

SELECTED DATA ON MIXTURES

International DATA Series*

3k. LIQUID-VAPOR EQUILIBRIUM

The Texas A&M University System, College Station, TX 77843-3111

Published by Thermodynamics Research Center

0147-1503/93/9902-7982.20

Components: 1. Ethanol, C_2H_5O [64-17-5]2. Methyl ethanol, $C_3H_6O_2$ [79-20-9]

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 phaseParameters: P , pressureMethod: Direct measurement of T , x_i , and y_i at constant P ; ref. 1

Author(s) Ortega, J. (Laboratorio de Termodinamica y Fisicoquimica, 35071 -University of Las Palmas de G. C., Canary Islands, Spain)

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

SOURCE OF DATA

Ortega, J.; Susial, P.; de Alfonso, C. (Laboratorio de Termodinamica y Fisicoquimica, 35071 -University of Las Palmas de G. C., Canary Islands, Spain); ref. 2

DIRECT EXPERIMENTAL VALUES

 $P/kPa = 101.32$

x_1	T/K	y_1	x_1	T/K	y_1								
0.0000	329.82	0.0000	0.4331	332.55	0.2777								
0.0120	329.85	0.0133	0.4771	333.05	0.2998								
0.0204	329.82	0.0216	0.5267	333.55	0.3208								
0.0300	329.81	0.0308	0.5661	334.15	0.3414								
0.0376	329.79	0.0379	0.5910	334.45	0.3537								
0.0459	329.80	0.0456	0.6279	335.15	0.3757								
0.0568	329.82	0.0550	0.6568	335.85	0.3957								
0.0763	329.85	0.0712	0.6945	336.75	0.4230								
0.1141	329.98	0.1003	0.7910	339.55	0.5202								
0.1544	330.15	0.1273	0.8094	340.15	0.5440								
0.1931	330.55	0.1612	0.8224	340.75	0.5618								
0.2326	330.85	0.1877	0.8457	341.75	0.5968								
0.2752	331.15	0.2085	0.9312	345.75	0.7517								
0.3708	332.05	0.2570	1.0000	351.46	1.0000								

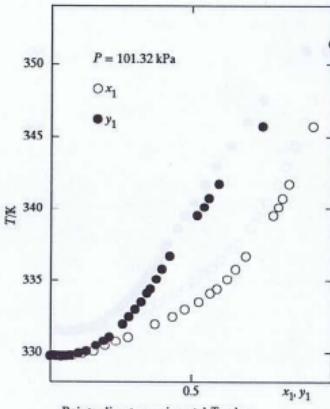
AUXILIARY INFORMATION

Apparatus: The apparatus was a glass ebulliometer employing continuous circulation of the liquid and vapor phases with a charge 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 vacuum pump and the pressure controlled by a Vakuumat electronic instrument (Normschliff Gerätetechnik Wertheim) and measured with a mercury manometer.

Procedure: Operation described in ref. 3. The equilibrium temperatures were measured with an accuracy of ± 0.01 K with a digital thermometer, Comark, Model 6900, calibrated against ITS-90. Compositions were determined by densimetric analysis, using an Anton Paar, Model DMA-55 transmittance-tube digital densimeter. Pressure was maintained constant to within 0.02 kPa.

Materials: 1. Fluka AG (Buchs, St. Gallen, Switzerland), "puriss p.a." grade material, purity > 99.8 mole %, degassed ultrasonically before use and stored in the dark for several days over molecular sieves type 4A (Fluka AG); $n(D, 298.15\text{ K}) = 1.3594$, $\rho(298.15\text{ K})/\text{kg}\cdot\text{m}^{-3} = 785.01$. 2. Fluka AG (Buchs, St. Gallen, Switzerland), "HPLC" grade material, degassed ultrasonically before use and stored in the dark for several days over molecular sieves; $n(D, 298.15\text{ K}) = 1.3593$, $\rho(298.15\text{ K})/\text{kg}\cdot\text{m}^{-3} = 926.99$.

Errors: $|\delta T(\text{estd.})|/K = 0.04$; $|\delta P(\text{estd.})|/Pa = 100$; $|\delta x_1| = 0.005$; $|\delta y_1| = 0.02$.

Points, direct experimental T values.

REFERENCES

- Int. DATA Ser., Ser. A, Guideline 3k, 1994, 22(4).
- Ortega, J.; Susial, P.; de Alfonso, C. J. Chem. Eng. Data 1990, 35, 350.
- Ortega, J.; Pena, J. A.; de Alfonso, C. J. Chem. Eng. Data 1986, 31, 339.

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Author(s) Ortega, J. (Laboratorio de Termodinamica y Fisicoquimica, 35071 -University of Las Palmas de G. C., of table: Canary Islands, Spain)

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

SOURCE OF DATA

Ortega, J.; Susial, P. (Laboratorio de Termodinamica y Fisicoquimica, 35071 -University of Las Palmas de G. C., Canary Islands, Spain); ref. 2

DIRECT EXPERIMENTAL VALUES

P/kPa = 114.66				P/kPa = 127.99							
x_1	T/K	y_1	x_1	T/K	y_1	x_1	T/K	y_1	x_1	T/K	y_1
0.0071	333.50	0.0080	0.4511	336.09	0.2911	0.0160	336.71	0.0165	0.6369	342.07	0.3959
0.0230	333.43	0.0241	0.4780	336.38	0.3036	0.0345	336.68	0.0345	0.6562	342.43	0.4098
0.0320	333.41	0.0327	0.5047	336.72	0.3179	0.0520	336.69	0.0510	0.7035	343.45	0.4441
0.0406	333.38	0.0408	0.5260	337.0	0.3285	0.0707	336.70	0.0674	0.7283	344.25	0.4679
0.0570	333.40	0.0561	0.5541	337.46	0.3441	0.0902	336.72	0.0836	0.7629	345.20	0.5011
0.0674	333.42	0.0650	0.5914	338.4	0.3680	0.1122	336.77	0.1011	0.7983	346.35	0.5399
0.0805	333.43	0.0756	0.6250	338.63	0.3867	0.1362	336.86	0.1188	0.8307	347.55	0.5809
0.0975	333.45	0.0891	0.6535	339.13	0.4054	0.1660	336.98	0.1390	0.8632	348.90	0.6348
0.1181	333.48	0.1047	0.6816	339.72	0.4247	0.2026	337.16	0.1627	0.8922	350.55	0.6905
0.1417	333.61	0.1214	0.7039	340.20	0.4430	0.2396	337.39	0.1843	0.9220	352.00	0.7515
0.1623	333.68	0.1356	0.7336	340.90	0.4699	0.2735	337.64	0.2031	0.9709	355.35	0.8966
0.1974	333.90	0.1573	0.7581	341.63	0.4909	0.3082	337.90	0.2215			
0.2138	333.95	0.1673	0.7728	342.22	0.5089	0.3439	338.19	0.2400			
0.2349	334.10	0.1797	0.7981	342.95	0.5347	0.3754	338.48	0.2557			
0.2564	334.20	0.1920	0.8397	344.72	0.5929	0.4093	338.83	0.2731			
0.2895	334.47	0.2094	0.8785	346.4	0.6576	0.4409	339.17	0.2891			
0.3156	334.70	0.2235	0.8954	347.18	0.6883	0.4753	339.53	0.3063			
0.3421	334.90	0.2362	0.9162	348.28	0.7334	0.5058	339.95	0.3218			
0.3634	335.11	0.2469	0.9350	349.40	0.7783	0.5365	340.40	0.3392			
0.3932	335.41	0.2618	0.9686	351.73	0.8783	0.5661	340.83	0.3552			
0.4248	335.76	0.2779	0.9783	352.50	0.9127	0.5974	341.37	0.3740			

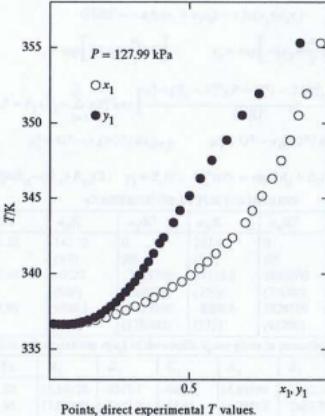
AUXILIARY INFORMATION

Apparatus: The apparatus was a glass ebulliometer employing continuous circulation of the liquid and vapor phases with a charge capacity of approx. 50 cm^3 , ref. 3. Turbulent mixing of the phases enabled equilibrium to be reached in a relatively short time. The ebulliometer was connected to vacuum pump and the pressure controlled by a Vakumat electronic instrument (Normschiff Geratebau Wertheim) and measured with a mercury manometer. High purity nitrogen was used for the backing pressure.

Procedure: Operation described in ref. 3. The equilibrium temperatures were measured with an accuracy of $\pm 0.01\text{ K}$ with a digital thermometer, Comark, Model 6900, calibrated against ITS-90. Compositions were determined by densimetric analysis using an Anton Paar, Model DMA-55 vibrating-tube digital densimeter. Pressure was maintained constant to within 0.02 kPa , indicated by an electronic pressure gauge (MKS Baratron).

Materials: 1. Fluka AG (Buchs, St. Gallen, Switzerland), "puriss p.a." grade material, purity > 99.8 mole %, degassed ultrasonically before use and stored in the dark for several days over molecular sieves type 4A (Fluka AG); $n(D, 298.15\text{ K}) = 1.3594$, $\rho(298.15\text{ K})/\text{kg}\cdot\text{m}^{-3} = 785.01$.
2. Fluka AG (Buchs, St. Gallen, Switzerland), "puriss p.a." grade material, purity > 99.5 mole %, degassed ultrasonically before use and stored in the dark for several days over molecular sieves; $n(D, 298.15\text{ K}) = 1.3593$, $\rho(298.15\text{ K})/\text{kg}\cdot\text{m}^{-3} = 926.99$.

Errors: $|\delta T(\text{estd.})|/K = 0.04$; $|\delta P(\text{estd.})|/Pa = 100$; $|\delta x_1| = 0.005$; $|\delta y_1| = 0.02$.

Points, direct experimental T values.

