

Compiled by Thermodynamics Research Center

Components: 1. Ethanol, C_2H_5O (64-17-5)
2. Ethyl methanoate, $C_3H_6O_2$ (108-89-0)

State: Binary system, single-phase liquid in equilibrium with vapor; pure components, both liquid in equilibrium with vapor

Variables: T , temperature
 x_i , mole fraction of component i in liquid phase
 y_i , mole fraction of component i in vapor phase

Parameters: P , pressure

Method: Direct measurement of T , x_i and y_i at constant P , ref. 1

Author(s): Ortega, J. (Laboratorio de Termodinámica y Fisicoquímica, Escuela Superior de Ingenieros Industriales, Universidad de Las Palmas de Gran Canaria, 35011 Las Palmas de Gran Canaria, Canary Islands, Spain)

Edited by: Slawos, A.; Mączyński, A. (Instytut Chemii Przemysłowej, Politechniki Akademickiej, ul. Koszowska 4452, 01-224 Warszawa, Poland)

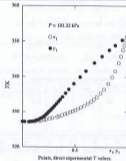
SOURCE OF DATA

Soto, A.; Hernández, P.; Ortega, J. (Laboratorio de Termodinámica y Fisicoquímica, Escuela Superior de Ingenieros Industriales, Universidad de Las Palmas de Gran Canaria, Canary Islands, Spain), ref. 2

DIRECT EXPERIMENTAL VALUES

P/kPa = 101.32

x_2	TK	y_1	y_2	TK	y_1										
0.000	327.28	0.000	0.505	336.53	0.269										
0.019	327.23	0.022	0.529	336.89	0.280										
0.065	327.19	0.061	0.538	336.32	0.293										
0.083	327.24	0.076	0.594	336.83	0.308										
0.102	327.27	0.088	0.620	332.40	0.326										
0.125	327.34	0.104	0.635	333.09	0.344										
0.160	327.48	0.129	0.681	333.62	0.361										
0.176	327.58	0.131	0.710	334.39	0.383										
0.206	327.75	0.146	0.746	335.43	0.412										
0.225	327.84	0.155	0.779	336.53	0.443										
0.260	328.11	0.171	0.820	338.14	0.492										
0.286	328.27	0.182	0.839	348.00	0.532										
0.333	328.34	0.198	0.886	341.09	0.608										
0.349	328.81	0.209	0.920	344.03	0.690										
0.379	329.08	0.218	0.942	345.88	0.762										
0.406	329.36	0.230	0.962	347.66	0.831										
0.429	329.63	0.238	0.975	348.98	0.888										
0.439	329.94	0.249	0.989	358.43	0.954										
0.682	330.25	0.279	1.000	331.45	1.000										



AUXILIARY INFORMATION

Apparatus: The apparatus was a glass ebulliometer employing continuous circulation of the liquid and vapor phases with a charge capacity of 50 cm³, ref. 3. Turbulent mixing of the phases enabled equilibrium to be reached in a relatively short time. The ebulliometer was connected to a vacuum pump and a Fisher model VEE pressure controller. High purity nitrogen was used for the backing pressure. The temperatures were measured by a ASL-925 digital platinum resistance thermometer with a precision of readings ± 0.01 mK.

Procedure: The procedure was described in ref. 3. The compositions were determined by measuring their densities at 298.15 K with an Anton Paar model DMA-35 vibrating-tube digital densimeter with a precision of ± 0.02 kg m⁻³. A polynomial equation describing the density-concentration curve obtained from mixtures of known composition was used in the calculations. Estimated uncertainty of composition ± 0.003 mole fraction.

Materials: 1. Fluka AG (Guchs, St. Gallen, Switzerland), "pure" p.a. grade material, purity > 99.8 mole %, degassed ultrasonically, dried over molecular sieve 3A; $\rho(298.15 \text{ K}) = 1.5994$, $\rho(298.15 \text{ K})/\text{kg m}^{-3} = 784.54$; ref. 4.
2. Fluka AG (Guchs, St. Gallen, Switzerland), highest commercial grade; degassed ultrasonically, dried over molecular sieve 3A; $\rho(298.15 \text{ K}) = 1.3576$, $\rho(298.15 \text{ K})/\text{kg m}^{-3} = 914.93$.

Purity: [M]K = 0.0; [M]P₁ = 10; [M]₂ = 0.003; [M]₃ = 0.003.

REFERENCES

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- Soto, A.; Hernández, P.; Ortega, J. *Fluid Phase Equilib.*, 1998, 146, 301.
- Ortega, J.; Peña, J. A.; de Albornoz, C. *J. Chem. Eng. Data*, 1986, 31, 336.
- Ortega, J.; Guehén, S. *J. Chem. Eng. Data*, 1995, 40, 699.

Compiled by Thermodynamics Research Center

Components:	1. Ethanol, C ₂ H ₅ O (66-13-5) 2. Methyl methanolate, C ₂ H ₄ O ₂ (39-96-7)
State:	Binary system, single phase liquid in equilibrium with vapor; pure components, both liquid in equilibrium with vapor
Variables:	T, temperature x _i , mole fraction of component i in liquid phase y _i , mole fraction of component i in vapor phase
Parameters:	P, pressure
Method:	Calculation from direct experimental liquid-vapor equilibrium temperature, T _{exp} , data at variable x ₁ and constant P, ref. 1

Author(s): Ortega, J. (Laboratorio de Termodinámica y Fisicoquímica, Escuela Superior de Ingenieros Industriales, s/n de la Universidad de Las Palmas de Gran Canaria, 36170 Las Palmas de Gran Canaria, Canary Islands, Spain)

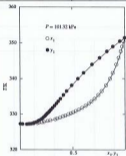
Edited by: Orszag, P. (Wydział Chemii, Uniwersytet Warszawski, ul. Pasteura 1, 02-093 Warszawa, Poland)

SOURCE OF DATA

Soto, A.; Hernández, P.; Ortega, J. (Laboratorio de Termodinámica y Fisicoquímica, Escuela Superior de Ingenieros Industriales, Universidad de Las Palmas de Gran Canaria, Canary Islands, Spain), FIRST PUBLISHED RESULTS

Notes: The table reports smoothed values of T and calculated values of y₁

P/Pa = 101.32						
x ₁	T/K	y ₁				
0.00	321.29	0.9008				
0.05	321.17	0.9303				
0.10	321.24	0.8888				
0.15	321.43	0.8197				
0.20	321.70	0.7457				
0.25	326.02	0.6584				
0.30	328.39	0.5891				
0.40	329.29	0.5275				
0.50	330.43	0.4670				
0.60	331.97	0.4135				
0.70	334.14	0.3759				
0.75	335.59	0.4178				
0.80	337.40	0.4714				
0.85	339.69	0.5425				
0.90	342.62	0.6409				
0.95	346.44	0.7833				
1.00	351.46	1.0000				

Standard deviations of T/K, relative standard deviation 100(dT/T), and absolute maximum deviation Δ₁/T/K at P/Pa = 101.32 are resp.: 0.074, 0.294, 0.238.Points, direct experimental T values; curves, T(x₁) and T(y₁), calculated from the equations.

