Densities of Some Molten Alkali Nitrate and Sulphate Mixtures

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The densities of several molten nitrate systems have been studied by the buoyancy method. For the system $LiNO_3$–$CsNO_3$, pure $CsNO_3$ and three mixtures were studied; for the system $NaNO_3$–$RbNO_3$, pure $RbNO_3$ and four mixtures were studied; for the system $NaNO_3$–KNO_3 the equimolar mixture, and for the system Li_2SO_4–K_2SO_4 the eutectic mixture were studied. All systems were studied over a range of temperatures and the data fitted to equations of the form $\rho = \alpha - \beta t$ by a least squares analysis.

MOLTEN SALT DENSITIES are often required to express other physical constants on the molar basis. In this work, the densities of the systems $LiNO_3$–$CsNO_3$ and $NaNO_3$–$RbNO_3$ were determined over the complete composition range; the minimum melting mixture of $NaNO_3$–KNO_3 and the Li_2SO_4–K_2SO_4 eutectic were also studied.

EXPERIMENTAL

The densities were determined by the buoyancy method. A platinum bob of known weight was immersed in the melts and weighed, and the densities of the melts were evaluated from the observed weight losses.

The apparatus and experimental techniques have been described elsewhere in detail (*3*). All chemicals used were commercial reagent grade. Before mixing in the appropriate proportions, all salts were recrystallized from water and oven dried, the nitrates at 140° C. and the sulphates at 200° C.

RESULTS AND DISCUSSION

The density data were fitted to the equation $\rho = \alpha - \beta t$ by the method of least squares. In this equation, ρ is the density, α and β are constants dependent on composition but not on temperature and t is the temperature in °C. The results are given in Table I. Each density equation is based on measurements at 9 to 15 temperatures.

In systems which form simple solutions without complex formation it has been found that molar volumes show only small deviations from additivity (*1, 3, 4*). This fact may be utilized in the interpolation of densities of mixtures for which experimental data are unavailable. All systems herein reported showed deviations from volumetric additivity which were small and temperature dependent as follows. In the system $LiNO_3$–$CsNO_3$, maximum deviation was −0.3% at 280° C. and +0.5% at 450° C., in the system $NaNO_3$–$RbNO_3$ maximum deviation was −0.9% at 250° C. and +0.4% at 450° C., in the system $NaNO_3$–KNO_3 deviation at the composition of the minimum melting mixture is +0.15% at 250° C. and +0.3% at 350° C., for the Li_2SO_4–K_2SO_4 eutectic deviation was +0.71% at 750° C. The density data used in these calculations for the pure salts $LiNO_3$, $NaNO_3$, KNO_3, Li_2SO_4, and K_2SO_4 were from previously published work (*1, 3*). The deviations noted are all within the experimental uncertainty of the points and so the molar volume isotherms of the systems $LiNO_3$–$CsNO_3$ and $NaNO_3$–$RbNO_3$ may be regarded as strictly linear. Consequently reliable density data may be obtained over the whole concentration range of these systems by interpolation of molar volume/composition isotherms.

LITERATURE CITED

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Table I. Density Data

Melt		$\rho = \alpha - \beta t$		Std. Dev.	
Component	Composition, mole %	α, grams/cc.	$\beta \times 10^3$, grams/cc./° C.	$\times 10^3$, grams/Cc.	Temp. Range, ° C.
		$LiNO_3$–$CsNO_3$ System			
$LiNO_3$	0	3.279	1.135	0.4	429–553
	35.4	2.979	1.079	2.2	282–468
	49.9	2.793	0.980	1.1	275–464
	80.1	2.330	0.736	1.4	275–451
		$NaNO_3$–$RbNO_3$ System			
$NaNO_3$	0	2.808	0.992	1.2	335–487
	20.6	2.701	0.959	2.4	262–453
	39.9	2.593	0.934	1.4	253–470
	59.9	2.464	0.881	1.4	244–471
	80.0	2.308	0.809	1.3	274–462
		$NaNO_3$–KNO_3 System			
$NaNO_3$	50.0	2.134	0.773	0.9	240–380
		Li_2SO_4–K_2SO_4 System			
Li_2SO_4	80.0	2.344	0.407	2.0	580–750