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3m. LIQUID-VAPOR EQUILIBRIUM

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Components:	1. Ethanol, C_2H_5O [64-17-5] 2. Methyl ethanone, $C_3H_6O_2$ [79-20-9]
State:	Binary system, single-phase liquid in equilibrium with vapor; pure components, both liquid in equilibrium with vapor
Variables:	T , temperature
	y_i , mole fraction of component i in vapor phase
	x_i , mole fraction of component i in liquid phase
Parameters:	P , pressure
Method:	Calculation from direct experimental liquid-vapor equilibrium temperature, T_{exp} , data at variable x_i and constant P ; ref. 1

Author(s) Ortega, J. (Laboratorio de Termodinamica y Fisicoquimica, 35071-University of Las Palmas de G. C., Canary Islands, Spain)
Compiled by Oracz, P. (Wydział Chemiczny, Uniwersytet Warszawski, ul. Pasteura 1, 02-093 Warsaw, Poland)

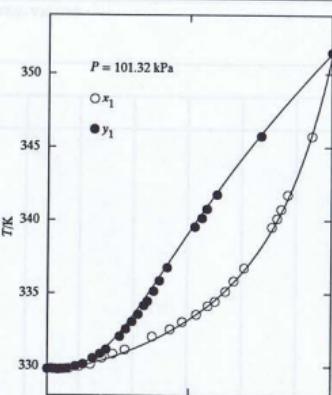
†

SOURCE OF DATA

Susila, P.; Ortega, J.; de Alfonso, C. (Laboratorio de Termodinamica y Fisicoquimica, 35071-University of Las Palmas de G. C., Canary Islands, Spain); FIRST PUBLISHED RESULTS

Notes: The table reports smoothed values of T and calcd. values of y_1

x_1	T/K	$P/kPa = 101.32$		$P/kPa = 114.66$		$P/kPa = 127.99$	
		y_1	T/K	y_1	T/K	y_1	T/K
0.00	329.92	0	333.54	0	336.82	0	
0.05	329.91	0.0478	333.46	0.0505	336.70	0.0510	
0.10	330.02	0.0871	333.50	0.0934	336.74	0.0928	
0.15	330.23	0.1204	333.65	0.1306	336.90	0.1283	
0.20	330.51	0.1495	333.88	0.1636	337.14	0.1596	
0.25	330.85	0.1757	334.19	0.1936	337.45	0.1882	
0.30	331.23	0.2000	334.55	0.2215	337.82	0.2151	
0.40	332.14	0.2461	335.46	0.2744	338.73	0.2670	
0.50	333.29	0.2931	336.64	0.3273	339.89	0.3204	
0.60	334.78	0.3472	338.15	0.3854	341.40	0.3804	
0.70	336.83	0.4168	340.18	0.4560	343.44	0.4543	
0.75	338.16	0.4618	341.48	0.4998	344.76	0.5005	
0.80	339.77	0.5176	343.06	0.5528	346.38	0.5564	
0.85	341.77	0.5890	345.01	0.6193	348.38	0.6268	
0.90	344.26	0.6837	347.43	0.7052	350.87	0.7181	
0.95	347.42	0.8138	350.41	0.8200	353.88	0.8379	
1.00	351.46	1	354.60	1	357.48	1	

Std. dev. of \bar{T} , rel. std. dev. 1000($\partial\bar{T}/\partial P$) and abs. max. dev. $\delta_m(\bar{T})/K$ at $P/kPa = 101.32$ are resp.: 0.122, 0.478, 0.351.at $P/kPa = 114.66$ are resp.: 0.039, 0.147, 0.08.at $P/kPa = 127.99$ are resp.: 0.034, 0.129, 0.085.Points, direct experimental T values, curves, $T(x_1)$ and $T(y_1)$, calculated from the equations.

AUXILIARY INFORMATION

Measurements: The T_{exp} data at 101.32, 114.66 and 127.99 kPa are reported in ref. 2.Computations: The 28 T_{exp} data at 101.32 kPa, 42 T_{exp} data at 114.66 kPa and 33 T_{exp} data at 127.99 kPa were reduced using the modified Wilson eq., ref. 3, for the partial molar excess Gibbs energies μ_i^E .Corrections: Vapor pressure equation parameters were taken from ref. 4 and parameters A_i were modified according to the experimental VLE data. 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 coeffs. B_{ij} (ref. 5) and the molar volumes under saturation pressure V_i^P (ref. 6).Errors: Std. dev. of $\bar{T} = [\Sigma(T - T_{exp})^2/(N-n-m)]^{1/2}$.Rel. std. dev. 1000($\partial\bar{T}/\partial P$) = $100[\Sigma((P - P_{exp})/P_{exp})^2/(N-n-m)]^{1/2}$, N , no. of exp. points, ref. 2, n , no. of coefficients in the smoothing equation, m , no. of exp. points of pure compounds.

EQUATIONS

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

$$c_1 = \exp \left[-(a_1 + \frac{a_2}{T})/T \right] \quad c_2 = \exp \left[-(a_3 + \frac{a_4}{T})/T \right]$$

$$P = P_1 + P_2 = \sum_{i=1}^2 x_i P_i^0 \exp \left[\frac{\mu_i^E - (B_{ii} - V_i^P)(P - P_i^0) - 2PB_{12}^E(1 - y_2)^2}{RT} \right]$$

$$\mu_1^E = G^E - x_2 (\partial G^E / \partial x_2)_{T,P} \quad \mu_2^E = G^E - x_1 (\partial G^E / \partial x_1)_{T,P}$$

$$B_{12}^E = B_{12} - (B_{11} + B_{22})/2; \quad y_i = P_i/P; \quad P_i^0/kPa = \exp [A_i + B_i/(C_i + T/K)]$$

COEFFICIENTS IN THE EQUATIONS

P/kPa	a_1/K	a_2/K^2	a_3/K	a_4/K^2
101.32	145.75	0	207.48	0
	(9.1)	(0)	(9.9)	(0)
114.66	10273	-3324700	-7335.3	2488000
	(686)	(229000)	(210)	(71000)
127.99	9938.1	-3293100	-8200.3	2829100
	(547)	(178000)	(175)	(61200)

The std. deviations $\sigma(a_i)$ of the coeffs. a_i are given in parentheses.

P/kPa	A_1	B_1	C_1	A_2	B_2	C_2
101.32	15.94126	-3247.7	-64.64	14.24998	-2662.78	-53.46
114.66	15.94229	-3247.7	-64.64	14.24918	-2662.78	-53.46
127.99	15.94229	-3247.7	-64.64	14.24912	-2662.78	-53.46

REFERENCES

- Int. DATA Ser., Ser. A, Guideline 3m, 1995, 23(2).
- Ortega, J. Int. DATA Ser., Sel. Data Mixtures, Ser. A 1995, 23, 79, 80.
- Wilson, G. M. J. Am. Chem. Soc. 1964, 86, 127.
- TRC Thermodynamic Tables - Hydrocarbons & Non-Hydrocarbons, 1976, k-5000, 1969, k-5550, Thermodynamics Research Center, The Texas A&M University System, College Station, TX, USA.
- Tsonopoulos, C. AIChE J. 1974, 20, 263; 1975, 21, 827.
- Yen, L. C.; Woods, S. S. AIChE J. 1966, 12, 95.

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State:	Binary system, single-phase liquid in equilibrium with vapor; pure components, both liquid in equilibrium with vapor
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	y_i , mole fraction of component i in vapor phase
Parameters:	P , pressure
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DIRECT EXPERIMENTAL VALUES

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x_1	T/K	y_1	x_1	T/K	y_1
0.0000	351.65	0.0000	0.5186	345.58	0.5139
0.0211	351.15	0.0414	0.5598	345.65	0.5375
0.0602	349.95	0.1105	0.5965	345.75	0.5598
0.0884	349.15	0.1554	0.6177	345.80	0.5754
0.1233	348.35	0.2043	0.6718	346.05	0.6091
0.1560	347.75	0.2449	0.7273	346.45	0.6464
0.1720	347.45	0.2616	0.7508	346.65	0.6667
0.2119	346.95	0.3026	0.8035	347.25	0.7109
0.2483	346.55	0.3333	0.8246	347.45	0.7317
0.2860	346.25	0.3615	0.8443	347.75	0.7542
0.3279	345.95	0.3953	0.8617	348.05	0.7737
0.3490	345.85	0.4098	0.8801	348.35	0.7967
0.3769	345.75	0.4269	0.9018	348.75	0.8260
0.4078	345.65	0.4468	0.9216	349.25	0.8571
0.4397	345.55	0.4674	0.9424	349.75	0.8908
0.4770	345.55	0.4883	1.0000	351.46	1.0000
0.5076	345.55	0.5108			

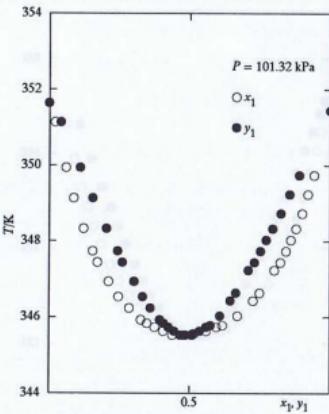
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Errors: $|\delta T(\text{estd.})|/K = 0.03$; $|\delta P(\text{estd.})|/Pa = 60$; $|\delta x_1| = 0.001$; $|\delta y_1| = 0.01$.



Points, direct experimental T values.

REFERENCES

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Variables: T, temperature

x_i, mole fraction of component i in liquid phasey_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

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DIRECT EXPERIMENTAL VALUES

P/kPa = 114.66					P/kPa = 127.99				
x ₁	T/K	y ₁	x ₁	T/K	y ₁	x ₁	T/K	y ₁	
0.0692	353.40	0.1201	0.5826	349.04	0.5551	0.0652	356.63	0.1138	0.5894
0.0951	352.55	0.1604	0.6019	349.09	0.5672	0.0924	355.90	0.1544	0.6137
0.1625	351.80	0.2034	0.6265	349.17	0.5829	0.1186	355.30	0.1932	0.6316
0.1982	350.66	0.2877	0.6678	349.30	0.6102	0.1638	354.48	0.2510	0.6800
0.2361	350.20	0.3225	0.6748	349.39	0.6148	0.1889	354.10	0.2776	0.7053
0.2768	349.77	0.3571	0.6997	349.53	0.6328	0.2208	353.67	0.3097	0.7320
0.3224	349.53	0.3920	0.7161	349.58	0.6443	0.2523	353.33	0.3391	0.7555
0.3686	349.28	0.4242	0.7405	349.78	0.6636	0.2865	353.04	0.3673	0.7825
0.4089	349.14	0.4498	0.7679	350.01	0.6858	0.3230	352.75	0.3953	0.8074
0.4238	349.09	0.4593	0.7911	350.21	0.7069	0.3586	352.53	0.4205	0.8343
0.4520	349.02	0.4771	0.8141	350.48	0.7283	0.3918	352.40	0.4421	0.8627
0.4771	348.98	0.4924	0.8361	350.77	0.7507	0.4294	352.27	0.4671	0.8871
0.4823	348.97	0.4932	0.8605	351.11	0.7773	0.4636	352.20	0.4891	0.9108
0.4912	348.95	0.4985	0.8806	351.44	0.8011	0.4931	352.17	0.5067	0.9360
0.5057	348.92	0.5074	0.9012	351.81	0.8277	0.5079	352.16	0.5158	0.9552
0.5211	348.93	0.5167	0.9206	352.22	0.8567	0.5235	352.15	0.5250	0.9699
0.5362	348.95	0.5259	0.9561	353.10	0.9145	0.5438	352.17	0.5379	0.9833
0.5599	348.98	0.5401	0.9701	353.55	0.9396	0.5654	352.19	0.5511	0.9926
0.5652	349.01	0.5436							357.13 0.9844