EQUATIONS

$$G^E/RT = -x_1 \ln \gamma_1 + x_2 \ln \gamma_2 - x_1 x_2 (c_1 + c_2 x_1)$$

$$c_1 = \exp \left[-b_1 + \frac{a_1}{T} \right] \quad c_2 = \exp \left[-b_2 + \frac{a_2}{T} \right]$$

$$P = P_1^s + P_2^s - \sum_{i=1}^2 x_i P_i^s \exp \left[\frac{V_i^L - (B_{i1} + B_{i2})/2}{RT} - \frac{P_i^s (V_i^L - B_{i1})}{RT} (1 - x_i)^2 \right]$$

$$a_i^L = G^E - x_i \ln G^E / dx_i / dx_i \quad a_i^V = G^E - x_i \ln G^E / dx_i \quad \text{exp} [A_i + B_i / (C_i + T)]$$

$$B_{12}^E = B_{21}^E - (B_{11} + B_{22})/2; \quad V_i^L = V_i^s / P; \quad P_i^s/P_a = \exp [A_i + B_i / (C_i + T)]$$

COEFFICIENTS IN THE EQUATIONS

P/Pa	a ₁ /K	a ₂ /K ²	a ₃ /K	a ₄ /K ²
101.32	154.27 (5.4)	0 (0)	263.00 (4.0)	0 (0)

The standard deviations (σ_{a_i}) of the coefficients a_i are given in parentheses.

P/Pa	A ₁	B ₁	C ₁	A ₂	B ₂	C ₂
101.32	15.94126	-3247.70	-64.64	14.00356	-2185.15	-37.17

AUXILIARY INFORMATION

Measurements: The T_{exp} data at 101.32 kPa are reported in ref. 2.Computations: The 38 T_{exp} data at 101.32 kPa were reduced using the modified Wilson equation, ref. 3, for the partial molar excess Gibbs energies g_i^E.Corrections: Vapor pressure equation parameters were taken from ref. 4 and parameters A_i were modified according to the experimental boiling points of pure substances. Vapor-phase imperfections and the variation of the Gibbs energy of the pure liquid components with pressure were accounted for in terms of the 2nd molar virial coefficients B_{ij}, ref. 5, and the molar volumes under saturation pressure V_i^s, ref. 6.Errors: Standard deviation σ(T) = [(dT - T_{exp})² / (N - 2)]^{1/2}
Relative standard deviation 100σ(T)/T = 100[(dT - T_{exp})² / (N - 2)]^{1/2} / T
N, number of experimental points, ref. 2.
n, number of coefficients in the smoothing equation.

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2. Ortega, J. *Int. DATA Ser., Ser. A*, **2003**, *31*, 26.
3. Wilson, G. M. *J. Am. Chem. Soc.*, **1964**, *86*, 127.
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5. Tsonopoulos, C. *AIChE J.*, **1974**, *20*, 263; **1975**, *21*, 827.
6. Yun, L. C.; Woods, S. S. *AIChE J.*, **1966**, *12*, 95.

Compiled by Thermodynamics Research Center

Components: 1. Ethanol, C_2H_5OH (M 77.10)
2. Butyl methacrylate, $C_{10}H_{18}O_2$ (M 154.20)

State: Binary system, single phase liquid in equilibrium with vapor; pure components, both liquid in equilibrium with vapor

Variables: T , temperature
 x_i , mole fraction of component i in liquid phase
 y_i , mole fraction of component i in vapor phase

Parameters: P , pressure

Method: Direct measurement of T , x_i and y_i at constant P , ref. 1

Author(s): Ortega, J. (Laboratorio de Termodinámica y Fisicoquímica, Escuela Superior de Ingenieros Industriales, Universidad de Las Palmas de Gran Canaria, 35071 Las Palmas de Gran Canaria, Canary Islands, Spain)

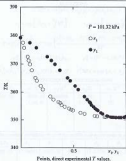
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SOURCE OF DATA

González, E.; Ortega, J. (Laboratorio de Termodinámica y Fisicoquímica, Escuela Superior de Ingenieros Industriales, Universidad de Las Palmas de Gran Canaria, Canary Islands, Spain); ref. 2

DIRECT EXPERIMENTAL VALUES

$P/P_0 = 101.32$					
x_1	T/K	y_1	x_2	T/K	y_2
0.0080	326.30	0.0080	0.4920	353.53	0.7504
0.0236	327.87	0.0289	0.3877	352.69	0.7664
0.0343	329.67	0.1582	0.6945	352.30	0.7765
0.0678	327.57	0.2542	0.7816	351.57	0.8179
0.0786	321.25	0.2029	0.7251	351.45	0.8275
0.0886	309.95	0.3267	0.7956	351.54	0.8545
0.1085	307.82	0.3725	0.8105	351.09	0.8668
0.1397	305.00	0.4445	0.8688	351.05	0.8829
0.1538	304.87	0.4714	0.9025	351.00	0.9055
0.1909	302.27	0.5171	0.9357	350.97	0.9330
0.2207	301.81	0.5462	0.9378	351.00	0.9495
0.2602	304.25	0.6047	0.9692	351.07	0.9815
0.3097	307.45	0.6302	1.0000	351.45	1.0000
0.3563	306.80	0.6517			
0.3733	306.28	0.6623			
0.3839	305.32	0.6708			
0.4215	304.85	0.6903			
0.4565	304.27	0.7069			
0.4772	303.87	0.7206			



AUXILIARY INFORMATION

Apparatus: The apparatus was a glass ebulliometer employing continuous circulation of the liquid and vapor phases with a capacity of around 60 cm³, ref. 3. Turbulent mixing of the phases enabled equilibrium to be reached in a relatively short time. The ebulliometer was connected to a vacuum pump and the pressure controlled by a Vakuumat electronic instrument (Naruckhoff Gerätebau Wertheim) and measured with a mercury manometer.

Procedure: The procedure was described in ref. 3. The compositions were determined by measuring their densities at 298.15 K with an Anton Paar model DMA-55 vibrating-tube digital densimeter with a precision of $\pm 0.02 \text{ kg m}^{-3}$. A polynomial equation describing the density-concentration curve obtained from mixtures of known composition was used in the calculations. Estimated uncertainty of composition < 0.002 mole fraction.

Materials: 1. Fluka AD (Buchs, St. Gallen, Switzerland), purity > 99.8 mol %; degassed ultrasonically, added over molecular sieves 3A; $\rho(298.15 \text{ K}) = 1.1095$, $\rho(298.15 \text{ K})/\text{kg m}^{-3} = 785.38$.

2. Aldrich (Steinheim, Germany), purity 97+ mol %; degassed ultrasonically, added over molecular sieves 3A; $\rho(298.15 \text{ K}) = 1.1872$, $\rho(298.15 \text{ K})/\text{kg m}^{-3} = 887.64$.

Notes: [87]K = 0.01; [M] P_0 = 10; [M] x_1 = 0.002; [M] y_1 = 0.06.

