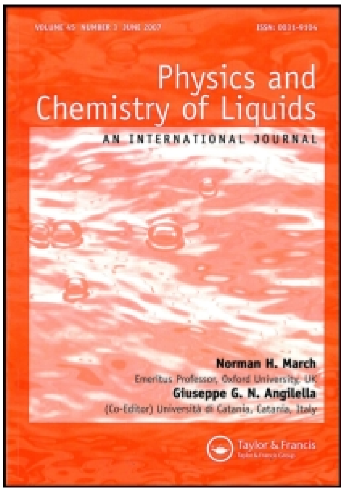

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T.E. Vittal Prasad[a]; B.M. Jaipuran Rao[a]; V. Ajay Kumar[a]; Sashidhar S. Bhatt[a]; D. H. L. Prasad[a]
[a] Properties Group, Chemical Engineering Laboratory, Indian Institute of Chemical Technology, Hyderabad, India

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BOILING TEMPERATURE MEASUREMENTS ON THE BINARY MIXTURES OF m-XYLENE WITH SOME ALIPHATIC ALCOHOLS

T.E. VITTAL PRASAD, B.M. JAIPURAN RAO[†],
V. AJAY KUMAR[†], SASHIDHAR S. BHATT[†] and
D.H.L. PRASAD*

Properties Group, Chemical Engineering Laboratory,
Indian Institute of Chemical Technology, Hyderabad 500 007, India

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Boiling temperatures at 95 kPa, over the entire composition range are measured for the four binary systems formed by m-xylene with n-butanol, *iso*-butanol, *sec*-butanol and *tert*-butanol. A Swietoslawski-type ebulliometer was used for the measurements. The composition versus temperature measurements are well represented by the Wilson model.

Keywords: Binary mixture; Boiling temperature

INTRODUCTION

This investigation on the boiling temperature measurements of the binary mixtures noted in the abstract is in continuation of our recent studies on the phase equilibria of the binary mixtures containing hydrocarbons and alcohols [1,2]. The measurements have been carried

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*Corresponding author.

[†] M.S. Ramiah Institute of Technology, Bangalore 560 054, India.

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out at 95 kPa. We could not locate any experimental data in the literature on the systems chosen for the present study.

EXPERIMENTAL SECTION

A Swietoswski-type ebulliometer, very similar to the one described by Hala *et al.* [3] was used for this experimental investigation. Connection of the ebulliometer to a good vacuum system, though a mercury manometer in line, facilitated the creation and the maintenance of the chosen pressure with in ± 1 mmHg. The equilibrium temperatures are measured to an accuracy of ± 0.1°C by means of a platinum resistance thermometer, carefully calibrated by means of point-to-point comparison with a Standard Platinum Resistance Thermometer certified by the National Bureau of Standards, Boulder (USA). The liquid mixtures for the studies are prepared gravimetrically making use of electronic balance precise to ± 0.0001 g and stirred well before being placed in the ebulliometer. The heating rate is adjusted to yield the desired condensate drop rate of 30 drops per minute in accordance with the suggestion of Hala *et al.* [3]. The equilibrium temperature measured after the steady drop rate and constancy of temperature are maintained for at least 30 min is recorded.

Materials

AR grade chemicals used in this study were further purified according to the easiest possible of the methods described in Riddick *et al.* [4]. The purity of the chemicals is ascertained by measuring their density and refractive index, which compare favourably with the literature values as shown in Table I.

RESULTS AND DISCUSSION

The experimental liquid phase composition (x_1) versus temperature (T) data, summarized in Table II, are fitted to the Wilson model [5].

TABLE I Comparison of the density (D) and refractive-index (n) of the pure substances used in this study with literature data from Riddick *et al.* [4] at 298.15 K

Substance	$D/(\text{kg/m}^{-3})$		*N*	
	This work	*Riddick et al.* [4]	*This work*	*Riddick et al.* [4]
m-Xylene	860.1	860.09	1.4946	1.49464
n-Butanol	805.8	805.75	1.3974	1.39741
iso-Butanol	797.8	797.80	1.3939	1.39389
sec-Butanol	802.4	802.41	1.3953	1.39530
tert-Butanol	781.2	781.20	1.3852	1.38520

TABLE II The boiling temperature measurements

n-Butanol(1) + p-Xylene(2)		*iso-Butanol(1) + p-Xylene(2)*		*sec-Butanol p-Xylene(2)*		*tert-Butanol(1) + p-Xylene(2)*	
x_1	T/K	x_1	T/K	x_1	T/K	x_1	T/K
0.0000	407.95	0.0000	407.95	0.0000	407.95	0.0000	407.95
0.0930	398.15	0.0930	393.15	0.0930	389.95	0.0911	381.65
0.2011	394.25	0.1990	387.85	0.1990	382.45	0.1965	372.25
0.3020	392.45	0.3001	385.55	0.3001	378.95	0.2962	367.65
0.3900	391.25	0.3950	383.75	0.3950	376.45	0.3910	365.05
0.5030	390.15	0.5007	382.45	0.5007	375.15	0.4959	362.65
0.6030	389.65	0.5990	381.25	0.5990	374.05	0.5953	360.45
0.6950	389.15	0.6935	380.65	0.6935	372.95	0.7025	358.65
0.7960	388.85	0.7940	380.05	0.7940	372.05	0.8035	356.95
0.9015	389.05	0.9006	379.55	0.9006	371.35	0.8989	355.45
1.0000	389.05	1.0000	379.35	1.0000	370.95	1.0000	353.85

The optimum Wilson parameters are obtained by minimizing the objective function defined as

$$\varphi = \sum [(\mathrm{P_{cal}}/\mathrm{P_{expt}}) - 1]^2, \tag{1}$$

where $\mathrm{P_{cal}}$ and $\mathrm{P_{expt}}$ stand for the calculated and experimental total pressures. The Nelder–Mead optimization technique described by Kuester and Mize [6] was used. Vapor pressures needed in the computations are calculated from the Antoine constants collected from Reid *et al.* [7] and noted in Table III for ready reference. The Antoine equation, with the constants noted in Table III, represents the literature vapor pressure data as well the present measurements with an average absolute deviation of 0.5%, for the nine pure liquids of the present study. The molar volumes of the pure liquids calculated from the

TABLE III Antoine constants for the equation in (P/kPa) = A–B/[(T/K) + C]

Substance	*A*	*B*	*C*
m-Xylene	14.1216	3366.99	−58.04
n-Butanol	15.1986	3137.02	−94.43
iso-Butanol	14.8538	2874.72	−100.30
sec-Butanol	15.1928	3026.03	−86.65
tert-Butanol	14.8374	2658.29	−95.50

TABLE IV Representation of the measurements by Wilson model

System	$[(\lambda_{12}-\lambda_{11})/R]$/K	$[(\lambda_{12}-\lambda_{22})/R]$/K	*Std. Dev. in* T/K
n-Butanol(1) + m-Xylene(2)	545.52	−39.48	0.08
iso-Butanol(1) + m-Xylene(2)	491.45	40.57	0.13
sec-Butanol(1) + m-Xylene(2)	309.93	183.05	0.12
tert-Butanol(1) + m-Xylene(2)	384.52	52.42	0.08

density measurements of this study (recorded in Table I) are used as the input in obtaining the optimum Wilson parameters. The results of the representation of the phase equilibrium data by the Wilson [5] model, summarized in Table IV, indicate that the data and the representation are quite good. The data and the representation presented in the paper are expected to be useful for engineering design purposes.

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