AUXILIARY INFORMATION

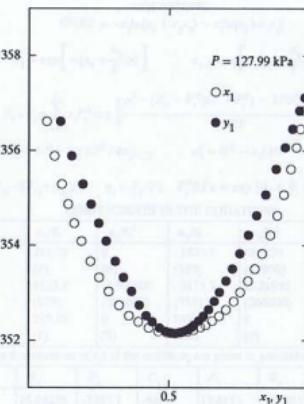
Apparatus: The apparatus was a glass ebulliometer employing continuous circulation of the liquid and vapor phases with a charge capacity of approx. 50 cm³, ref. 3. Turbulent mixing of the phases enabled equilibrium to be reached in a relatively short time. The ebulliometer was connected to vacuum pump and the pressure controlled by a Vakumat electronic instrument (Normschliff Geratebau Wertheim) and measured with a mercury manometer. High purity nitrogen was used for the backing pressure.

Procedure: Operation described in ref. 3. The equilibrium temperatures were measured with an accuracy of ±0.01 K with a digital thermometer, Comark, Model 6900, calibrated against ITS-90. Compositions were determined by densimetric analysis, using an Anton Paar, Model DMA-55 viscometer-tube digital densimeter. Pressure was maintained constant to within 0.02 kPa, indicated by an electronic pressure gauge (MKS Baratron).

Materials: 1. Fluka AG (Buchs, St. Gallen, Switzerland), "puriss p.a." grade material, purity > 99 mole %, degassed ultrasonically before use and stored in the dark for several days over molecular sieves type 4A (Fluka AG); n(D, 298.15 K) = 1.3594, ρ(298.15 K)/kg·m⁻³ = 785.01.

2. Fluka AG (Buchs, St. Gallen, Switzerland), "purum" grade material, purity > 99 mole %, degassed ultrasonically before use and stored in the dark for several days over molecular sieves type 4A (Fluka AG); n(D, 298.15 K) = 1.3740, ρ(298.15 K)/kg·m⁻³ = 908.53.

Errors: |δT(estd.)|/K = 0.03; |δP(estd.)|/Pa = 60; |δx₁| = 0.001; |δy₁| = 0.01.



Points, direct experimental T values.

REFERENCES

1. Int. DATA Ser., Ser. A, Guideline 3k, 1994, 22(4).
2. Ortega, J.; Susial, P. J. Chem. Eng. Jpn. 1990, 23, 349.
3. Ortega, J.; Pena, J. A.; de Alfonso, C. J. Chem. Eng. Data 1986, 31, 339.

SELECTED DATA ON MIXTURES

International DATA Series*

3m. LIQUID-VAPOR EQUILIBRIUM

The Texas A&M University System, College Station, TX 77843-3111

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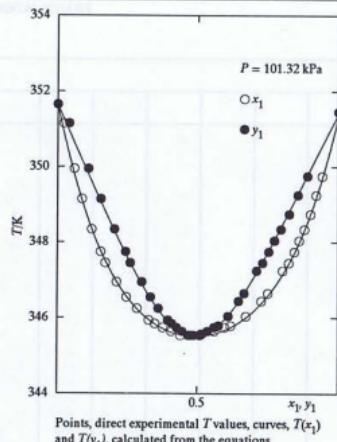
0147-1508/95/0502-84\$2.00

Notes: The table reports smoothed values of T and calcd. values of y_i

x_1	$P/kPa = 101.32$		$P/kPa = 114.66$		$P/kPa = 127.99$	
	T/K	y_1	T/K	y_1	T/K	y_1
0.00	351.65	0	355.42	0	358.88	0
0.05	350.11	0.0933	353.80	0.0948	357.07	0.0979
0.10	348.66	0.1697	352.48	0.1729	355.72	0.1750
0.15	347.89	0.2329	351.44	0.2370	354.70	0.2378
0.20	347.14	0.2857	350.65	0.2903	353.93	0.2905
0.25	346.57	0.3307	350.06	0.3355	353.35	0.3359
0.30	346.15	0.3699	349.63	0.3747	352.91	0.3760
0.40	345.67	0.4370	349.12	0.4420	352.37	0.4456
0.50	345.54	0.4964	349.95	0.5022	352.17	0.5077
0.60	345.71	0.5553	349.08	0.5617	352.25	0.5689
0.70	346.22	0.6211	349.51	0.6277	352.64	0.6354
0.75	346.62	0.6594	349.86	0.6655	352.97	0.6734
0.80	347.16	0.7036	350.33	0.7086	353.43	0.7164
0.85	347.86	0.7559	350.96	0.7584	354.04	0.7667
0.90	348.78	0.8196	351.79	0.8197	354.85	0.8273
0.95	349.95	0.8989	352.93	0.8966	355.94	0.9028
1.00	351.46	1	354.54	1	357.40	1

Std. dev. of $\langle T \rangle / K$, rel. std. dev. $100(\delta P/\bar{P})$, and abs. max. dev. $\delta_m(T)/K$ at $P/kPa = 101.32$ are resp.: 0.049, 0.168, 0.179.at $P/kPa = 114.66$ are resp.: 0.036, 0.124, 0.133.at $P/kPa = 127.99$ are resp.: 0.012, 0.041, 0.024.

AUXILIARY INFORMATION

Measurements: The T_{exp} data at 101.32, 114.66 and 127.99 kPa are reported in ref. 2.Computations: The 33 T_{exp} data at 101.32 kPa, 39 T_{exp} data at 114.66 kPa and 38 T_{exp} data at 127.99 kPa were reduced using the modified Wilson eq. ref. 3, for the partial molar excess Gibbs energies μ_i^E .Corrections: Vapor pressure equation parameters were taken from ref. 4 and parameters A_i were modified according to the experimental VLE data.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 coeffs. B_{ij} (ref. 5) and the molar volumes under saturation pressure V_i^S (ref. 6).Errors: Std. dev. of $\langle T \rangle = [2(T - T_{exp})^2/(N-n-m)]^{1/2}$,Rel. std. dev. $100(\delta P/\bar{P}) = 100[(P - P_{exp})/P_{exp}]^2/(N-n-m)]^{1/2}$, N , no. of exp. points, ref. 2, n , no. of coefficients in the smoothing equation, m , no. of exp. points of pure compounds.Points, direct experimental T values, curves, $T(x_1)$ and $T(y_1)$, calculated from the equations.

$$\text{EQUATIONS}$$

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

$$c_1 = \exp \left[-(a_1 + \frac{a_2}{T})/T \right] \quad c_2 = \exp \left[-(a_3 + \frac{a_4}{T})/T \right]$$

$$P = P_1 + P_2 = \sum_{i=1}^2 x_i P_i^0 \exp \left[\frac{\mu_i^E - (B_{ii} - V_i^S)(P - P_i^0) - 2PB_{12}^E(1-y)^2}{RT} \right]$$

$$\mu_1^E = G^E - x_2(G^E/\partial x_2)_{T,P} \quad \mu_2^E = G^E - x_1(G^E/\partial x_1)_{T,P}$$

COEFFICIENTS IN THE EQUATIONS

P/kPa	a_1/K	a_2/K^2	a_3/K	a_4/K^2
101.32	215.29	0	-1839.9	681870
(4)	(0)	(0)	(193)	(67000)
114.66	4125.8	-1366800	-3675.7	1328500
(879)	(309000)	(757)	(266000)	
127.99	210.78	0	119.67	0
(1)	(0)	(0.9)	(0)	

The std. deviations $\sigma(a_i)$ of the coeffs. a_i are given in parentheses.

P/kPa	A_1	B_1	C_1	A_2	B_2	C_2
101.32	15.94125	-3247.7	-64.64	13.8173	-2600.93	-68.91
114.66	15.94465	-3247.7	-64.64	13.81994	-2600.93	-68.91
127.99	15.94519	-3247.7	-64.64	13.8216	-2600.93	-68.91

REFERENCES

- Int. DATA Ser., Ser. A, Guideline 3m, 1995, 23(2).
- Ortega, J. Int. DATA Ser., Sel. Data Mixtures, Ser. A 1995, 23, 82, 83.
- Wilson, G. M. J. Am. Chem. Soc. 1964, 86, 127.
- TRC Thermodynamic Tables - Hydrocarbons & Non-Hydrocarbons, 1976, k-5000, 1969, k-5580, Thermodynamics Research Center, The Texas A&M University System, College Station, TX, USA.
- Tsonopoulos, C. AIChE J. 1974, 20, 263; 1975, 21, 827.
- Yen, L. C.; Woods, S. S. AIChE J. 1966, 12, 95.