REFERENCES

- Int. Data Ser., Ser. A, *Guidelines*, 3, 1994, 22(1).
- González, E.; Ortega, J. *J. Chem. Eng. Data*, 1995, 46, 1178.
- Ortega, J.; Peña, J. A.; de Alencar, C. *J. Chem. Eng. Data*, 1996, 37, 339.

Components: 1. Ethanol, C_2H_5O (84-74-7)
 2. Butyl methacrylate, $C_8H_{16}O_2$ (792-84-7)

State: Binary system, single-phase liquid in equilibrium with vapor; pure components, both liquid in equilibrium with vapor

Variables: T , temperature
 x_i , mole fraction of component i in liquid phase
 y_i , mole fraction of component i in vapor phase

Parameters: P , pressure

Methods: Calculations from direct experimental liquid-vapor equilibrium temperatures, T_{exp} , data at variable x_i and constant P , ref. 1

Authentic: Ortega, J. (Laboratorio de Termodinámica y Fisicoquímica, Escuela Superior de Ingenieros Industriales, at table No. Universidad de Las Palmas de Gran Canaria, 35071 Las Palmas de Gran Canaria, Canary Islands, Spain)

Edited by: Orawa, F. (Wydział Chemii, Uniwersytet Warszawski, ul. Pasteura 1, 02-093 Warszawa, Poland)

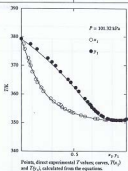
SOURCE OF DATA

González, E.; Ortega, J. (Laboratorio de Termodinámica y Fisicoquímica, Escuela Superior de Ingenieros Industriales, Universidad de Las Palmas de Gran Canaria, Canary Islands, Spain); FIRST PUBLISHED RESULTS

Notes: The table reports smoothed values of T and calculated values of y_i

P/MPa = 101.32		
x_1	T/K	y_1
0.00	379.30	0.0000
0.05	375.86	0.1899
0.10	368.94	0.5365
0.15	364.92	0.6472
0.20	361.86	0.7133
0.25	359.50	0.7497
0.30	357.70	0.8097
0.40	355.29	0.8682
0.50	353.57	0.7111
0.60	352.44	0.7481
0.70	351.64	0.7861
0.75	351.35	0.8079
0.80	351.13	0.8316
0.85	350.99	0.8608
0.90	350.96	0.8856
0.95	351.11	0.9410
1.00	351.45	1.0000

Standard deviations of T (K), relative standard deviation 100(ΔT)/ T , and absolute maximum deviation Δy_1 (K) at $P/MPa = 101.32$ are resp.: 0.263, 0.813, 0.444.



Points, direct experimental T values; curves, $T(x_1)$ and $T(y_1)$, calculated from the equations.

EQUATIONS

$$G^E RT = -x_1 \ln \gamma_1 + x_2 \ln \gamma_2 - x_2 \ln \gamma_2 + v_1 x_1$$

$$\gamma_1 = \exp \left[-A_1 \left(-x_1 + \frac{x_1^2}{2} \right) / T \right] \quad \gamma_2 = \exp \left[-A_2 \left(-x_2 + \frac{x_2^2}{2} \right) / T \right]$$

$$P = P_1^s + P_2^s - \sum_{i=1}^2 x_i P_i^s \exp \left[\frac{V_i^L (P_i^s - P^s) (P^s - P)}{RT^2} (1 - \gamma_i)^2 \right]$$

$$P_i^s = G^E - x_i \Delta G^E / (x_i)_{i=1,2} \quad P_j^s = G^E - x_j \Delta G^E / (x_j)_{i=1,2}$$

$$A_{12}^E = A_{12} - (A_{11} + A_{22})/2; \gamma_1 = P_1/P^s; \quad P_i^s(P/MPa) = \exp [A_i + B_i/T + C_i/T^2]$$

COEFFICIENTS IN THE EQUATIONS

P/MPa	A_i /K	A_i /K ²	B_i /K	C_i /K ²
101.32	-3028.10 (286.8)	1468896 (92000)	237.94 (65.6)	0 (0)

The standard deviations (σ_{e_i}) of the coefficients e_i are given in parentheses.

P/MPa	A_1	B_1	C_1	A_2	B_2	C_2
101.32	15.94165	-3247.79	-64.64	15.02896	-3530.38	-40.15

AUXILIARY INFORMATION

Measurements: The T_{exp} data at 101.32 kPa are reported in ref. 2.

Computations: The 32 T_{exp} data at 101.32 kPa were reduced using the modified Wilson equation, ref. 3, for the partial molar excess Gibbs energies μ_i^E .

Conventions: Vapor pressure equation parameters were taken from ref. 4 and parameters A_i were modified according to the experimental boiling points of pure substances. Vapor-phase imperfections and the variation of the Gibbs energy of the pure liquid components with pressure were accounted for in terms of the 2nd molar virial coefficients B_i , eq. 5, and the molar volumes under saturation pressure V_i^s , ref. 6.

Errors: Standard deviation of T = $[\sum(T - T_{exp})^2 / (N-2)]^{1/2}$
 Relative standard deviation 100(ΔT)/ T = $100[\sum(T - T_{exp})^2 / \sum T_{exp}^2]^{1/2} / (N-2)^{1/2}$
 N , number of experimental points, ref. 2.
 n , number of coefficients in the smoothing equation.

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Int. Data Ser., Ser. A, Guidelines, Ser. A, 2003, 31(01), 26-31

Component:	1. Ethanol, C_2H_5O (66-17-3)
	2. Benzyl ethanoate, $C_{11}H_{14}O_2$ (125-98-4)
State:	Binary system, single-phase liquid in equilibrium with vapor; pure components, both liquid in equilibrium with vapor
Variables:	T , temperature; x_i , mole fraction of component i in liquid phase y_i , mole fraction of component i in vapor phase
Parameters:	P , pressure
Method:	Direct measurement of T , x_i , and y_i at constant P , ref. 1

Author(s): Ortega, J. (Laboratorio de Termodinámica y Fisicoquímica, Escuela Superior de Ingenieros Industriales, Universidad de Las Palmas de Gran Canaria, 35071 Las Palmas de Gran Canaria, Canary Islands, Spain)

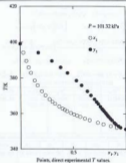
Edited by: Skrzecniak, A., Majczyk, A. (Instytut Chemii Fizycznej, Polska Akademia Nauk, ul. Kasprzaka 44/52, 01-224 Warszawa, Poland)

SOURCE OF DATA

González, E.; Ortega, J. (Laboratorio de Termodinámica y Fisicoquímica, Escuela Superior de Ingenieros Industriales, Universidad de Las Palmas de Gran Canaria, Canary Islands, Spain); ref. 2

