

A plot of $\ln(f/P)$ against P had only slight curvature, and a short extrapolation allowed values of f to be obtained over the pressure range of the solubility measurements. The solubility data for Ar+NaNO₃ at 410°C were adjusted to 400°C, using the van't Hoff equation with $\Delta H = 15.8$ kJ/mol (see table 1). A plot of $\log(f/C_d)$ against P is shown in fig. 8. A straight line was fitted to the points by least squares, and \bar{v}_d and K_H were found from the slope and intercept. The values were: $\bar{v}_d = 34 \pm 8$ ml/mol and $K_H = (1.0 \pm 0.1) \times 10^{-7}$ mol ml⁻¹ bar⁻¹ at 410°C, where the intervals quoted correspond to 95% confidence limits. These values are not materially altered if the calculation is restricted to the pressure range 0-776 bar. Similar plots (not shown) were made for Ar+NaNO₃ at 440°C, Ar+NaNO₃ at 331°C and Ar+RbNO₃ at 440°C, and yielded values for \bar{v}_d of 26 ± 13 , 30 ± 13 and 34 ± 13 mol/mol, respectively. The corresponding K_H values were $(1.1 \pm 0.2) \times 10^{-7}$, $(0.65 \pm 0.1) \times 10^{-7}$ and $(2.9 \pm 0.5) \times 10^{-7}$ mol ml⁻¹ bar⁻¹. For N₂+NaNO₃ at 390°C, the same procedure gave $\bar{v}_d = 46 \pm 40$ ml/mol and $K_H = (0.8 \pm 0.5) \times 10^{-7}$ mol ml⁻¹ bar⁻¹. The PVT data used for N₂ were those of Bartlett.²⁷ The poorer precision of the results for Ar+RbNO₃ and N₂+NaNO₃ reflects the fact that fewer data points were available for these systems. The fact that straight lines are obtained

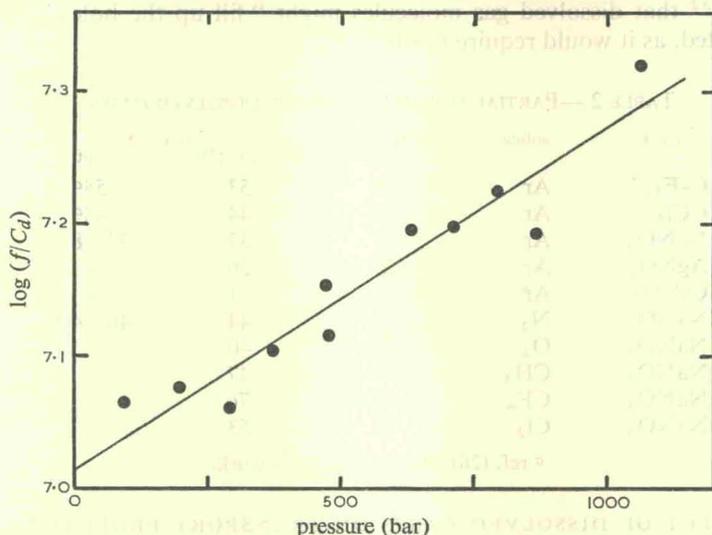


FIG. 8.—Plot of $\log(f/C_d)$ against pressure for the system Ar+NaNO₃ at 400°C.

when $\ln(f/C_d)$ is plotted against P is evidence that the solvent is not deviating from Raoult's law as the solute concentration increases. Such deviations would lead to curvature in these plots.

In table 1, K_H was evaluated from the slope of the best straight line through the origin of an isothermal plot of C_d against P , over the range 0-500 bar. This corresponds to the approximation $\ln(f/P) - (P\bar{v}_d/RT) = 0$ (cf. eqn (2)). Since the K_H values in table 1 agree with those derived using eqn (2) within the combined limits of error, the use of the simpler procedure is justified in the general case.