SELECTED DATA ON MIXTURES

International DATA Series*

3k. LIQUID-VAPOR EQUILIBRIUM

Published by Thermodynamics Research Center

The Texas A&M University System, College Station, TX 77843-3111

0147-1503/94/0002-033\$2.00

Components:	1. Ethanol, C_2H_5OH [64-17-5] 2. Methyl butanoate, $C_5H_{10}O_2$ [623-42-7]	Author(s) Ortega, J. (Laboratorio de Termodinamica y Fisicoquimica, 35071 - University of Las Palmas de G. C., Canary Islands, Spain)
State:	Binary system, single-phase liquid in equilibrium with vapor; pure components, both liquid in equilibrium with vapor	Edited by: Mączyński, A. (Instytut Chemii Fizycznej, Polska Akademia Nauk, ul. Kasprzaka 44/52, 01-224 Warszawa, Poland)
Variables:	T , temperature x_i , mole fraction of component i in liquid phase y_i , mole fraction of component i in vapor phase	SOURCE OF DATA
Parameters:	P , pressure	Ortega, J.; Susial, P.; de Alfonso, C. (Laboratorio de Termodinamica y Fisicoquimica, 35071 - University of Las Palmas de G. C., Canary Islands, Spain); ref. 2
Method:	Direct measurement of T , x_i , and y_i at constant P ; ref. 1	

DIRECT EXPERIMENTAL VALUES

$P/kPa = 101.32$						
x_1	T/K	y_1	x_1	T/K	y_1	
0.0000	375.30	0.0000	0.5829	352.75	0.7224	
0.0256	372.45	0.1044	0.5968	352.65	0.7305	
0.0592	369.35	0.2059	0.6448	352.15	0.7525	
0.1054	365.60	0.3102	0.6769	351.90	0.7672	
0.1346	363.85	0.3649	0.6961	351.83	0.7773	
0.1682	362.15	0.4148	0.7169	351.77	0.7874	
0.1867	361.25	0.4408	0.7371	351.75	0.7981	
0.2394	359.25	0.5002	0.7837	351.45	0.8244	
0.2739	358.15	0.5329	0.8304	351.25	0.8510	
0.3016	357.45	0.5551	0.8707	351.05	0.8793	
0.3365	356.65	0.5818	0.8842	350.99	0.8890	
0.3754	355.75	0.6068	0.8967	350.98	0.8990	
0.4014	355.15	0.6258	0.9088	350.97	0.9086	
0.4279	354.65	0.6444	0.9220	350.98	0.9187	
0.4696	354.15	0.6645	0.9443	351.00	0.9385	
0.4964	353.65	0.6808	0.9609	351.10	0.9558	
0.5225	353.35	0.6965	0.9732	351.15	0.9687	
0.5543	353.05	0.7094	1.0000	351.46	1.0000	

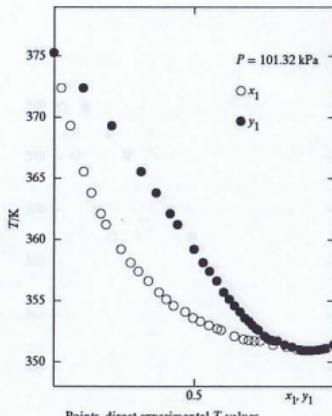
AUXILIARY INFORMATION

Apparatus: The apparatus was a glass ebulliometer employing continuous circulation of the liquid and vapor phases with a charge capacity of approx. 50 cm^3 , ref. 3. Turbulent mixing of the phases enabled equilibrium to be reached in a relatively short time. The ebulliometer was connected to vacuum pump and the pressure controlled by a Vakumat electronic instrument (NORMSCHIFF Geratebau Wertheim) and measured with a mercury manometer.

Procedure: Operation described in ref. 3. The equilibrium temperatures were measured with an accuracy of $\pm 0.01\text{ K}$ with a digital thermometer, Comark, Model 6900, calibrated against ITS-90. Compositions were determined by densimetric analysis, using an Anton Paar, Model DMA-55 vibrating-tube digital densimeter. Pressure was maintained constant to within 0.02 kPa .

Materials: 1. Fluka AG (Buchs, St. Gallen, Switzerland), "puriss p.a." grade material, purity > 99.8 mole %, degassed ultrasonically before use and stored in the dark for several days over molecular sieves type 4A (Fluka AG); $n(D, 298.15\text{ K}) = 1.3594$, $\rho(298.15\text{ K})/\text{kg m}^{-3} = 785.01$.
2. Fluka AG (Buchs, St. Gallen, Switzerland), "purum" grade material, purity > 99 mole %, degassed ultrasonically before use and stored in the dark for several days over molecular sieves type 4A (Fluka AG); $n(D, 298.15\text{ K}) = 1.3851$, $\rho(298.15\text{ K})/\text{kg m}^{-3} = 892.37$.

Errors: $|\delta T(\text{estd.})|/K = 0.1$; $|\delta P(\text{estd.})|/Pa = 60$; $|\delta x_1| = 0.001$; $|\delta y_1| = 0.02$.

Points, direct experimental T values.

REFERENCES

- Int. DATA Ser., Ser. A, Guideline 3k, 1994, 22(4).
- Ortega, J.; Susial, P.; de Alfonso, C. J. Chem. Eng. Data 1990, 35, 216.
- Ortega, J.; Pena, J. A.; de Alfonso, C. J. Chem. Eng. Data 1986, 31, 339.

SELECTED DATA ON MIXTURES

International DATA Series*

3k. LIQUID-VAPOR EQUILIBRIUM

Published by Thermodynamics Research Center

The Texas A&M University System, College Station, TX 77843-3111

Components:	1. Ethanol, C_2H_5O [64-17-5] 2. Methyl butanoate, $C_6H_{10}O_2$ [623-42-7]
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:	Direct measurement of T , x_i , and y_i at constant P ; ref. 1

Author(s) Ortega, J. (Laboratorio de Termodinamica y Fisicoquimica, 35071 -University of Las Palmas de G. C., Canary Islands, Spain)

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

SOURCE OF DATA

Ortega, J.; Susial, P. (Laboratorio de Termodinamica y Fisicoquimica, 35071 -University of Las Palmas de G. C., Canary Islands, Spain); ref. 2

DIRECT EXPERIMENTAL VALUES

$P/kPa = 114.66$						$P/kPa = 127.99$						
x_1	T/K	y_1	x_1	T/K	y_1	x_1	T/K	y_1	x_1	T/K	y_1	
0.0438	374.79	0.1502	0.2748	0.5970	0.355.97	0.7344	0.0114	381.82	0.0484	0.6055	358.94	0.7500
0.0914	370.88	0.1502	0.2748	0.5970	0.355.97	0.7344	0.0309	379.80	0.1183	0.6273	358.71	0.7611
0.1188	369.17	0.1324	0.6179	0.355.77	0.7442	0.0570	377.30	0.2002	0.6515	358.51	0.7710	
0.1434	367.61	0.1380	0.6448	0.355.50	0.7562	0.0795	375.30	0.2629	0.6816	358.25	0.7810	
0.1676	366.11	0.4227	0.6708	0.355.35	0.7680	0.1342	371.20	0.3846	0.7108	358.03	0.7949	
0.2100	364.37	0.4789	0.6955	0.355.17	0.7799	0.1563	370.02	0.4203	0.7405	357.82	0.8095	
0.2382	363.30	0.5094	0.7198	0.355.02	0.7923	0.1838	368.70	0.4603	0.7744	357.64	0.8264	
0.2532	362.67	0.5274	0.7416	0.354.85	0.8034	0.2096	367.50	0.4940	0.8009	357.50	0.8410	
0.2980	360.99	0.5692	0.7666	0.354.70	0.8167	0.2370	366.42	0.5247	0.8281	357.38	0.8570	
0.3373	360.51	0.5845	0.7901	0.354.59	0.8297	0.2906	364.58	0.5719	0.8508	357.30	0.8711	
0.3325	360.05	0.5937	0.8110	0.354.49	0.8423	0.3234	363.68	0.5977	0.8704	357.24	0.8844	
0.3577	359.32	0.6160	0.8329	0.354.40	0.8558	0.3538	362.91	0.6187	0.8886	357.20	0.8972	
0.3839	359.14	0.6248	0.8565	0.354.35	0.8712	0.3762	362.42	0.6324	0.9053	357.18	0.9097	
0.4029	358.65	0.6405	0.8738	0.354.31	0.8834	0.4139	361.62	0.6559	0.9206	357.16	0.9221	
0.4480	357.87	0.6631	0.8894	0.354.29	0.8944	0.4375	361.15	0.6718	0.9347	357.16	0.9343	
0.4689	357.51	0.6753	0.9011	0.354.27	0.9037	0.4575	360.72	0.6829	0.9513	357.18	0.9490	
0.4850	357.15	0.6865	0.9241	0.354.25	0.9228	0.4786	360.32	0.6962	0.9636	357.21	0.9608	
0.5060	356.94	0.6937	0.9483	0.354.29	0.9446	0.5121	359.87	0.7116	0.9753	357.24	0.9725	
0.5366	356.59	0.7062				0.5546	359.47	0.7274	0.9841	357.27	0.9820	
						0.5833	359.16	0.7393	0.9918	357.30	0.9904	

AUXILIARY INFORMATION

Apparatus The apparatus was a glass ebulliometer employing continuous circulation of the liquid and vapor phases with a charge capacity of approx. 50 cm^3 , ref. 3. Turbulent mixing of the phases enabled equilibrium to be reached in a relatively short time. The ebulliometer was connected to vacuum pump and the pressure controlled by a Vakumat electronic instrument (NORMSCHIFF GERATEBAU Wertheim) and measured with a mercury manometer. High purity nitrogen was used for the backing pressure.

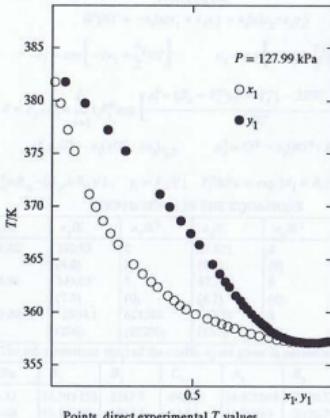
Procedure Operation described in ref. 3. The equilibrium temperatures were measured with an accuracy of $\pm 0.01\text{ K}$ with a digital thermometer, Comark, Model 6900, calibrated against ITS-90. Compositions were determined by densimetric analysis, using an Anton Paar, Model DMA-55 vibrating-tube digital densimeter. Pressure was maintained constant to within 0.02 kPa , indicated by an electronic pressure gauge (MKS Baratron).

Materials: 1. Fluka AG (Buchs, St. Gallen, Switzerland), "puriss p.a." grade material, purity > 99.8 mole %, degassed ultrasonically before use and stored in the dark for several days over molecular sieves type 4A (Fluka AG); $n(D, 298.15\text{ K}) = 1.3594$, $\rho(298.15\text{ K})/\text{kg m}^{-3} = 785.01$.
2. Fluka AG (Buchs, St. Gallen, Switzerland), "purum" grade material, purity > 99 mole %, degassed ultrasonically before use and stored in the dark for several days over molecular sieves type 4A (Fluka AG); $n(D, 298.15\text{ K}) = 1.3851$, $\rho(298.15\text{ K})/\text{kg m}^{-3} = 892.37$.

Errors: $|\delta T(\text{estd.})|/K = 0.1$; $|\delta P(\text{estd.})|/\text{kPa} = 60$; $|\delta x_1| = 0.001$; $|\delta y_1| = 0.02$ and 0.01 at 115 and 128 kPa.