DIRECT EXPERIMENTAL VALUES

$P/P_0 = 101.32$					
x_1	T/K	y_1	x_2	T/K	y_2
0.0000	399.26	0.0000	0.5660	358.37	0.8382
0.0297	394.31	0.1721	0.6105	357.42	0.8538
0.0570	389.68	0.3002	0.6564	356.52	0.8690
0.0795	386.12	0.3829	0.7036	355.17	0.8869
0.1011	383.05	0.4484	0.7479	354.21	0.9064
0.1375	378.36	0.5329	0.8063	353.16	0.9315
0.1647	376.04	0.5817	0.9044	352.32	0.9568
0.2845	372.77	0.6255	1.0000	351.45	1.0000
0.2969	370.52	0.6696			
0.2756	368.25	0.7029			
0.3037	366.82	0.7280			
0.3208	365.39	0.7378			
0.3678	364.12	0.7392			
0.3999	362.97	0.7366			
0.4087	362.32	0.7303			
0.4411	361.62	0.7093			
0.4769	360.58	0.6868			
0.5028	359.76	0.6799			
0.5374	359.04	0.6729			



AUXILIARY INFORMATION

Apparatus: The apparatus was a glass ebulliometer employing continuous circulation of the liquid and vapor phases with a capacity of approx. 50 cm³, ref. 3. Turbulent mixing of the phases enabled equilibrium to be reached in a relatively short time. The ebulliometer was connected to a vacuum pump and the pressure controlled by a Valomat electronic instrument (NormaGEE GmbH, Wetzlar) and associated with a mercury manometer.

Procedure: The procedure was described in ref. 3. The compositions were determined by measuring their densities at 298.15 K with an Anton Paar model DMA 55 vibrating-tube digital densimeter with a precision of $\pm 0.02 \text{ kg m}^{-3}$. A polynomial equation describing the density-concentration curve obtained from mixtures of known composition was used in the calculations. Estimated uncertainty of composition < 0.002 mole fraction.

Materials: 1. Fluka AG (Buchs, St. Gallen, Switzerland), purity > 99.8 and %; degassed ultrasonically, dried over molecular sieves SA; $\rho(1, 298.15 \text{ K}) = 1.2095, \rho(2, 298.15 \text{ K})/\text{kg m}^{-3} = 785.38$.

2. Fluka AG (Buchs, St. Gallen, Switzerland), purity > 99 mol %; degassed ultrasonically, dried over molecular sieves SA; $\rho(1, 298.15 \text{ K}) = 1.2620, \rho(2, 298.15 \text{ K})/\text{kg m}^{-3} = 875.89$.

Notes: [a] $T/K = 0.01$; [b] $P/\text{kPa} = 10$; [c] $x_1 = 0.002$; [d] $y_1 = 0.01$.

REFERENCES

- Int. Data Ser., Ser. A, *Guidance*, 36, (1994), 23(1).
- González, E.; Ortega, J. *J. Chem. Eng. Data*, 1998, 49, 1135.
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Compiled by Thermodynamics Research Center

Components: 1. Ethanol, C₂H₅O [66-17-3]
2. Butyl ethanoate, C₄H₁₀O₂ [123-86-0]
State: Binary system, single-phase liquid in equilibrium with vapor; pure components, both liquid in equilibrium with vapor
Variables: T, temperature
x_i, mole fraction of component i in liquid phase
y_i, mole fraction of component i in vapor phase
Parameters: P, pressure
Method: Calculation from direct experimental liquid-vapor equilibrium temperature, T_{exp}, data at variable x₁ and constant P, ref. 1

Author(s): Ortega, J. (Laboratorio de Termodinámica y Fisicoquímica, Escuela Superior de Ingenieros Industriales, de la Universidad de Las Palmas de Gran Canaria, 35071 Las Palmas de Gran Canaria, Canary Islands, Spain)

Edited by: Czert, P. (Wydział Chemii, Uniwersytet Warszawski, ul. Pasteura 1, 02-093 Warszawa, Poland)

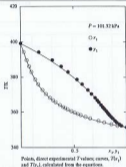
SOURCE OF DATA

Casado, E.; Ortega, J. (Laboratorio de Termodinámica y Fisicoquímica, Escuela Superior de Ingenieros Industriales, Universidad de Las Palmas de Gran Canaria, Canary Islands, Spain); FIRST PUBLISHED RESULTS

Note: The table reports smoothed values of T and calculated values of y₂.

P/Pa = 101.32		
x ₁	T/K	y ₂
0.00	399.26	0.0000
0.03	398.87	0.2503
0.10	393.20	0.4329
0.15	377.41	0.5598
0.20	373.08	0.6282
0.25	369.74	0.6863
0.30	367.05	0.7272
0.40	362.96	0.7898
0.50	359.94	0.8351
0.60	357.58	0.8759
0.70	355.67	0.9023
0.75	354.84	0.9154
0.80	354.08	0.9284
0.85	353.37	0.9407
0.90	352.71	0.9530
0.95	352.07	0.9649
1.00	351.45	1.0000

Standard deviation σ_T/K, relative standard deviation 100σ_T/T, and absolute maximum deviation δ_T/K at P/Pa = 101.32 are resp.: 0.050, 0.228, 0.187.



EQUATIONS

$$G^E/RT = -a_1x_1 + a_2x_2 - x_1x_2(a_3 + a_4x_1)$$

$$v_1 = \exp\left[-(a_1 + \frac{a_2}{x_1})/RT\right] \quad v_2 = \exp\left[-(a_2 + \frac{a_3}{x_2})/RT\right]$$

$$P = P_1^s + P_2^s + \sum_{i=1}^2 x_i^2 \exp\left[\frac{A_i^E - (B_{12} - 1)^2(P - P_1^s) - 2PB_{12}(1 - x_1)^2}{RT}\right]$$

$$P_1^s = G_1^E - a_1(RG^E/RT)_{T,P} \quad P_2^s = G_2^E - a_2(RG^E/RT)_{T,P}$$

$$B_{12}^E = B_{12} - (B_{11} + B_{22})/2; z_1 = P/P_1^s; P_1^s/Pa = \exp\{A_1 + B_1/(C_1 + 293K)\}$$

COEFFICIENTS IN THE EQUATIONS

P/Pa	a ₁ /K	a ₂ /K ²	a ₃ /K	a ₄ /K ²
101.32	-5183.42 (237.2)	19796.68 (94900)	3302.96 (138.9)	-1335403 (54430)

The standard deviations (σ_{a_i}) of the coefficients a_i are given in parentheses.

P/Pa	A ₁	B ₁	C ₁	A ₂	B ₂	C ₂
101.32	15.54365	-3247.70	-64.64	14.56279	-3678.54	-45.83

AUXILIARY INFORMATION

Measurements: The T_{exp} data at 101.32 kPa are reported in ref. 2.

Computations: The 27 T_{exp} data at 101.32 kPa were reduced using the modified Wilson equation, ref. 3, for the partial molar excess Gibbs energies g_i^E.

Corrections: Vapor pressure equation parameters were taken from ref. 4 and parameters A_i were modified according to the experimental boiling points of pure substances. Vapor-phase imperfections and the variation of the Gibbs energy of the pure liquid components with pressure were accounted for in terms of the 2nd molar virial coefficients B_{ii}, ref. 5, and the molar volumes under saturation pressure V_i^s, ref. 6.

