082 | 0.054 |
| | 10.0 | 0.723 | 0.583 | 0.418 | 0.260 | 0.153 | 0.111 |
| | 31.6 | 0.838 | 0.752 | 0.593 | 0.431 | 0.286 | 0.205 |
| | 100 | 0.924 | 0.867 | 0.765 | 0.625 | 0.455 | 0.349 |
| | 316 | 1.000 | 0.937 | 0.884 | 0.809 | 0.647 | 0.530 |
| | 1000 | 1.115 | 1.047 | 1.002 | 0.933 | 0.854 | 0.747 |
| | 2000 | 1.390 | 1.225 | 1.153 | 1.070 | 0.990 | 0.892 |
| | 2500 | ... | ... | 1.260 | 1.158 | 1.050 | 0.938 |

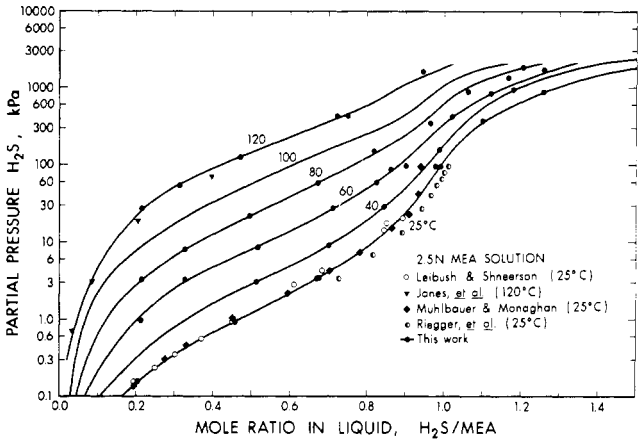


**Figure 1.** Solubility of hydrogen sulfide in 2.5 N MEA solutions

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