REFERENCES

1. Int. DATA Ser., Ser. A, Guideline 3k, 1994, 22(4).
2. Ortega, J.; Susial, P. Can. J. Chem. Eng. 1991, 69, 394.
3. Ortega, J.; Pena, J. A.; de Alfonso, C. J. Chem. Eng. Data 1986, 31, 339.

Points, direct experimental T values.

SELECTED DATA ON MIXTURES

International DATA Series*

3m. LIQUID-VAPOR EQUILIBRIUM

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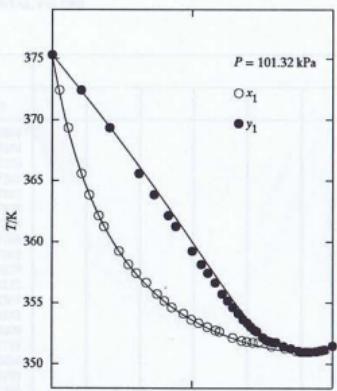
Published by Thermodynamics Research Center

Components:	1. Ethanol, C ₂ H ₅ O /64-17-5/ 2. Methyl butanoate, C ₆ H ₁₂ O ₂ /623-42-7/	Author(s)	Ortega, J. (Laboratorio de Termodinamica y Fisicoquimica, 35071 -University of Las Palmas de G. C., de table 3k Canary Islands, Spain)
State:	Binary system, single-phase liquid in equilibrium with vapor; pure components, both liquid in equilibrium with vapor	Compiled by:	Oracz, P. (Wydzial Chemii, Uniwersytet Warszawski, ul. Pasteura 1, 02-093 Warsaw, Poland)
Variables:	T, temperature		
<i>y_i</i> , mole fraction of component <i>i</i> in vapor phase			
<i>x_i</i> , mole fraction of component <i>i</i> in liquid phase			
Parameters:	<i>P_v</i> , pressure		
Method:	Calculation from direct experimental liquid-vapor equilibrium temperature, <i>T_{exp}</i> , data at variable <i>x_i</i> and constant <i>P</i> ; ref. 1		

Notes: The table reports smoothed values of *T* and calcd. values of *y_i*

<i>x_i</i>	<i>T/K</i>	<i>P/kPa</i> =101.32		<i>P/kPa</i> =114.66		<i>P/kPa</i> =127.99		
		<i>T/K</i>	<i>y_i</i>	<i>T/K</i>	<i>y_i</i>	<i>T/K</i>	<i>y_i</i>	
0.00	375.30	0	380.01	0	383.31	0		
0.05	369.94	0.1890	374.34	0.1921	377.87	0.1830		
0.10	366.04	0.3161	370.22	0.3209	373.68	0.3115		
0.15	363.09	0.4077	367.09	0.4136	370.44	0.4049		
0.20	360.70	0.4772	364.65	0.4837	367.89	0.4751		
0.25	358.94	0.5321	362.69	0.5389	365.88	0.5298		
0.30	357.45	0.5767	361.11	0.5839	364.26	0.5739		
0.40	355.22	0.6462	358.74	0.6535	361.85	0.6419		
0.50	353.67	0.6999	357.09	0.7070	360.18	0.6948		
0.60	352.57	0.7457	355.91	0.7522	358.98	0.7411		
0.70	351.79	0.7894	355.07	0.7949	358.09	0.7869		
0.75	351.50	0.8123	354.75	0.8172	357.75	0.8114		
0.80	351.27	0.8372	354.50	0.8414	357.48	0.8383		
0.85	351.12	0.8656	354.32	0.8688	357.28	0.8687		
0.90	351.06	0.8995	354.24	0.9017	357.17	0.9042		
0.95	351.15	0.9424	354.30	0.9434	357.18	0.9469		
1.00	351.46	1	354.60	1	357.35	1		

Std. dev. of *T/K*, rel. std. dev. 1000(*d_m/dT*)*P*, and abs. max. dev. *d_m(T/K)* at *P/kPa*=101.32 are resp.: 0.087, 0.316, 0.178.
 at *P/kPa*=114.66 are resp.: 0.105, 0.361, 0.304.
 at *P/kPa*=127.99 are resp.: 0.056, 0.189, 0.154.



Points, direct experimental *T* values, curves, *T(x_i)* and *T(y_i)*, calculated from the equations.

AUXILIARY INFORMATION

Measurements: The *T_{exp}* data at 101.32, 114.66 and 127.99 kPa are reported in ref. 2.

Computations: The 37 *T_{exp}* data at 101.32 kPa, 37 *T_{exp}* data at 114.66 kPa and 40 *T_{exp}* data at 127.99 kPa were reduced using the modified Wilson eq., ref. 3, for the partial molar excess Gibbs energies μ_i^E .

Corrections: Vapor pressure equation parameters were taken from ref. 4 and parameters *A_i* were modified according to the experimental VLE data.

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 coeffs. $B_{ij}^{(2)}(N, n, m)$ and the molar volumes under saturation pressure V_i^0 (ref. 6).

Errors: Std. dev. $\sigma(T) = [2(T-T_{exp})^2(N-n-m)]^{1/2}$,
 $\text{Rel. std. dev. } 100\sigma(T/P) = 100[\Sigma(P-P_{exp})^2/N]^1/2$,

N, no. of exp. points, ref. 2,

n, no. of coefficients in the smoothing equation,

m, no. of exp. points of pure compounds.

EQUATIONS

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

$$c_1 = \exp\left[-(a_1 + \frac{a_2}{T})/T\right] \quad c_2 = \exp\left[-(a_2 + \frac{a_1}{T})/T\right]$$

$$P = P_1 + P_2 = \sum_{i=1}^2 x_i P_i^0 \exp\left[\frac{\mu_i^E - (B_{ii} - V_i^0)(P - P_i^0) - 2PB_{12}^E(1-y)^2}{RT}\right]$$

$$\mu_i^E = G^E - x_i(\partial G^E / \partial x_i)_{T,P} \quad \mu_i^0 = G^0 - x_i(\partial G^0 / \partial x_i)_{T,P}$$

$$B_{12}^E = B_{12} - (B_{11} + B_{22})/2; \quad y_i = P_i/P; \quad P_i^0/kPa = \exp[A_i + B_i/(C_i + (T/K))]$$

COEFFICIENTS IN THE EQUATIONS

<i>P/kPa</i>	<i>a_i/K</i>	<i>a_i/K²</i>	<i>a_j/K</i>	<i>a_j/K²</i>
101.32	332.93	0	55.821	0
	(6.8)	(0)	(4.5)	(0)
114.66	349.03	0	47.743	0
	(7.3)	(0)	(4.7)	(0)
127.99	-1504.1	621580	143.71	0
	(206)	(69200)	(15.3)	(0)

The std. deviations (σ_i) of the coeffs. *a_i* are given in parentheses.

<i>P/kPa</i>	<i>A_i</i>	<i>B_i</i>	<i>C_i</i>	<i>A_j</i>	<i>B_j</i>	<i>C_j</i>
101.32	15.941255	-3247.7	-64.636	14.078848	-2926.72	-65.94
114.66	15.94229	-3247.7	-64.64	14.06053	-2926.72	-65.94
127.99	15.94708	-3247.7	-64.64	14.07374	-2926.72	-65.94

REFERENCES

- Int. DATA Ser., Ser. A, Guideline 3m, 1993, 23(2).
- Ortega, J. Int. DATA Ser., Sel. Data Mixtures, Ser. A 1993, 23, 85, 86.
- Wilson, G. M. J. Am. Chem. Soc. 1964, 86, 127.
- TRC Thermodynamic Tables - Hydrocarbons & Non-Hydrocarbons, 1976, k-5000, 1978, k-5620, Thermodynamics Research Center, The Texas A&M University System, College Station, TX, USA.
- Tsionopoulos, C. AIChE J. 1974, 20, 263; 1975, 21, 827.
- Yen, L. C.; Woods, S. S. AIChE J. 1968, 12, 95.

SELECTED DATA ON MIXTURES

International DATA Series*

3k. LIQUID-VAPOR EQUILIBRIUM

The Texas A&M University System, College Station, TX 77843-3111

Published by Thermodynamics Research Center

Components:	1. Ethanol, C ₂ H ₅ O [64-17-5] 2. Ethyl ethanoate, C ₄ H ₈ O ₂ [141-78-6]
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>i</i> in liquid phase
y _i :	mole fraction of component <i>i</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 Termodinamica y Fisicoquimica, 35071 - University of Las Palmas de G. C., Canary Islands, Spain)

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

SOURCE OF DATA

Ortega, J.; Pena, J. A.; de Alfonso, C. (Laboratorio de Termodinamica y Fisicoquimica, 35071 - University of Las Palmas de G. C., Canary Islands, Spain); ref. 2

DIRECT EXPERIMENTAL VALUES

P/kPa = 101.325

x ₁	T/K	y ₁	x ₁	T/K	y ₁	x ₁	T/K	y ₁				
0.0097	349.55	0.0314	0.3305	345.15	0.3960	0.8008	347.15	0.6964				
0.0157	349.35	0.0474	0.3575	345.05	0.4169	0.8204	347.25	0.7164				
0.0252	349.15	0.0652	0.3789	344.95	0.4348	0.8259	347.35	0.7220				
0.0366	348.85	0.0792	0.4035	344.90	0.4548	0.8312	347.45	0.7288				
0.0474	348.65	0.0962	0.4331	344.85	0.4688	0.8394	347.65	0.7380				
0.0555	348.45	0.1081	0.4900	344.85	0.4891	0.8532	347.85	0.7553				
0.0633	348.25	0.1202	0.5245	344.90	0.5005	0.8563	347.95	0.7598				
0.0846	347.85	0.1496	0.5349	344.95	0.5066	0.8709	348.15	0.7766				
0.1084	347.45	0.1784	0.5530	345.00	0.5130	0.8784	348.25	0.7862				
0.1210	347.25	0.1926	0.5756	345.05	0.5270	0.8907	348.55	0.8029				
0.1366	347.05	0.2086	0.5816	345.10	0.5309	0.8995	348.75	0.8132				
0.1497	346.85	0.2227	0.5981	345.15	0.5389	0.9152	349.05	0.8367				
0.1602	346.65	0.2339	0.6446	345.45	0.5669	0.9266	349.25	0.8553				
0.1806	346.35	0.2551	0.6623	345.55	0.5779	0.9309	349.35	0.8609				
0.2027	346.15	0.2773	0.6914	345.85	0.5998	0.9385	349.55	0.8755				
0.2233	345.95	0.2980	0.7214	346.15	0.6219	0.9465	349.75	0.8886				
0.2549	345.65	0.3275	0.7503	346.45	0.6483	0.9532	349.95	0.8993				
0.2808	345.45	0.3525	0.7812	346.85	0.6766	0.9692	350.35	0.9294				
0.3146	345.25	0.3831	0.7902	346.95	0.6857	0.9752	350.55	0.9423				

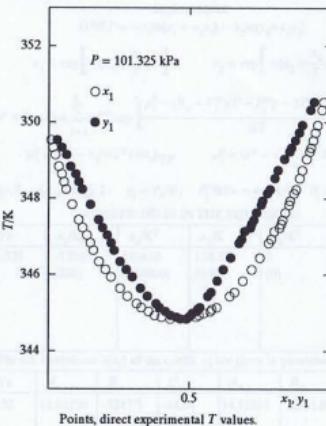
AUXILIARY INFORMATION

Apparatus: The apparatus was a glass ebulliometer employing continuous circulation of the liquid and vapor phases with a charge capacity of approx. 50 cm³, ref. 2. Turbulent mixing of the phases enabled equilibrium to be reached in a relatively short time. The ebulliometer was connected to vacuum pump and the pressure controlled by a Vakumat electronic instrument (Normschliff Gerätetechnik Wertheim) and measured with a mercury manometer.