Errors: Standard deviation σ(T) = [Σ(T - T_{exp})²/(N-2)]^{1/2}
Relative standard deviation 100σ_T/T = 100[Σ(T - T_{exp})²/ΣT_{exp}²]^{1/2} × 100/(N-2)^{1/2}
N, number of experimental points, ref. 2,
n, number of coefficients in the smoothing equation.

REFERENCES

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- Wilson, G. M. *J. Am. Chem. Soc.*, 1964, 86, 127.
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- Spanopoulos, C. *AIChE J.*, 1974, 20, 263, 1978, 21, 827.
- Yeo, L. C.; Woods, S. S. *AIChE J.*, 1966, 12, 95.

SELECTED DATA ON MIXTURES
International Data Series*
No. LIQUID-VAPOR EQUILIBRIUM

National Institute of Standards and Technology, Boulder, CO 80505-3338

Compiled by Thermodynamics Research Center

Components: 1. Ethanol, C_2H_5O (64-17-3)
2. Butyl propenoate, $C_7H_{14}O_2$ (190-01-2)
State: Binary system, single-phase liquid in equilibrium with vapor; pure components, both liquid in equilibrium with vapor
Variables: T , temperature
 x_i , mole fraction of component i in liquid phase
 y_i , mole fraction of component i in vapor phase
Parameters: P , pressure
Method: Direct measurement of T , x_i and y_i at constant P ; ref. 1

Author(s): Ortega, J. Laboratorio de Termodinámica y Fisicoquímica, Escuela Superior de Ingenieros Industriales, Universidad de Las Palmas de Gran Canaria, 35071 Las Palmas de Gran Canaria, Canary Islands, Spain)

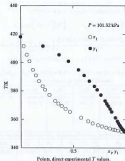
Edited by: Siroz, A.; Maczynski, A. Geopost Chemii Fizykej, Polska Akademia Nauk, ul. Kasprzaka 44/52, 01-224 Warszawa, Poland)

SOURCE OF DATA

Ortega, J.; Ortega, J. Laboratorio de Termodinámica y Fisicoquímica, Escuela Superior de Ingenieros Industriales, Universidad de Las Palmas de Gran Canaria, Canary Islands, Spain; ref. 2

DIRECT EXPERIMENTAL VALUES

$P/P_s = 101.32$					
x_1	T/K	y_1	x_2	T/K	y_2
0.0000	418.26	0.0000	0.7136	315.28	0.9490
0.0298	411.70	0.7143	0.6123	314.33	0.9518
0.0590	405.73	0.3679	0.8470	313.89	0.9627
0.0827	406.85	0.4578	0.8797	313.11	0.9695
0.1172	395.00	0.5523	0.8963	312.88	0.9743
0.1442	391.81	0.6858	0.9256	312.32	0.9805
0.1798	383.03	0.6561	0.9583	311.63	0.9883
0.2087	383.31	0.7629	0.9863	311.30	0.9954
0.2312	383.08	0.7387	1.0000	311.45	1.0000
0.2727	373.28	0.7658			
0.3273	373.18	0.8052			
0.3569	371.25	0.8193			
0.3886	369.60	0.8338			
0.4268	367.52	0.8307			
0.4684	365.58	0.8667			
0.5745	361.20	0.9008			
0.6430	358.94	0.9196			
0.6844	357.55	0.9303			
0.7348	356.23	0.9408			



AUXILIARY INFORMATION

Apparatus: The apparatus was a glass ebullimeter employing continuous circulation of the liquid and vapor phases with a capacity of approx. 60 cm³; ref. 3.
Procedure: The procedure was described in ref. 1. The compositions were determined by measuring their densities at 298.15 K with an Anton Paar model DMA-55 vibrating-tube digital densimeter with a precision of $\pm 0.02 \text{ kg m}^{-3}$. A polynomial equation describing the density-concentration curve obtained from mixtures of known composition was used in the calculations. Estimated uncertainty of composition = 0.002 mole fraction.
Materials: 1. Fluka AG (Buchs, St. Gallen, Switzerland), purity > 99.8 mol %; degassed ultrasonically, dried over molecular sieves 3A; $\rho(298.15 \text{ K}) = 1.3195$, $\rho(298.15 \text{ K})/\text{kg m}^{-3} = 785.38$.
2. Aldrich (Steinheim, Germany), purity 99+ mol %; degassed ultrasonically, dried over molecular sieves 3A; $\rho(298.15 \text{ K}) = 0.7112$, $\rho(298.15 \text{ K})/\text{kg m}^{-3} = 871.12$.
Errors: $\pm 0.01 \text{ K}$; $\pm 0.01 \text{ Pa}$; $|u_{x_1}| = 0.002$; $|u_{y_1}| = 0.03$.

REFERENCES

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- González, E.; Ortega, J. *J. Chem. Eng. Data*, 1995, 40, 1178.
- Ortega, J.; Peña, J. A.; de Alfonso, C. *J. Chem. Eng. Data*, 1996, 41, 339.

Compiled by Thermodynamics Research Center

Components:	1. Ethanol, C ₂ H ₅ O [64-17-5] 2. Butyl propionate, C ₇ H ₁₄ O ₂ [190-61-2]
State:	Binary system, single-phase liquid in equilibrium with vapor; pure components, both liquid in equilibrium with vapor
Variables:	T, temperature x _i , mole fraction of component i in liquid phase y _i , mole fraction of component i in vapor phase
Parameters:	P, pressure
Method:	Calculations from direct experimental liquid-vapor equilibrium temperatures, T _{exp} , data at variable x _i and constant P; ref. 1

Author(s): Ortega, J. (Laboratorio de Termodinámica y Fisicoquímica, Escuela Superior de Ingenieros Industriales, Universidad de Las Palmas de Gran Canaria, 35071 Las Palmas de Gran Canaria, Canary Islands, Spain)
Edited by: Orosz, F. (Miyelal Chemil, Uniwersitet Warszawski, ul. Pasteura 1, 02-093 Warszawa, Poland)

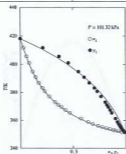
SOURCE OF DATA

Ortega, J.; Orosz, F. (Laboratorio de Termodinámica y Fisicoquímica, Escuela Superior de Ingenieros Industriales, Universidad de Las Palmas de Gran Canaria, Canary Islands, Spain); FIRST PUBLISHED RESULTS

Notes: The table reports smoothed values of T and calculated values of y_i

P/Pa = 101.32		
x ₂	T/K	y ₂
0.09	418.26	0.0008
0.05	437.80	0.2894
0.18	397.87	0.4948
0.15	390.16	0.6294
0.29	384.12	0.7099
0.25	376.27	0.7603
0.30	375.27	0.8138
0.40	368.96	0.8733
0.50	364.22	0.9130
0.60	360.25	0.9362
0.70	357.34	0.9580
0.75	355.83	0.9699
0.80	354.68	0.9727
0.81	353.69	0.9787
0.90	352.87	0.9842
0.95	352.36	0.9886
1.00	351.45	1.0000

Standard deviation of T/K, relative standard deviation 100(ΔT/T), and absolute maximum deviation Δ_i/T/K at P/Pa = 101.32 are resp. 0.237, 0.518, 0.398.



