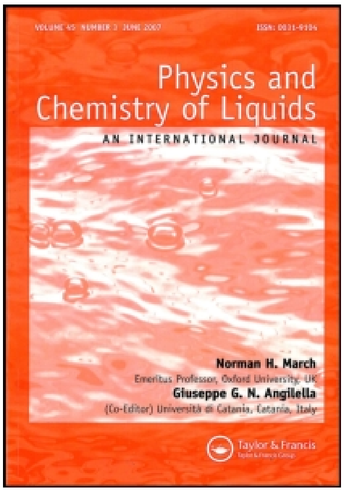

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Heat Capacity of Toluene Dimethyl Formamide Mixtures

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HEAT CAPACITY OF TOLUENE + DIMETHYL FORMAMIDE MIXTURES*

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Heat Capacity data of the binary mixtures of: toluene + dimethyl formamide – measured in the temperature range of 20–50°C using a differential heating technique are reported. The measurements are well represented by the mixture rules proposed by Jamieson and Cartwright, and Teja.

KEY WORDS: Heat capacity, mixtures, toluene, dimethyl formamide.

INTRODUCTION

The importance of liquid heat capacity data in process design calculations needs no fresh mention. In continutation of our experimental[1,2] and theoretical[3] work on the heat capacity of liquids and liquid mixtures, this work on the heat capacity of toluene + dimethyl formamide mixtures is undertaken.

APPARATUS AND EXPERIMENTAL

A simplified form of differential heating/cooling apparatus, similar to the one presented by Spear[4] and described in detail earlier[1,2], is used for the measurements. The experimental procedure and the method of treating the time-temperature observations, to calculate the liquid (liquid-mixture) heat capacity are also given in our earlier papers[1,2].

RESULTS AND DISCUSSION

The physical properties of the pure liquids are compared with the literature data[5] in Table 1. Table 2 compares the pure liquid heat capacity measurements of the present

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Table 1 Comparison of the physical properties of pure liquids with literature data.

Substance	*Density at 25°C, g/cc*		*Refractive index at 20 °C*		*Normal boiling point, °C*	
	Present	*Lit*[5]	*Present*	*Lit*[5]	*Present*	*Lit*[5]
Dimethyl formamide	0.9448	0.9445	1.4300	1.4301	152.8	153
Toluene	0.8625	0.8623	1.5000	1.49693	110.5	110.629

Table 2 Comparison of the heat capacity of pure liquids with literature data[6,7].

Substance	*Temperature* °C	*Heat Capacity,* Cal/g. °C	
		Present	*Literature*
Toluene	20	0.416	0.415
	30	0.420	0.419
	40	0.424	0.423
	50	0.430	0.429
Dimethyl formamide	20	0.4920	0.4918
	30	0.4980	0.4976
	40	0.5030	0.5025
	50	0.5060	0.5058

work with the literature data[6,7]. The measurements on mixtures are presented and compared with the following estimation methods in Table 3.

Weight fraction average

$$C_{P\,mix} = W_1 C_{P1} + W_2 C_{P2} \tag{1}$$

Jamieson and Cartwright method[8]

$$C_{P\,mix} = (W_1 C_{P1} + W_2 C_{P2})(1 + a + \beta) \tag{2}$$

where

$$a = (0.00141)\,|H_1 - H_2|^{0.88} \tag{3}$$

$$\beta = 5 \times 10^{-5}\,|H_1 - H_2|\sin(360\,W_2) \tag{4}$$

H = enthalpy of vaporization

and Teja's method[9]

$$C_{P\,mix}[T_R]_{mix} = X_1 C_{P1}\,[T_{R1}] + X_2 C_{P2}[T_{R2}] \tag{5}$$

Table 3 Mixture heat capacity data of toluene + dimethyl formamide system and comparison with estimation methods.

Temp. °C	*Weight* % *of toluene*	*Heat Capacity*, Cal/g. °C			
		Experimental	*Weight fraction average method*	*Jamieson & CartWright method*	*Teja's method*
20	9.2382	0.4851	0.4849	0.5062	0.4853
	18.6340	0.4780	0.4778	0.4987	0.4773
	28.1918	0.4707	0.4705	0.4932	0.4697
	37.9158	0.4634	0.4632	0.4838	0.4624
	47.8096	0.4558	0.4556	0.4765	0.4548
	57.8787	0.4482	0.4480	0.4694	0.4472
	68.1273	0.4404	0.4402	0.4594	0.4395
	78.5604	0.4325	0.4323	0.4513	0.4317
	89.1828	0.4244	0.4242	0.4427	0.4239
30	9.2382	0.4910	0.4908	0.5124	0.4912
	18.6340	0.4863	0.4864	0.5046	0.4829
	28.1918	0.4762	0.4760	0.4988	0.4753
	37.9158	0.4686	0.4684	0.4969	0.4676
	47.8096	0.4609	0.4607	0.4819	0.4599
	57.8787	0.4530	0.4528	0.4732	0.4520
	68.1273	0.4450	0.4448	0.4644	0.4441
	78.5604	0.4389	0.4387	0.4559	0.4381
	89.1828	0.4286	0.4284	0.4472	0.4281
40	9.2382	0.4959	0.4957	0.5157	0.4961
	18.6340	0.4885	0.4883	0.5087	0.4878
	28.1918	0.4890	0.4807	0.5037	0.4800
	37.9158	0.4733	0.4731	0.4939	0.4723
	47.8096	0.4654	0.4652	0.4866	0.4644
	57.8787	0.4575	0.4573	0.4783	0.4564
	68.1273	0.4494	0.4492	0.4689	0.4484
	78.5604	0.4411	0.4409	0.4603	0.4404
	89.1828	0.4327	0.4325	0.4515	0.4322
50	9.2382	0.4991	0.4989	0.5208	0.4993
	18.6340	0.4920	0.4918	0.5134	0.4913
	28.1918	0.4847	0.4845	0.5077	0.4839
	37.9155	0.4774	0.4772	0.4982	0.4765
	47.8097	0.4698	0.4696	0.4912	0.4689
	57.8787	0.4622	0.4620	0.4827	0.4613
	68.1273	0.4544	0.4542	0.4742	0.4535
	78.5604	0.4465	0.4463	0.4659	0.4458
	89.1828	0.4384	0.4382	0.4574	0.4378

where X = mole fraction

$$T_R = T/T_C; [T_R]_{mix} = T/T_{Cm} \tag{6}$$

and

$$T_{Cm} = W_1 T_{C1} + W_2 T_{C2} \tag{7}$$

For this system, the weight fraction average method gives the best estimate with a percent average absolute deviation (PAAD) of 0.04 compared to a PAAD of 4.3 in using Jamieson and Cart Wright method and a PAAD of 0.2 in using Teja's method.

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