Procedure: Operation described in ref. 2. The equilibrium temperatures were measured with an accuracy of ± 0.1 K with a digital thermometer, Bailey Instruments, calibrated against IPTS-68. Compositions were determined by densimetric analysis, using a Anton Paar, Model DMA-55 vibrating-tube densimeter. Pressure was maintained constant to within 0.07 kPa.

Materials: 1. Fluka AG (Buchs, St. Gallen, Switzerland), "puriss p.a." grade material, purity > 99.8 mole %, degassed ultrasonically before use and stored in the dark for several days over molecular sieves type 4A (Fluka AG); n(D, 298.15 K) = 1.3594, $\rho(298.15 \text{ K})/\text{kg} \cdot \text{m}^{-3}$ = 785.05.
2. Fluka AG (Buchs, St. Gallen, Switzerland), "puriss p.a." grade material, purity > 99.5 mole %, degassed ultrasonically before use and stored in the dark for several days over molecular sieves type 4A (Fluka AG); n(D, 298.15 K) = 1.3699, $\rho(298.15 \text{ K})/\text{kg} \cdot \text{m}^{-3}$ = 894.34.

Errors: | $\delta T(\text{estd.})|/K = 0.1$; | $\delta P(\text{estd.})|/\text{Pa} = 20$; | $\delta x_1| = 0.001$; | $\delta y_1| = 0.02$.



REFERENCES

- Int. DATA Ser., Ser. A, Guideline 3k, 1994, 22(4).
- Ortega, J.; Pena, J. A.; de Alfonso, C. J. Chem. Eng. Data 1986, 31, 339.

SELECTED DATA ON MIXTURES

International DATA Series*

3m. LIQUID-VAPOR EQUILIBRIUM

Published by Thermodynamics Research Center

The Texas A&M University System, College Station, TX 77843-3111

Components: 1. Ethanol, C_2H_5O [64-17-5]2. Ethyl ethanoate, $C_4H_8O_2$ [141-78-6]

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

Variables: T , temperature y_i , mole fraction of component i in vapor phase x_i , mole fraction of component i in liquid phaseParameters: P , pressureMethod: Calculation from direct experimental liquid-vapor equilibrium temperature, T_{exp} , data at variable x_i and constant P ; ref. 1

Author(s) Ortega, J. (Laboratorio de Termodinámica y Físicoquímica, 35071-University of Las Palmas de G. C., Canary Islands, Spain)

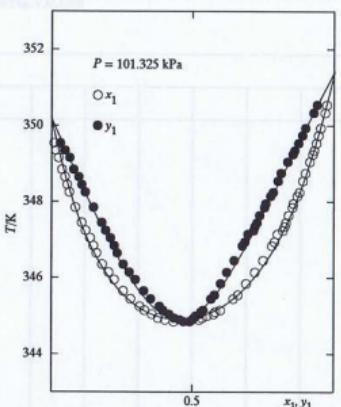
Compiled by Oracz, P. (Wydział Chemiczny, Uniwersytet Warszawski, ul. Pasteura 1, 02-093 Warszawa, Poland)

SOURCE OF DATA

Ortega, J.; Pena, J. A.; de Alfonso, C. (Laboratorio de Termodinámica y Físicoquímica, 35071-University of Las Palmas de G. C., Canary Islands, Spain); FIRST PUBLISHED RESULTS

Notes: The table reports smoothed values of T and calcd. values of y_1

x_1	T/K	y_1				
0.00	350.21	0				
0.05	348.69	0.0925				
0.10	347.55	0.1658				
0.15	346.70	0.2254				
0.20	346.08	0.2752				
0.25	345.62	0.3179				
0.30	345.30	0.3554				
0.40	344.97	0.4208				
0.50	344.96	0.4800				
0.60	345.25	0.5401				
0.70	345.87	0.6085				
0.75	346.35	0.6489				
0.80	346.96	0.6955				
0.85	347.75	0.7509				
0.90	348.73	0.8176				
0.95	349.95	0.8994				
1.00	351.44	1				

Std. dev. of T/K , rel. std. dev. $100\sigma(\Delta P/P)$, and abs. max. dev. $\delta_m(T)/K$ at $P/kPa = 101.325$ are resp.: 0.104, 0.37, 0.312.

AUXILIARY INFORMATION

Measurements: The T_{exp} data at 101.325 kPa are reported in ref. 2.Computations: The 57 T_{exp} data at 101.325 kPa were reduced using the modified Wilson eq., ref. 3, for the partial molar excess Gibbs energies μ_i^E .Corrections: Vapor pressure equation parameters were taken from ref. 4 and parameters A_i were modified according to the experimental VLE data. 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 coeffs. B_{ij} (ref. 5) and the molar volumes under saturation pressure V_i^0 (ref. 6).Errors: Std. dev. $\sigma(T) = [\Sigma(T - T_{exp})^2/(N-n)]^{1/2}$.
Rel. std. dev. $100\sigma(\Delta P/P) = 100[\Sigma((P - P_{exp})/P_{exp})^2/(N-n)]^{1/2}$.
 N , no. of exp. points, ref. 2.
 n , no. of coefficients in the smoothing equation.

EQUATIONS

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

$$c_1 = \exp \left[-(a_1 + \frac{a_2}{T})/T \right] \quad c_2 = \exp \left[-(a_3 + \frac{a_4}{T})/T \right]$$

$$P = P_1 + P_2 = \sum_{i=1}^2 x_i P_i^0 \exp \left[\frac{\mu_i^E - (B_{ii} - V_i^0)(P - P_i^0) - 2PB_{12}^E(1-y)^2}{RT} \right]$$

$$\mu_i^E = G^E - x_i (\partial G^E / \partial x_i)_{T,P} \quad \mu_2^E = G^E - x_1 (\partial G^E / \partial x_1)_{T,P}$$

$$B_{12}^E = B_{12} - (B_{11} + B_{22})/2; \quad y_i = P_i/P; \quad P_i^0 \text{ kPa} = \exp [A_i + B_i / (C_i + T/K)]$$

COEFFICIENTS IN THE EQUATIONS

P/kPa	a_1/K	a_2/K^2	a_3/K	a_4/K^2
101.325 (338)	-1534.1 (338)	591650 (118000)	158.87 (6.9)	0 (0)

The std. deviations $\sigma(a_i)$ of the coeffs. a_i are given in parentheses.

P/kPa	A_1	B	C_1	A_2	B_2	C_2
101.32	15.94229	-3247.7	-64.64	14.12316	-2751.89	-60.68

REFERENCES

- Int. DATA Ser., Ser. A, Guideline 3m, 1995, 23(2).
- Ortega, J. Int. DATA Ser., Sel. Data Mixtures, Ser. A 1995, 23, 88.
- Wilson, G. M. J. Am. Chem. Soc. 1964, 86, 127.
- TRC Thermodynamic Tables - Hydrocarbons & Non-Hydrocarbons, 1976, k-5000, 1969, k-5550, Thermodynamics Research Center, The Texas A&M University System, College Station, TX, USA.
- Tsonopoulos, C. AIChE J. 1974, 20, 263; 1975, 21, 827.
- Yen, L. C.; Woods, S. S. AIChE J. 1966, 12, 95.

Components:	1. Ethanol, C_2H_5O [64-17-5] 2. Ethyl propanoate, $C_5H_{10}O_2$ [105-37-3]	Author(s) of table:	Ortega, J. (Laboratorio de Termodinamica y Fisicoquimica, 35071 -University of Las Palmas de G. C., Canary Islands, Spain)
State:	Binary system, single-phase liquid in equilibrium with vapor; pure components, both liquid in equilibrium with vapor	Edited by:	Mączyński, A. (Instytut Chemii Fizycznej, Polska Akademia Nauk, ul. Kasprzaka 44/52, 01-224 Warszawa, Poland)
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	SOURCE OF DATA	Ortega, J.; Ocon, J.; Pena, J. A.; de Alfonso, C.; Paz-Andrade, M. I.; Fernandez, J. (Laboratorio de Termodinamica y Fisicoquimica, 35071 -University of Las Palmas de G. C., Canary Islands, Spain); ref. 2

DIRECT EXPERIMENTAL VALUES

 $P/kPa = 101.32$

x_1	T/K	y_1	x_1	T/K	y_1							
0.0497	366.90	0.1948	0.5592	352.10	0.6867							
0.0594	363.90	0.2843	0.5958	351.80	0.7045							
0.1101	363.30	0.3022	0.6330	351.60	0.7238							
0.1286	362.50	0.3332	0.6679	351.40	0.7419							
0.1431	361.80	0.3559	0.6905	351.30	0.7549							
0.1594	361.00	0.3794	0.7193	351.20	0.7708							
0.2100	359.30	0.4412	0.7525	351.10	0.7908							
0.2452	358.00	0.4775	0.7886	351.00	0.8118							
0.2722	357.20	0.5032	0.8228	350.90	0.8353							
0.3044	356.30	0.5287	0.8576	350.90	0.8604							
0.3360	355.50	0.5522	0.8797	350.90	0.8775							
0.3638	354.80	0.5692	0.9181	350.90	0.9108							
0.3796	354.50	0.5784	0.9396	351.10	0.9308							
0.4632	353.00	0.6316	0.9497	351.20	0.9407							
0.5016	352.60	0.6545	0.9719	351.30	0.9647							
0.5311	352.30	0.6699	0.9938	351.40	0.9903							

AUXILIARY INFORMATION

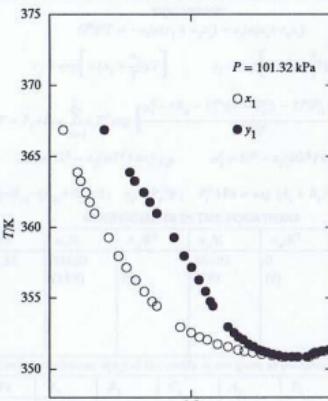
Apparatus: The apparatus was a glass ebulliometer employing continuous circulation of the liquid and vapor phases with a charge capacity of approx. 50 cm^3 , ref. 3. Turbulent mixing of the phases enabled equilibrium to be reached in a relatively short time. The ebulliometer was connected to vacuum pump and the pressure controlled by a Vakuumat electronic instrument (Normschliff Geratebau Wertheim) and measured with a mercury manometer.