Points, direct experimental T values; curves, T(x₂) and T(y₂), calculated from the equations.

EQUATIONS

$$G^E RT = -x_2 B_1 x_1 + x_2^2 C_1 - x_2 B_2 (x_2 + x_1 x_1)$$

$$x_1 = \exp \left[-A_1 + \frac{B_1}{T} \right] \quad x_2 = \exp \left[-A_2 + \frac{B_2}{T} \right]$$

$$P = P_1^* + P_2^* = \sum_{i=1}^2 x_i P_i^* \exp \left[\frac{P_i^* - (B_{11} - x_1^2 P_1^* - P_1^*) - 2 P_1^* x_2 (1 - x_2)^2}{RT} \right]$$

$$P_i^* = G_i^* - x_i (G_i^* / h_{i,2}^L)_{T,P} \quad P_i^* = G_i^* - x_i (G_i^* / h_{i,1}^L)_{T,P}$$

$$B_{11} = B_{11} - (B_{11} + B_{22})/2; y_1 = P/P; P_i^* P_i = \exp [A_i + B_i / (C_i + T/K)]$$

COEFFICIENTS IN THE EQUATIONS

P/Pa	A ₁ /K	A ₂ /K ²	A ₃ /K	A ₄ /K ²
101.32	-4644.58	1965279	905.53	-426603
	(285.1)	(117717)	(86.1)	(37202)

The standard deviation σ(A_i) of the coefficients A_i are given in parentheses.

P/Pa	A ₁	B ₁	C ₁	A ₂	B ₂	C ₂
101.32	15.94165	-5267.70	-64.64	13.47576	-2837.30	-67.91

Measurements: The T_{exp} data at 101.32 kPa are reported in ref. 2.

Computations: The 28 T_{exp} data at 101.32 kPa were reduced using the modified Wilson equation, ref. 3, for the partial molar excess Gibbs energies G^E.

Corrections: Vapor pressure equation parameters were taken from refs 4 and 5, and parameters A_i were modified according to the experimental boiling points of pure substances. Vapor-phase imperfection and the variation of the Gibbs energy of the pure liquid components with pressure were accounted for in terms of the 2nd molar virial coefficients B_{ij}, ref. 6, and the molar volumes under saturation pressure V_i^L, ref. 7.

Errors: Standard deviation of T = [2(7 - T_{exp})² / (20 - 2)]^{1/2}, Relative standard deviation 100(ΔT/T) = 100[(7 - T_{exp})² / (20 - 2)]^{1/2}, N, number of experimental points, ref. 2, n, number of coefficients in the smoothing equation.

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2. Ortega, J. *Int. DATA Ser., Sel. Data Mixtures Ser. A*, 1995, 11, 32.
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5. 1980, Thermodynamics Research Center, The Texas A&M University System, College Station, TX, USA.
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7. Yen, L. C.; Woods, S. S. *AIChE J.*, 1966, 12, 95.

SELECTED DATA ON MIXTURES
International Data Series^a

Compiled by Thermodynamic Research Center

In EXCESS VOLUME

National Institute of Standards and Technology, Boulder, CO 80501-3328

Components:	1. Ethanol, C ₂ H ₅ O (66-17-5) 2. Ethyl methanoate, C ₃ H ₆ O ₂ (109-94-4)
State:	Binary system, single-phase liquid, pure components, both liquid
Variables:	V^E , molar excess volume x_1 , mole fraction of component 1
Parameters:	T , temperature
Constants:	P , pressure
Method:	Calculation of V^E from density measurements at constant T and P and variable x_1 , ref. 1

Author(s) of data:	Ortega, J. (Laboratorio de Termodinámica y Fisicoquímica, Escuela Superior de Ingenieros Industriales, Universidad de Las Palmas de Gran Canaria, 35071 Las Palmas de Gran Canaria, Canary Islands, Spain)
Edited by:	Slomkowski, A. (Instytut Chemii Fizycznej, Polska Akademia Nauk, ul. Kasprzaka 44/52, 01-224 Warszawa, Poland)

SOURCE OF DATA

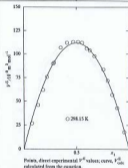
Soto, A.; Hernández, P.; Ortega, J. (Laboratorio de Termodinámica y Fisicoquímica, Escuela Superior de Ingenieros Industriales, Universidad de Las Palmas de Gran Canaria, Canary Islands, Spain), ref. 2

DIRECT EXPERIMENTAL VALUES

State: $P = 101.32$ kPa

$T/K = 298.15$

x_1	$V^E/10^{-6} \text{ m}^3 \text{ mol}^{-1}$						
0.0152	27						
0.0348	46						
0.0625	62						
0.2201	76						
0.2709	90						
0.2883	91						
0.3586	107						
0.4101	112						
0.4730	113						
0.5168	113						
0.5552	112						
0.6081	106						
0.6285	104						
0.6738	98						
0.7588	84						
0.7991	72						
0.8425	57						
0.8882	43						
0.9546	18						



SMOOTHING EQUATION

$$V^E_{\text{calc}} = a_1 x_1 \sum_{i=1}^n (x_i - x_j)^{i-1}$$

Coefficient a_n in the smoothing equation, standard deviation s_m , and maximum deviation δ_m determined by least-squares analysis

TK	a_1	a_2	a_3	a_4	a_5	a_6	s_m
	298.15	448.4 (3.10)					2.8

The standard deviation $\text{cov}(a_i)$ of the coefficients a_i are given in parentheses
 $\Delta a_n = \max \{ |V^E_{\text{calc}} - V^E_{\text{exp}}| \}$; $s_m = [20 \sum_{i=1}^n (V^E_{\text{calc}} - V^E_{\text{exp}})^2 / (N - n)]^{1/2}$
 N , number of direct experimental values, n , number of coefficients a_i
 All direct experimental values equally weighted

AUXILIARY INFORMATION

Apparatus: The density was determined by an Anton Paar Model DMA-35 vibrating-tube digital densimeter with a precision of $\pm 0.02 \text{ kg m}^{-3}$. The temperature was controlled at $\pm 0.01 \text{ K}$ with a fibre thermometer.

Procedure: The procedure was described in ref. 3. Mixtures were prepared by weighing in hermetically sealed 2.5 cm³ glass vials. The apparatus was calibrated with doubly distilled and degassed water and toluene. A polynomial equation was used for describing the density-concentration curve.

Materials: 1. Fluka AG (Buchs, St. Gallen, Switzerland), "puriss-pur" grade material, purity > 99.8 mole-%; degassed ultrasonically, dried over molecular sieves 3A, $w(0, 298.15 \text{ K}) = 1.3594$, $\rho(298.15 \text{ K})/\text{kg m}^{-3} = 784.94$, ref. 4; $T_f(101.32 \text{ kPa})/\text{K} = 351.46$.
 2. Fluka AG (Buchs, St. Gallen, Switzerland), highest commercial grade; degassed ultrasonically, dried over molecular sieves 3A, $w(0, 298.15 \text{ K}) = 1.3576$, $\rho(298.15 \text{ K})/\text{kg m}^{-3} = 914.93$, $T_f(101.32 \text{ kPa})/\text{K} = 327.29$.

