Table III. Parameters of Equations 1, 2, and 3 and Standard Deviations

	nonanoate			
	Na	K	Rb	Cs
$\varphi_V{}^0$, mL/mol	168	170	180	(182)
S_V, ($10^{3/2}$ mL$^{3/2}$ mol$^{-3/2}$)	2.53	3.76	0.94	(3.46)
σ	0.2	0.4	0.6	(0.2)
$10^6\gamma$, bar^{-1}	65.8	65.5	65.8	(65.6)
$10^6\delta$, (bar M)$^{-1}$	3.24	3.75	6.45	(5.55)
σ	0.1	0.08	0.08	(0.07)
λ, cP M^{-1}	8.61	11.80	11.83	(12.84)
σ	0.06	0.10	0.09	(0.07)

previously proposed for the higher homologues (*2*), S_f(odd) = $2.56n - 9.64$; from this equation in fact a value of $S_f = 13.4$ eu may be calculated.

Density, Compressibility, and Viscosity. The density values and the apparent molar volumes derived from the equation $\varphi_V = 10^3(d^\circ - d)/mdd^\circ + M_2/d$ (*9*), the compressibility, and the viscosity data are given in Table II, whereas in Table III are given the parameters of the following equations

$$\varphi_V = \varphi_V{}^\circ + S_V\sqrt{C} \qquad (1)$$

$$\beta_s = \gamma - \delta C \qquad (2)$$

$$\eta = \eta^\circ + \lambda C \qquad (3)$$

that fit the experimental data; η° is given in Table I. Parameter A of the Jones–Dole equation (*8*), $\eta/\eta^\circ = 1 + AC^{1/2} + BC$, is $\simeq 0$ in the limits of experimental error. From Table III it is evident that the dependence of η/C or β_s/C is more important in solutions with higher cation soaps, generally. Under the assumption that the salts are completely dissociated, the Glueckauf method (*7*), slightly modified as previously reported (*1*), may be employed in order to obtain $\varphi_V{}^+$ and $\varphi_V{}^-$. The $\varphi_V{}^0$ values concerning Na, K, and Rb soaps (more reliable owing to the high number of experimental measurements) expressed in the form

$$\varphi_V{}^0 = (4/3)\pi r^3 N + Kr^2 - A'z^2/r + \varphi_V{}^- \qquad (4)$$

give the following values: $A' = 40\ (\pm 5)$ (mL/mol) Å; $K = 11\ (\pm 2)$ mL/(mol Å^2); $\varphi_V{}^- = 174\ (\pm 2)$ mL/mol. The low values of $\varphi_V{}^+$ obtained from the additivity rule (−6, Na$^+$; −4, K$^+$; 6, Rb$^+$; 8, Cs$^+$) may be ascribed to the high value of the electrostriction constant. It is noteworthy that $\varphi_V{}^- \simeq V_{\text{nonanoic acid}}$.

Glossary

φ_V	apparent molar volume of the solute, the symbols 0, +, − have the following meaning, respectively: at infinite dilution, of the cation, of the anion, mL/mol
β_s	adiabatic compressibility, β° is of the pure solvent, bar^{-1}
u	ultrasonic velocity
d	density, d° is density of pure solvent, g/mL
η	viscosity, cP
m	molality
C	molarity
M	molecular weight of the solvent
M_2	molecular weight of the solute
N	Avogadro's number
n	number of carbon atoms in the molecule
k	cryoscopic constant
ΔT	cryoscopic lowering
H_f	fusion enthalpy
S_f	fusion entropy
T_0, T_{fus}	fusion temperature of nonanoic acid
S_V	slope of the Masson equation
σ	standard deviation

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Low-Temperature Heat Capacities of Potassium Disilicate

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Low-temperature heat capacities of crystalline potassium disilicate, $K_2Si_2O_5$(c), were measured over the range 5–308 K by adiabatic calorimetry. The entropy, S° at 298.15 K, was calculated to be 45.55 ± 0.05 cal K^{-1} mol^{-1}. The heat capacity, $C_p{}^\circ$, entropy, S°, and Gibbs energy function, $(G^\circ - H_0{}^\circ)/T$, are tabulated over the temperature range investigated. The heat capacity curve showed a normal sigmoid shape.

One of the Bureau of Mines overall goals is to maintain an adequate supply of minerals to meet national economic and strategic needs. Part of this effort involves supplying thermodynamic data on compounds of mineral and metallurgical interest, such as potassium disilicate. The heat capacities of potassium disilicate, $K_2Si_2O_5$(c), were measured over the range of 5–308 K by adiabatic calorimetry. Related thermodynamic functions are tabulated over the range 5–300 K.

Materials and Apparatus

Crystalline potassium disilicate was prepared by reacting a mixture of reagent-grade potassium carbonate, K_2CO_3, and silicic acid, $SiO_2 \cdot xH_2O$, in stoichiometric quantities of K_2O and SiO_2. The reaction was initiated by heating the mixture in a platinum dish at 813 K for several hours, followed by a 5-day heating

Table I. Observed Heat Capacities of $K_2Si_2O_5$(c)