Procedure: Operation described in ref. 3. The equilibrium temperatures were measured with an accuracy of $\pm 0.1\text{ K}$ with a digital thermometer, Bailey Instruments, calibrated according to IPTS-68. Compositions were determined by densimetric analysis, using a Anton Paar, Model DMA-55 vibrating-tube digital densimeter. Pressure was maintained constant to within 0.07 kPa .

Materials: 1. Fluka AG (Buchs, St. Gallen, Switzerland), "puriss p.a." grade material, purity > 99.8 mole %, degassed ultrasonically before use and stored in the dark for several days over molecular sieves type 4A (Fluka AG); $\rho(298.15\text{ K})/\text{kg}\cdot\text{m}^{-3} = 785.05$.

Materials: 1. Fluka AG (Buchs, St. Gallen, Switzerland), "puriss" grade material, purity > 99.0 mole %, degassed ultrasonically before use and stored in the dark for several days over molecular sieves type 4A (Fluka AG); $\rho(298.15\text{ K})/\text{kg}\cdot\text{m}^{-3} = 883.91$.

Errors: $|\delta T(\text{estd.})|/K = 0.1$; $|\delta P(\text{estd.})|/Pa = 300$; $|\delta x_1| = 0.002$; $|\delta y_1| = 0.02$.

Points, direct experimental T values.

REFERENCES

- Int. DATA Ser., Ser. A, Guideline 3k, 1994, 22(4).
- Ortega, J.; Ocon, J.; Pena, J. A.; de Alfonso, C.; Paz-Andrade, M. I.; Fernandez, J. Can. J. Chem. Eng. 1987, 65, 982.
- Ortega, J.; Pena, J. A.; de Alfonso, C. J. Chem. Eng. Data 1986, 31, 339.

SELECTED DATA ON MIXTURES

International DATA Series*

3m. LIQUID-VAPOR EQUILIBRIUM

The Texas A&M University System, College Station, TX 77843-3111

Published by Thermodynamics Research Center

Components: 1. Ethanol, C₂H₅O [64-17-5]2. Ethyl propanoate, C₅H₁₀O₂ [105-37-3]

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

Variables: T, temperature

y_i, mole fraction of component i in vapor phasex_i, mole fraction of component i in liquid phase

Parameters: P, pressure

Method: Calculation from direct experimental liquid-vapor equilibrium temperature, T_{exp}, data at variable x_i and constant P; ref. 1

Author(s) Ortega, J. (Laboratorio de Termodinamica y Fisicoquimica, 35071 -University of Las Palmas de G. C., of table 3k Canary Islands, Spain)

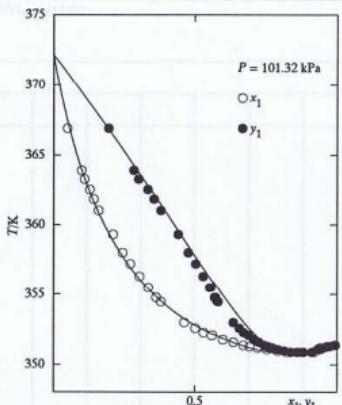
Compiled by: Oracz, P. (Wydział Chemiczny, Uniwersytet Warszawski, ul. Pasteura 1, 02-093 Warszawa, Poland)

SOURCE OF DATA

Ortega, J.; Ocon, J.; Pena, J. A.; de Alfonso, C.; Paz-Andrade, M. I.; Fernandez, J. (Laboratorio de Termodinamica y Fisicoquimica, 35071 -University of Las Palmas de G. C., Canary Islands, Spain); FIRST PUBLISHED RESULTS

Notes: The table reports smoothed values of T and calcd. values of y_i

P/kPa=101.32		
x ₁	T/K	y ₁
0.00	372.18	0
0.05	367.47	0.1738
0.10	364.01	0.2942
0.15	361.36	0.3828
0.20	359.28	0.4511
0.25	357.62	0.5057
0.30	356.28	0.5507
0.40	354.26	0.6217
0.50	352.88	0.6774
0.60	351.91	0.7255
0.70	351.24	0.7721
0.75	351.01	0.7967
0.80	350.85	0.8236
0.85	350.77	0.8543
0.90	350.80	0.8911
0.95	350.99	0.9376
1.00	351.43	1

Std. dev. σ(T)/K, rel. std. dev. 100σ(ΔP/P), and abs. max. dev. σ_m(T)/K at P/kPa = 101.32 are resp.: 0.188, 0.64, 0.569.Points, direct experimental T values, curves, T(x₁) and T(y₁), calculated from the equations.

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 eq., ref. 3, for the partial molar excess Gibbs energies μ_i^E.Corrections: Vapor pressure equation parameters were taken from ref. 4 and parameters A_i were modified according to the experimental VLE data. 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 coeffs. B_{ij} (ref. 5) and the molar volumes under saturation pressure V_i⁰ (ref. 6).Errors: Std. dev. σ(T) = [Σ(T-T_{exp})²(N-n)]^{1/2},
Rel. std. dev. 100σ(ΔP/P) = 100[Σ((P-P_{exp})/P_{exp})²(N-n)]^{1/2},
N, no. of exp. points, ref. 2,
n, no. of coefficients in the smoothing equation.

EQUATIONS

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

$$c_1 = \exp \left[-(a_1 + \frac{a_2}{T})/T \right] \quad c_2 = \exp \left[-(a_3 + \frac{a_4}{T})/T \right]$$

$$P = P_1 + P_2 = \sum_{i=1}^2 x_i P_i^0 \exp \left[\frac{\mu_i^E - (B_{ii} - V_i^0)(P - P_i^0) - 2PB_{12}^E(1-y)}{RT} \right]$$

$$\mu_1^E = G^E - x_2 (\partial G^E / \partial x_2)_{T,P} \quad \mu_2^E = G^E - x_1 (\partial G^E / \partial x_1)_{T,P}$$

$$B_{12}^E = B_{12} - (B_{11} + B_{22})/2; \quad y_i = P_i/P; \quad P_i^0/kPa = \exp [A_i + B_i/(C_i + T/K)]$$

COEFFICIENTS IN THE EQUATIONS

P/kPa	a ₁ /K	a ₂ /K ²	a ₃ /K	a ₄ /K ²
101.32	323.22 (14.6)	0 (0)	58.503 (9.6)	0 (0)

The std. deviations σ(a_i) of the coeffs. a_i are given in parentheses.

P/kPa	A ₁	B ₁	C ₁	A ₂	B ₂	C ₂
101.32	15.94229	-3247.7	-64.64	14.14708	-2935.11	-64.15

REFERENCES

- Int. DATA Ser., Ser. A, Guideline 3m, 1995, 23(2).
- Ortega, J. Int. DATA Ser., Sel. Data Mixtures, Ser. A 1995, 23, 90.
- Wilson, G. M. J. Am. Chem. Soc. 1964, 86, 127.
- TRC Thermodynamic Tables - Hydrocarbons & Non-Hydrocarbons, 1976, k-5000, 1976, k-5620, Thermodynamics Research Center, The Texas A&M University System, College Station, TX, USA.
- Tsonopoulos, C. AIChE J. 1974, 20, 263; 1975, 21, 827.
- Yen, L. C., Woods, S. S. AIChE J. 1966, 12, 95.

SELECTED DATA ON MIXTURES
International DATA Series*
3k. LIQUID-VAPOR EQUILIBRIUM

Published by Thermodynamics Research Center

The Texas A&M University System, College Station, TX 77843-3111

Components:	1. Ethanol, C_2H_5O [64-17-5]
State:	Binary system, single-phase liquid in equilibrium with vapor; pure components, both liquid in equilibrium with vapor
Variables:	T , temperature
Parameters:	x_i , mole fraction of component i in liquid phase
Method:	y_i , mole fraction of component i in vapor phase
	P , pressure
	Direct measurement of T , x_i , and y_i at constant P ; ref. 1

Author(s) Ortega, J. (Laboratorio de Termodinamica y Fisicoquimica, 35071-University of Las Palmas de G. C., Canary Islands, Spain)

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

SOURCE OF DATA

Ortega, J.; Pena, J. A.; de Alfonso, C. (Laboratorio de Termodinamica y Fisicoquimica, 35071-University of Las Palmas de G. C., Canary Islands, Spain); ref. 2

DIRECT EXPERIMENTAL VALUES

$P/kPa = 101.32$

x_1	T/K	y_1	x_1	T/K	y_1															
0.0000	394.00	0.0000	0.4842	357.40	0.7790															
0.0468	383.90	0.2900	0.5107	356.80	0.7913															
0.0698	381.60	0.3528	0.5402	356.30	0.8032															
0.0791	380.60	0.3745	0.5755	355.80	0.8167															
0.0921	379.10	0.4012	0.6248	355.10	0.8375															
0.1028	378.10	0.4216	0.6445	354.90	0.8456															
0.1132	376.80	0.4415	0.6744	354.50	0.8564															
0.1811	370.90	0.5545	0.7324	353.80	0.8775															
0.2122	368.90	0.5934	0.7775	353.40	0.8942															
0.2260	367.90	0.6090	0.8286	352.90	0.9160															
0.2468	366.70	0.6296	0.8738	352.50	0.9355															
0.2811	364.90	0.6597	0.9111	352.30	0.9532															
0.3132	363.30	0.6832	0.9359	352.10	0.9666															
0.3583	361.40	0.7125	0.9666	351.80	0.9849															
0.3766	360.70	0.7204	0.9771	351.60	0.9923															
0.4125	359.30	0.7425	1.0000	351.65	1.0000															
0.4397	358.60	0.7574																		

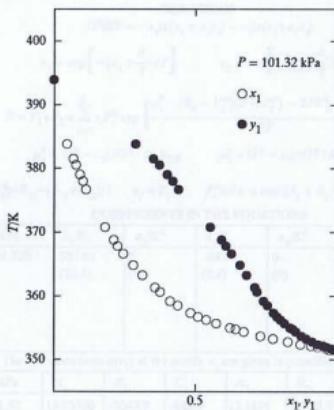
AUXILIARY INFORMATION

Apparatus: The apparatus was a glass ebulliometer employing continuous circulation of the liquid and vapor phases with a charge 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 Vakummett electronic instrument (Normschliff Geratebau Wertheim) and measured with a mercury manometer.

