A comparison of the data from this paper and those of Muhlbauer and Monaghan (*5*) at 100°C. was made. Because data in the two studies were not obtained at the same liquid or vapor compositions, comparison values were derived as follows. The various partial pressures of hydrogen sulfide and solution loadings (from *5*) were obtained from a large scale plot provided in a preprint. The authors' values were derived from a series of correlation graphs for 100°C. similar to Figures 4 and 5 of this report. R_L values were computed from the solution loadings of Muhlbauer. Lines representing these R_L values were then constructed from the authors' data. The hydrogen sulfide contents of the liquid phases were read from these lines at selected partial pressures of hydrogen sulfide. A comparison was made in the region of 80- to 800-mm. partial pressure, because this was the region in which most of the data of (*5*) were obtained.

The agreement between the two sets of values is good, considering the experimental difficulties of handling this system at the elevated temperature. When carbon dioxide is present, the authors' computed values for the hydrogen sulfide contents of the equilibrium solutions are consistently higher at given partial pressures of hydrogen sulfide than those reported by Muhlbauer and Monaghan. The authors believe that the differences in the computed solution loadings are caused in part by the different analytical techniques used to determine the carbon dioxide content of the liquid phase.

The method of correlation using mole ratios appears to be more useful than those employed by other investigators. A wide range of concentrations of the acidic gases can be studied with a comparatively few carefully selected experimental determinations.

CONCLUSIONS

This study provides accurate solubility data for the system carbon dioxide-hydrogen sulfide-15.3 weight % MEA over temperature and concentration ranges of particular interest in the design and operation of amine units. An empirical correlation is presented by which either the solution loading or vapor composition of an equilibrium system can be obtained when the composition of either phase is known.

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Received for review February 23, 1957. Accepted June 5, 1958. Southwide Chemical Conference, Memphis, Tenn., 1956.

Solubility of Nitrogen in Freon-114

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Nitrogen has been injected into the cell coolant systems at various times to lower the condenser heat transfer coefficient on the Freon side, thus making it possible to increase water velocity. However, difficulty has been encountered in removing the injected nitrogen by venting, and results of analyses of Freon in the cells indicate that an appreciable amount of nitrogen dissolves in the liquid phase. The objective of this study was to determine the equilibrium solubility of nitrogen in Freon-114 at various temperatures.

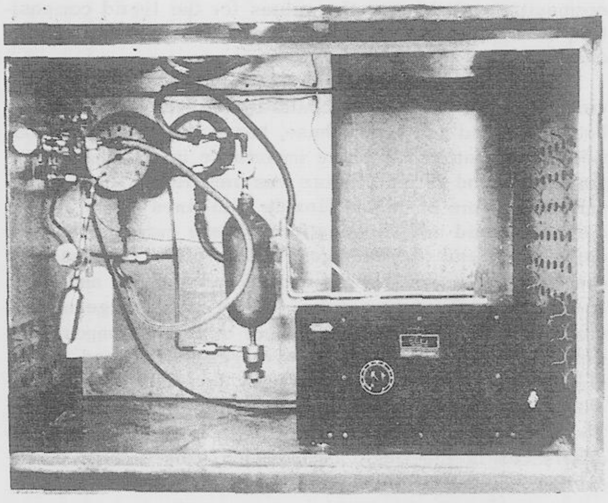

Figure 1. Apparatus for determining the concentration of nitrogen in liquid and vapor phases at different temperatures

PROCEDURE

Concentration of Nitrogen in Liquid and Vapor Phases. A method similar to that used by Parmelee (*1*) to determine the solubility of air in Freon-12 and Freon-22 was used. The apparatus, shown in Figure 1, consists of a Harshaw bomb, a sampling manifold, and pressure gages.

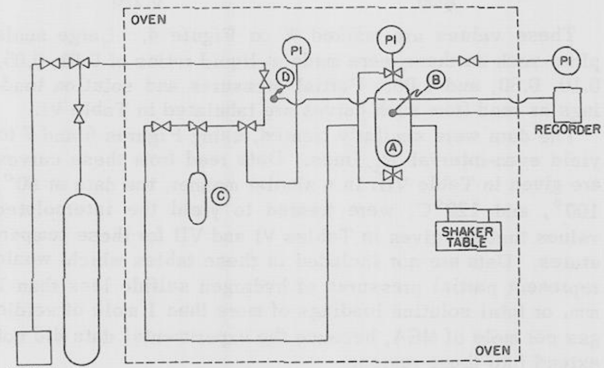

Figure 2. Schematic of experimental equipment

As is indicated schematically in Figure 2, a 1000-cc. Harshaw bomb, *A*, with a three-way diaphragm Hoke valve at the top and a normal diaphragm Hoke valve at the bottom, was fitted with a

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thermocouple, *B*. A charging and sampling manifold and calibrated pressure gages were attached to the bomb. The bomb was supported vertically on an oscillating table. This unit plus the small bomb, *C*, a thermocouple, *D*, and all sampling lines were placed in the oven. Connected to the manifold, but located outside the oven, were the vacuum pump and nitrogen cylinder.