Errors: $\delta T/K = 0.02$; $\delta w_1 = 0.0005$; $\Delta V^E/10^{-6} \text{ m}^3 \text{ mol}^{-1} < 3$.

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Received January 1, 2003

^a Ser. A, Thermodynamic Properties of Non-reacting Binary Systems

Published January 31, 2003

Composites:	1. Ethanol, C_2H_5O (54-17-1) 2. Butyl stannate, $C_4H_9Sn_2O_7$ (728-86-4)	Author(s):	Ortega, J. Laboratorio de Termodinámica y Fisicoquímica, Escuela Superior de Ingenieros Industriales, Universidad de Las Palmas de Gran Canaria, 36711 Las Palmas de Gran Canaria, Canary Islands, Spain)
State:	Binary system, single-phase liquid; pure components, both liquid	Edited by:	Siracusa, A.; Moczyński, A. Geoszt. Chem. Fizyogr., Polska Akademia Nauk, ul. Kasprzaka 40/52, 01-224 Warszawa, Poland)
Variables:	V^E , molar excess volume		
Parameters:	x_1 , mole fraction of component 1		
Parameters:	T , temperature		
Constants:	P , pressure		
Methods:	Calculation of V^E from density measurements at constant T and P and variable x_1 ; ref. 1		

SOURCE OF DATA

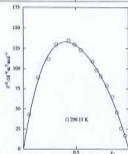
González, E.; Ortega, J. Laboratorio de Termodinámica y Fisicoquímica, Escuela Superior de Ingenieros Industriales, Universidad de Las Palmas de Gran Canaria, Canary Islands, Spain; ref. 2

DIRECT EXPERIMENTAL VALUES

Note: $P = 101.32$ kPa.

$T/K = 298.15$

x_1	$V^E/10^{-6}$ $m^3 \cdot mol^{-1}$								
0.0514	43								
0.1410	89								
0.2393	112								
0.3139	130								
0.4307	135								
0.4882	130								
0.5438	123								
0.6268	109								
0.6937	98								
0.7361	91								
0.7923	79								
0.8463	63								
0.8872	46								
0.9380	26								
0.9857	17								



Points, direct experimental V^E values; curve, V^E calculated from the equation.

SMOOTHING EQUATION

$$V_{calc}^E = x_1 x_2 \sum_{j=1}^N a_j (x_1 - x_2)^{j-1}$$

Coefficients a_j in the smoothing equation, standard deviation σ_{a_j} , and maximum deviation δ_{a_j} determined by least-squares analysis.

T/K	a_1	a_2	a_3	a_4	a_5	a_6	a_7
	$10^{-6} m^3 \cdot mol^{-1}$						
298.15	306.2 (5.6)	-168.3 (11.6)	146 (26)			3.0	6.0

The standard deviations σ_{a_j} of the coefficients a_j are given in parentheses. $\delta_{a_1} = \max |V_{calc}^E - V^E|$; $\delta_{a_2} = [D(V_{calc}^E - V^E)^2 / (N-6)]^{1/2}$. N : number of direct experimental values; n : number of coefficients a_j . All direct experimental values equally weighted.

AUXILIARY INFORMATION

Apparatus: The density was determined by an Anton Paar Model DMA-51 vibrating-tube digital densimeter with a precision of ± 0.02 kg m⁻³. The temperature was controlled at ± 0.01 K with a Heto thermostat.

Procedure: The procedure was described in ref. 3. Mixtures were prepared by weighing in hermetically sealed 2.5 cm³ glass vials. The apparatus was calibrated with doubly distilled and degassed water and acetone. A polynomial equation was used for describing the density-concentration curve.

Materials: 1. Fluka AG (Buchs, St. Gallen, Switzerland), purity > 99.8 mol %; degassed ultrasonically, dried over molecular sieves 3A; $\rho(298.15$ K) = 1.3916, $\rho(298.15$ K)/kg m⁻³ = 785.38, $T_p(101.32$ kPa)/K = 351.83.
2. Fluka AG (Buchs, St. Gallen, Switzerland), purity > 99 mol %; degassed ultrasonically, dried over molecular sieves 3A; $\rho(298.15$ K) = 1.3926, $\rho(298.15$ K)/kg m⁻³ = 875.89, $T_p(101.32$ kPa)/K = 509.26.

Errors: $\delta T/K = 0.02$; $\delta x_1 = 0.0005$; $\delta(V^E/10^{-6} m^3 \cdot mol^{-1}) < 3$.

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- Int. Data Ser., Ser. A, Guidelines No. 1994, 22(1).
- González, E.; Ortega, J. *J. Chem. Eng. Data*, 1991, 40, 1178.
- Ortega, J.; Matus, J. S.; Fur-Austrich, M. J.; Jiménez, E. *J. Chem. Thermodyn.*, 1988, 17, 1127.

SELECTED DATA ON MIXTURES
International Data Series*

2c. EXCESS VOLUME

National Institute of Standards and Technology, Boulder, CO 80501-3328

Compiled by Thermodynamics Research Center

Components	1. Ethanol, C_2H_5O / 99.77-1/2 2. Butyl propanoate, $C_7H_{14}O_2$ / 100.07-2/
State	Binary system, single-phase liquid; pure components, both liquid
Variables	V^E , molar excess volume x_1 , mole fraction of component 1
Parameters	T , temperature
Constants	P , pressure
Method	Calculation of V^E from density measurements at constant T and P and variable x_1 ; ref. 1

Author(s) of table	Ortega, J. (Laboratorio de Termodinámica y Fisicoquímica, Escuela Superior de Ingenieros Industriales, Universidad de Las Palmas de Gran Canaria, 35031 Las Palmas de Gran Canaria, Canary Islands, Spain)
Edited by	Slomkowski, A.; Muzajski, A. (Instytut Chemii Fizycznej, Polska Akademia Nauk, ul. Kasprowka 44/52, 01-224 Warszawa, Poland)

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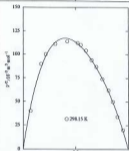
Ortega, J.; Orta, J. (Laboratorio de Termodinámica y Fisicoquímica, Escuela Superior de Ingenieros Industriales, Universidad de Las Palmas de Gran Canaria, Canary Islands, Spain); ref. 1

DIRECT EXPERIMENTAL VALUES

Note: $P = 101.32 \text{ kPa}$.

$T/K = 298.15$

x_1	$V^E/10^{-6} \text{ m}^3 \text{ mol}^{-1}$						
0.0795	40						
0.1716	90						
0.2174	100						
0.3079	111						
0.4223	114						
0.5199	112						
0.5489	110						
0.5977	104						
0.6519	98						
0.6967	87						
0.7582	78						
0.8128	62						
0.8736	30						
0.9569	34						
0.9489	30						



Points, direct experimental V^E values; curve, V^E values calculated from the equation.