T, K	$C_p°$, cal K^{-1} mol^{-1}	T, K	$C_p°$, K^{-1} mol^{-1}	T, K	$C_p°$, K^{-1} mol^{-1}
4.80	0.014	37.75	5.891	156.62	26.712
5.21	0.017	41.33	6.848	165.97	27.755
5.79	0.024	46.07	8.089	176.28	28.841
6.46	0.035	50.65	9.253	187.31	29.933
7.10	0.049	51.69	9.518	197.55	30.869
7.70	0.068	55.93	10.532	211.86	32.134
8.44	0.095	59.08	11.260	222.89	33.070
9.28	0.135	60.96	11.686	229.44	33.597
9.85	0.169	66.23	12.840	243.27	34.664
10.17	0.189	68.68	13.322	253.37	35.399
11.28	0.270	72.45	14.134	263.28	36.114
12.27	0.357	78.21	15.256	273.45	36.811
13.23	0.456	84.88	16.506	283.64	37.487
14.21	0.568	90.56	17.517	283.83	37.482
15.45	0.736	96.95	18.601	288.94	37.838
17.09	0.989	104.02	19.739	294.09	38.160
18.73	1.272	110.73	20.775	295.85	38.262
20.71	1.648	118.70	21.928	302.78	38.700
23.05	2.145	127.78	23.173	304.26	38.776
25.68	2.760	137.12	24.402	308.08	39.029
28.43	3.437	146.97	25.602		

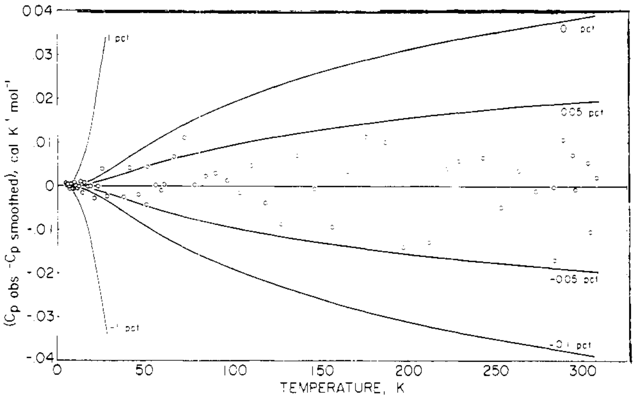

Figure 1. Deviations of observed heat capacities from smoothed values of $K_2Si_2O_5$(c).

period at 1073 K. After the reaction was completed, the sample was ground and blended in an argon atmosphere and then heated at 1189 K for 19 h. The procedure was repeated twice, with a heating period each time of 6 days. The sample was ground and blended one final time and then analyzed. The X-ray analysis was in good agreement with the ASTM pattern for $K_2Si_2O_5$(c). Optical microscopic examination indicated the material was crystalline and single phase, with an index of refraction of 1.50. This is in agreement with Kracek (*2*). Chemical analysis showed an average K_2O content of 43.93 wt % and a SiO_2 average of 56.16 wt % for a mole ratio of 1:2.004. Emission spectrographic analysis showed no significant metallic impurities. The molecular weight was calculated as 214.365 (*1*).

The details of construction of the adiabatic calorimeter and the method of operation have been reported elsewhere (*3*).

Results and Discussion

Experimental heat capacity data are listed in Table I. The overall uncertainty of the heat capacities was estimated to be ±1% below 25 K, ±0.5% for 25–50 K, and ±0.2% for 50–310 K. Listed in Table II are the smoothed heat capacities and related functions given at convenient temperature intervals. The entropy, enthalpy, and Gibbs energy were determined below 5 K by smoothly extrapolating a plot of C_p/T vs. T^2 to 0 K. Deviations of the experimental heat capacities from the smoothed values are shown in Figure 1. Energy units of the tabular data are the defined thermochemical calorie (1 cal = 4.184 J). No other low-temperature data on $K_2Si_2O_5$(c) were found in the literature.

Table II. Thermodynamic Properties of $K_2Si_2O_5$(c)

	cal K^{-1} mol^{-1}			
T, K	$C_p°$	$S°$	$-(G° - H_0°)/T$	$H° - H_0°$, cal mol^{-1}
5	0.015	0.005	0.001	0.019
10	0.178	0.050	0.011	0.387
15	0.673	0.204	0.047	2.362
20	1.510	0.505	0.120	7.701
25	2.593	0.954	0.239	17.870
30	3.843	1.536	0.406	33.914
35	5.163	2.227	0.615	56.42
40	6.492	3.003	0.864	85.56
45	7.812	3.844	1.148	121.32
50	9.096	4.734	1.462	163.61
60	11.468	6.606	2.162	266.64
70	13.624	8.538	2.934	392.26
80	15.60	10.488	3.757	538.5
90	17.42	12.432	4.613	703.7
100	19.10	14.355	5.491	886.4
110	20.66	16.25	6.384	1085.3
120	22.12	18.11	7.283	1299.3
130	23.48	19.94	8.192	1527.3
140	24.76	21.72	9.088	1768.5
150	25.96	23.47	9.989	2022.2
160	27.10	25.18	10.883	2287.5
170	28.18	26.86	11.778	2564.0
180	29.21	28.50	12.661	2851.0
190	30.18	30.11	13.542	3147.9
200	31.11	31.68	14.408	3454.4
210	31.99	33.22	15.27	3769.9
220	32.83	34.72	16.11	4094.0
230	33.64	36.20	16.95	4426.4
240	34.41	37.65	17.79	4766.6
250	35.16	39.07	18.61	5114
260	35.88	40.46	19.42	5470
270	36.58	41.83	20.23	5832
273.15	36.79	42.25	20.47	5948
280	37.25	43.17	21.02	6201
290	37.90	44.49	21.81	6577
298.15	38.41	45.55	22.45	6888
300	38.52	45.79	22.59	6959

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