The bomb was placed in a mixture of solid carbon dioxide and methanol and charged with 450 grams of Freon-114. After the Freon-114 had frozen, the bomb was evacuated to remove noncondensable gases. The bomb was allowed to come to room temperature (68° F.) and the vapor pressure was measured. Agreement of the vapor pressure with theoretical values at 68° F. indicated that the Freon-114 was pure.

Nitrogen was injected into the bomb to a predetermined pressure and the oscillating table was started. The system was oscillated for 0.5 hour after the pressure had stabilized. The sampling manifold and sampling bomb were evacuated and liquid was allowed to vaporize into the sampling cylinder to a pressure in the range of 1 to 2 p.s.i.a. The sampling manifold was again evacuated and a sample of the gas was withdrawn from the bomb. Low pressure samples were taken to ensure that no fractionation occurred in the sampling manifold. The same procedure was used in obtaining samples at elevated temperatures. Care was taken to ensure that the temperature, as well as the pressure, had stabilized before a sample was withdrawn. All samples were analyzed by means of the mass spectrometer.

Comparison with Experiment of Parmelee. Because the method outlined differed to some degree from that of Parmelee, two determinations of the solubility of air in Freon-22 were made. The results of these determinations are shown in Figure 3. The curves are those constructed by Parmelee for the indicated temperatures, while the points are those obtained experimentally. The point for 74° F. differs from the curve by approximately 4.0% while the point for 68° F. differs by approximately 6.0%. These differences are no greater than were the variations of the points from which Parmelee constructed the curves.

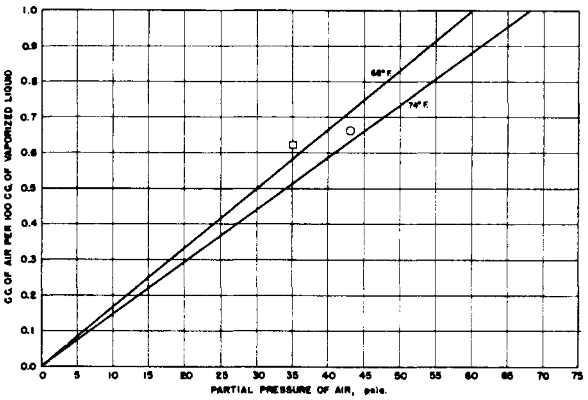

Figure 3. Solubility of air in Freon-22

Comparison with Parmelee

RESULTS

The results of this experiment are shown in Figure 4. The curves, which were obtained through least-squares fitting of experimental data, indicate that the solubility of nitrogen is proportional to its partial pressure above the solution. Since the curves are straight lines that pass through the origin, Henry's law, which is expressed in Equation 1, may be applied.

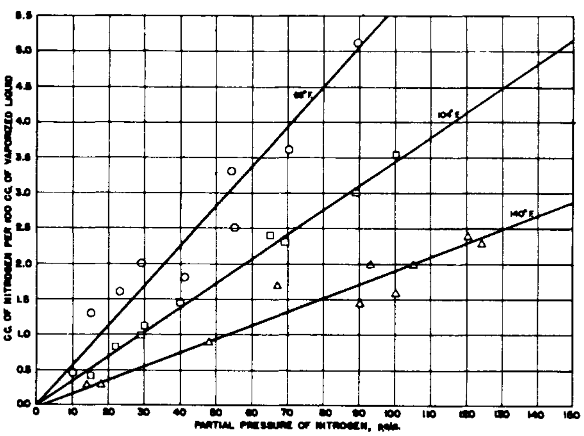

Figure 4. Solubility of nitrogen in Freon-114

Variation with partial pressure

$$X_n = KP_n \qquad (1)$$

where P_n is the partial pressure of the nitrogen above the solution in pounds per square inch absolute, X_n is the mole fraction of the nitrogen in the liquid phase, and K is the solubility constant with dimensions of reciprocal pressure per unit area. In this case, K, for each temperature is equal to the slope of the curves in Figure 4. The values of K for the curves in Figure 4 are given in Table 1.

Table I indicates that the solubility of nitrogen decreases with increasing temperature. This is shown approximately in Figure 5. From Figure 5, K may be obtained for any temperature and the solubility can be calculated by using Equation 1.

Table I. Solubility Constants

Temp., °F.	Solubility Constant, K, for Nitrogen in Freon-114 (P.S.I.A.)$^{-1}$
68	5.5×10^{-4}
104	3.7×10^{-4}
140	2.0×10^{-4}

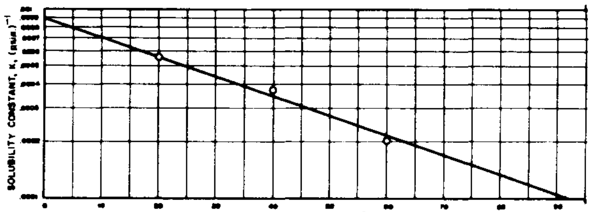

Figure 5. Change of solubility factor with temperature for nitrogen in Freon-114

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Received for review February 24, 1958. Accepted September 9, 1958. Work performed under contract AT-(33-2)-1 with the United States Atomic Energy Commission.