SMOOTHING EQUATION

$$V_{\text{calc}}^E = x_1 x_2 \sum_{i=1}^6 a_i (x_1 - x_2)^{i-1}$$

Coefficients a_i in the smoothing equation, standard deviation σ_{ij} , and maximum deviation δ_{ij} , determined by least-squares analysis.

TK	a_1	a_2	a_3	a_4	a_5	a_6	δ_{ij}
	$10^{-6} \text{ m}^3 \text{ mol}^{-1}$						
298.15	455.4 (4.3)	-157.5 (6.6)	111.8 (19.6)			2.3	4.0

The standard deviations σ_{ij} of the coefficients a_i are given in parentheses. $\delta_{ij} = \max |V_{\text{calc}}^E - V^E|$; $\sigma_{ij} = [10^6 \sum_{i=1}^N (V_{\text{calc}}^E - V^E)^2 / (N - 6)]^{1/2}$. N , number of direct experimental values; n , number of coefficients a_i . All direct experimental values equally weighted.

AUXILIARY INFORMATION

Apparatus: The density was determined by an Anton Paar Model DMA-35 vibrating-tube digital densimeter with a precision of $\pm 0.02 \text{ kg m}^{-3}$. The temperature was controlled at $\pm 0.01 \text{ K}$ with a beta ultrathermostat.

Procedure: The procedure was described in ref. 1. Mixtures were prepared by weighing in hermetically sealed 2.5 cm^3 glass vials. The apparatus was calibrated with doubly distilled and degassed water and acetone. A polynomial equation was used for describing the density-concentration curve.

Materials: 1. Fluka AG (Buchs, St. Gallen, Switzerland), purity > 99.8 mol-%; degassed ultrasonically, dried over molecular sieves 3A; $n_D(298.15 \text{ K}) = 1.3095$, $\rho(298.15 \text{ K})/10^3 \text{ kg m}^{-3} = 785.38$, $V_m(101.32 \text{ kPa}/298.15 \text{ K}) = 351.45$.
2. Aldrich (Steinheim, Germany), purity 99+ mol-%; degassed ultrasonically, dried over molecular sieves 3A; $n_D(298.15 \text{ K}) = 1.3089$, $\rho(298.15 \text{ K})/10^3 \text{ kg m}^{-3} = 871.12$, $V_m(101.32 \text{ kPa}/298.15 \text{ K}) = 408.26$.

Purity: $\delta T/K = 0.02$, $\delta x_1 = 0.0001$, $\delta(V^E/10^{-6} \text{ m}^3 \text{ mol}^{-1}) < 3$.

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- Int. Data Ser., Ser. A, Goldfarb, B., 1994, 22(1).
- Ortega, J.; Orta, J. *J. Chem. Eng. Data*, 1999, 40, 1078.
- Ortega, J.; Mates, J. S.; Paz-Antelo, M. I.; Jiménez, E. *J. Chem. Thermodyn.*, 1998, 30, 1127.

Compiled by Thermodynamics Research Center

Component: 1. Ethanol, C_2H_5OH (66-17-3)
2. Butyl butanoate, $C_8H_{16}O_2$ (109-21-7)

State: Binary system, single-phase liquid; pure components, both liquid

Variable: V^E , molar excess volume

Parameters: x_1 , mole fraction of component 1
 T , temperature

Constants: P , pressure

Method: Calculation of V^E from density measurements at constant T and P and variable x_1 ; ref. 1

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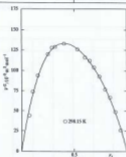
SOURCE OF DATA

González, E.; Ortega, J. Laboratorio de Termodinámica y Filoquímica, Escuela Superior de Ingenieros Industriales, Universidad de Las Palmas de Gran Canaria, Canary Islands, Spain; ref. 2

DIRECT EXPERIMENTAL VALUES

Notes: $P = 101.32$ kPa.

T/K = 298.15							
x_1	$V^E/10^{-6} \text{ m}^3 \text{ mol}^{-1}$						
0.0735	44						
0.1062	74						
0.1544	94						
0.2518	120						
0.3082	128						
0.3285	129						
0.4052	133						
0.5329	126						
0.6039	116						
0.6496	112						
0.6698	104						
0.7397	93						
0.7945	77						
0.8397	67						
0.8913	49						
0.9407	26						



Points, direct experimental V^E values; curve, V_{calc}^E calculated from the equation.

SMOOTHING EQUATION

$$V_{\text{calc}}^E = v_1 v_2 \sum_{i=1}^6 (x_1 - x_2)^{i-1}$$

Coefficients v_i in the smoothing equation, standard deviation s_p and maximum deviation δ_{max} determined by least-squares analysis.

T/K	v_1	v_2	v_3	v_4	v_5	v_6	δ_{max}
	$10^{-6} \text{ m}^3 \text{ mol}^{-1}$						
298.15	518.7 (5.8)	-157.1 (5.8)	161 (20)			2.9	8.4

The standard deviations s_p of the coefficients v_i are given in parentheses
 $\delta_{\text{max}} = \max |V_{\text{calc}}^E - V^E|$; $v_6 = 10^{10} (s_p^2 - V^E)^2 / (N - 6)^{1/2}$
 N , number of direct experimental values; v_i , number of coefficients
 All direct experimental values equally weighted

AUXILIARY INFORMATION

Apparatus: The density was determined by an Anton Paar Model DMA-55 vibrating-tube digital densimeter with a precision of $\pm 0.02 \text{ kg m}^{-3}$. The temperature was controlled at $\pm 0.01 \text{ K}$ with a Heix thermostat.

Procedure: The procedure was described in ref. 3. Mixtures were prepared by weighing in hermetically sealed 25 cm^3 glass vials. The apparatus was calibrated with doubly distilled and degassed water and ethanol. A polynomial equation was used for describing the density-concentration curve.

Materials: 1. Fluka AG (Buchs, St. Gallen, Switzerland), purity > 99.8 mol %; degassed ultrasonically, dried over molecular sieves 3A; $\rho(298.15 \text{ K}) = 1.3595 \text{ g cm}^{-3}$; $\rho(298.15 \text{ K})/\text{kg m}^{-3} = 785.36$; $T_f(101.32 \text{ kPa})/\text{K} = 35.45$.
 2. Fluka AG (Buchs, St. Gallen, Switzerland), purity > 99 mol %; degassed ultrasonically, dried over molecular sieves 3A; $\rho(298.15 \text{ K}) = 1.4040 \text{ g cm}^{-3}$; $\rho(298.15 \text{ K})/\text{kg m}^{-3} = 894.67$; $T_f(101.32 \text{ kPa})/\text{K} = 438.13$.

Error: $\delta T/K = 0.02$; $\delta x_1 = 0.0005$; $\delta V^E/10^{-6} \text{ m}^3 \text{ mol}^{-1} < 3$.

REFERENCES

- Int. J. Ref. Data Ser., Ser. A, Goldfarb Jb, 1994, 22(1).
- González, E.; Ortega, J. *J. Chem. Eng. Data*, 1996, 40, 1178.
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