Smith and Walkley²⁸ described a simple method for estimating the partial molar volume of a solute gas from a knowledge of the volume v_0 of the gas at 0 K and the thermal pressure coefficient of the solvent $(\partial P/\partial T)_v$. Their formula is

$$\bar{v}_d = v_0 \left[1 - \frac{R}{\bar{v}_d} \left(\frac{\partial P}{\partial T} \right)_v^{-1} \right]^{-3} \quad (3)$$

Eqn (3) was derived by treating the gas as a hard-sphere fluid, and calculating the volume for which the gas pressure was equal to the internal pressure of the solvent. This volume was equated to \bar{v}_d . Values of v_0 may be found either from the volumes of solidified gases, or from molecular diameters obtained from second virial coefficients or from gas viscosities. Calculated values of \bar{v}_d were in good agreement with experiment for simple solute molecules in a range of organic solvents. Eqn (3) has been used to calculate \bar{v}_d for argon, nitrogen, and some other gases in molten nitrates (see table 2). The results agree with those derived from our solubility data, within experimental error. No figures are tabulated for helium, as quantum effects make it difficult to assign a value to v_0 ; the liquid molar volume is 27.4 ml/mol at 1.2 K,²⁹ but the molar volume estimated from the molecular diameter is only 10 ml/mol.³⁰ For NaNO_3 as solvent, these values of v_0 give $\bar{v}_d = 39$ and 21 ml/mol respectively. Table 2 shows that for a given gas, \bar{v}_d is less in molten nitrates than in organic solvents. This reflects the higher internal pressure of the former group of liquids, for which $T(\partial P/\partial T)_v$ is in the range 10-12 kbar.³¹ Eqn (3) requires that, if $(\partial P/\partial T)_v$ is positive, \bar{v}_d must be greater than v_0 . This is confirmed by the experimental data for organic liquids, and by the more limited data for molten salts. The suggestion^{9, 32} that dissolved gas molecules might "fill up the holes" in the melt is not supported, as it would require $\bar{v}_d \sim 0$.

TABLE 2.—PARTIAL MOLAR VOLUMES OF DISSOLVED GASES

solvent	solute	v_0 (ml/mol) (a,b)	\bar{v}_d (ml/mol)	
			(calc., eqn (3))	(expt.)
C_7F_{16}	Ar	25	53	54 ^a
CCl_4	Ar	25	44	44 ^a
NaNO_3	Ar	25	37	34 + 8 ^c
AgNO_3	Ar	25	36	—
CsNO_3	Ar	25	41	—
NaNO_3	N_2	32	44	46 ± 40 ^c
NaNO_3	O_2	28	40	—
NaNO_3	CH_4	35	47	—
NaNO_3	CF_4	63	76	—
NaNO_3	Cl_2	41	53	—

^a ref. (28); ^b ref. (30); ^c this work.

EFFECT OF DISSOLVED GASES ON TRANSPORT PROPERTIES

An applied pressure of 1 kbar changes the electrical conductivity of molten alkali nitrates by between 1 % (LiNO_3) and 12 % (CsNO_3).¹⁸ Considering argon or nitrogen as pressurizing gases, dissolution of gas to the equilibrium concentration at this pressure would cause a further change in conductivity by simple dilution. Assuming no change in ion mobility when the gas dissolves, the conductivity decrease is estimated to be not more than 1 %, based on the solubilities and partial molar volumes in tables 1 and 2. It seems likely that the ion mobilities would increase, rather than decrease, when dilution occurs: this is observed when water is added to molten LiClO_3 ,³³ and when p-xylene is added to molten tetra-n-amyl ammonium thiocyanate.³⁴ The net decrease in conductivity when argon or nitrogen dissolve isothermally in a nitrate melt at 1 kbar is therefore unlikely to exceed 1 %, which corresponds to a change of +0.6 ml/mol in the specific conductance activation volume ΔV_κ . This is much less than the reported difference between the "gas-free" and "gas-saturated" values of ΔV_κ for sodium nitrate,¹⁸ which may have other experimental causes. The "gas-free" value has been confirmed independently.³⁵