Procedure: Operation described in ref. 3. The equilibrium temperatures were measured with an accuracy of ± 0.1 K with a digital thermometer, Bailey Instruments, calibrated against IPTS-68. Compositions were determined by densimetric analysis, using a Anton Paar, Model DMA-55 vibrating-tube digital densimeter. Pressure was maintained constant to within 0.07 kPa.

Materials: 1. Fluka AG (Buchs, St. Gallen, Switzerland), purity > 99 mole %, degassed ultrasonically before use and stored in the dark for several days over molecular sieves type 4A (Fluka AG); $\rho(298.15\text{ K})/\text{kg} = 785.05$.
 2. Fluka AG (Buchs, St. Gallen, Switzerland), purity < 99 mole %, treated with calcium chloride, dried with potassium carbonate, and fractionally distd. through a 120-plate lab. column; degassed ultrasonically before use and stored in the dark for several days over molecular sieves type 4A (Fluka AG); $\rho(298.15\text{ K})/\text{kg} = 873.75$.

Errors: $|\delta T(\text{estd.})|/K = 0.1$; $|\delta P(\text{estd.})|/\text{kPa} = 300$; $| \delta x_1 | = 0.005$; $| \delta y_1 | = 0.03$.



REFERENCES

- Int. DATA Ser., Ser. A, Guideline 3k, 1994, 22(4).
- Ortega, J.; Pena, J. A.; de Alfonso, C. Rev. Latinoamer. Ing. Quim. Quim. Appl. 1987, 17, 195.
- Ortega, J.; Pena, J. A.; de Alfonso, C. J. Chem. Eng. Data 1986, 31, 339.

SELECTED DATA ON MIXTURES

International DATA Series*

3m. LIQUID-VAPOR EQUILIBRIUM

The Texas A&M University System, College Station, TX 77843-3111

Published by Thermodynamics Research Center

Components: 1. Ethanol, C_2H_5OH /64-17-5/
2. Ethyl butanoate, $C_6H_{12}O_2$ /105-54-4/

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

Variables: T , temperature

y_i , mole fraction of component i in vapor phase

x_i , mole fraction of component i in liquid phase

Parameters: P , pressure

Method: Calculation from direct experimental liquid-vapor equilibrium temperature, T_{exp} , data at variable x_i and constant P ; ref. 1

Author(s) Ortega, J. (Laboratorio de Termodinamica y Fisicoquimica, 35071 -University of Las Palmas de G. C., of table 3c Canary Islands, Spain)

Compiled by: Oracz, P. (Wydział Chemiczny, Uniwersytet Warszawski, ul. Pasteura 1, 02-093 Warszawa, Poland)

SOURCE OF DATA

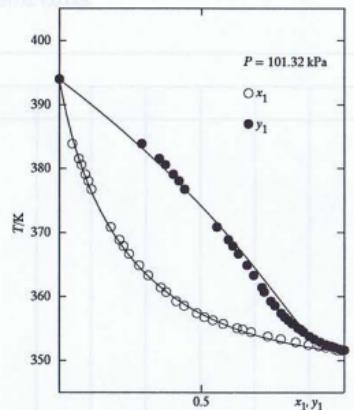
Ortega, J.; Pena, J. A.; de Alfonso, C. (Laboratorio de Termodinamica y Fisicoquimica, 35071 -University of Las Palmas de G. C., Canary Islands, Spain); FIRST PUBLISHED RESULTS

Notes: The table reports smoothed values of T and calcd. values of y_1

$P/kPa=101.32$		
x_1	T/K	y_1
0.00	394.00	0
0.05	384.48	0.2609
0.10	377.97	0.4167
0.15	373.15	0.5210
0.20	369.39	0.5961
0.25	366.38	0.6529
0.30	363.91	0.6975
0.40	360.13	0.7634
0.50	357.42	0.8103
0.60	355.45	0.8462
0.70	353.99	0.8762
0.75	353.41	0.8901
0.80	352.91	0.9043
0.85	352.47	0.9196
0.90	352.09	0.9376
0.95	351.79	0.9617
1.00	351.65	1

Std. dev. $\sigma(T)/K$, rel. std. dev. $100\sigma(\delta P/P)$, and abs. max. dev. $\delta_m(T)/K$

at $P/kPa = 101.32$ are resp.: 0.302, 1.001, 1.026.



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

AUXILIARY INFORMATION

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

Computations: The 33 T_{exp} data at 101.32 kPa were reduced using the modified Wilson eq., ref. 3, for the partial molar excess Gibbs energies μ_i^E .

Corrections: Vapor pressure equation parameters were taken from ref. 4 and parameters A_i were modified according to the experimental VLE data. 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 coeffs. B_{ij} (ref. 5) and the molar volumes under saturation pressure V_i^0 (ref. 6).

Errors: Std. dev. $\sigma(T) = [2(T-T_{exp})^2/(N-n-2)]^{1/2}$,
Rel. std. dev. $100\sigma(\delta P/P) = 100[\sum((P-P_{exp})/P_{exp})^2/(N-n-2)]^{1/2}$,
 N , no. of exp. points, ref. 2,
 n , no. of coefficients in the smoothing equation.

EQUATIONS

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

$$c_1 = \exp \left[-(a_1 + \frac{a_2}{T}) \right] \quad c_2 = \exp \left[-(a_3 + \frac{a_4}{T}) \right]$$

$$P = P_1 + P_2 - \sum_{i=1}^2 x_i P_i^0 \exp \left[\frac{\mu_i^E - (B_i - V_i^0)(P - P_i^0) - 2P B_{12}^E(1-y)^2}{RT} \right]$$

$$\mu_1^E = G^E - x_2 (\partial G^E / \partial x_2)_{T,P} \quad \mu_2^E = G^E - x_1 (\partial G^E / \partial x_1)_{T,P}$$

$$B_{12}^E = B_{12} - (B_{11} + B_{22})/2; \quad y_j = P_j/P; \quad P_i^0/kPa = \exp [A_i + B_i/(C_i + T/K)]$$

COEFFICIENTS IN THE EQUATIONS

P/kPa	a_1/K	a_2/K^2	a_3/K	a_4/K^2
101.320	539.95 (25.1)	0 (0)	-64.93 (9.1)	0 (0)

The std. deviations $\sigma(a_i)$ of the coeffs. a_i are given in parentheses.

P/kPa	A_1	B_1	C_1	A_2	B_2	C_2	
101.32	15.93376	-3247.7		-64.64	12.1636	-2121.97	-112.77

REFERENCES

- Int. DATA Ser., Ser. A, Guideline 3m, 1995, 23(2).
- Ortega, J. Int. DATA Ser., Ser. Data Mixtures, Ser. A 1995, 23, 92.
- Wilson, G. M. J. Am. Chem. Soc. 1964, 86, 127.
- TRC Thermodynamic Tables - Hydrocarbons & Non-Hydrocarbons, 1976, k-5000, 1978, k-5620, Thermodynamics Research Center, The Texas A&M University System, College Station, TX, USA.
- Tsonopoulos, C. AIChE J. 1974, 20, 263; 1975, 21, 827.
- Yen, L. C.; Woods, S. S. AIChE J. 1966, 12, 95.

SELECTED DATA ON MIXTURES

International DATA Series*

3k. LIQUID-VAPOR EQUILIBRIUM

Published by Thermodynamics Research Center

The Texas A&M University System, College Station, TX 77843-3111

Components:	1. Ethanol, C ₂ H ₆ O [64-17-5] 2. Propyl metanoate, C ₄ H ₈ O ₂ [110-74-7]
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:	Direct measurement of T, x _i , and y _i at constant P; ref. 1

Author(s) Ortega, J. (Laboratorio de Termodinamica y Fisicoquimica, 35071 -University of Las Palmas de G. C., Canary Islands, Spain)

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

SOURCE OF DATA

Galvan, S.; Ortega, J.; Susial, P.; Pena, J. A. (Laboratorio de Termodinamica y Fisicoquimica, 35071 -University of Las Palmas de G. C., Canary Islands, Spain); ref. 2

DIRECT EXPERIMENTAL VALUES

P/kPa = 101.32						
x ₁	T/K	y ₁	x ₁	T/K	y ₁	
0.0000	353.79	0.0000	0.6418	345.31	0.5839	
0.0533	351.65	0.1079	0.6921	345.49	0.6152	
0.0567	351.47	0.1140	0.7165	345.65	0.6317	
0.0732	350.87	0.1424	0.7634	345.97	0.6662	
0.0785	350.68	0.1512	0.7891	346.23	0.6862	
0.1392	348.70	0.2458	0.8131	346.45	0.7081	
0.1653	348.10	0.2750	0.8369	346.78	0.7333	
0.2426	346.75	0.3516	0.8549	347.10	0.7520	
0.3272	345.90	0.4113	0.8885	347.66	0.7917	
0.3675	345.63	0.4361	0.9038	347.95	0.8129	
0.4185	345.36	0.4647	0.9261	348.50	0.8485	
0.4604	345.24	0.4879	0.9464	349.08	0.8858	
0.5016	345.15	0.5096	0.9561	349.37	0.9027	
0.5464	345.13	0.5331	0.9686	349.67	0.9221	
0.5832	345.17	0.5533	1.0000	351.13	1.0000	

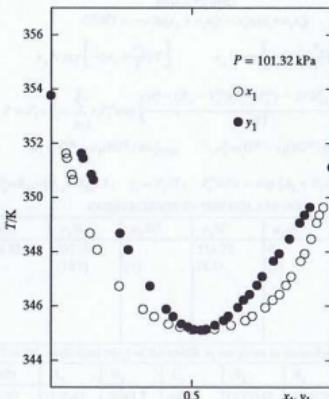
AUXILIARY INFORMATION

Apparatus: The apparatus was a glass ebulliometer employing continuous circulation of the liquid and vapor phases with a charge 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 vacuum pump and the pressure controlled by a Vakumat electronic instrument (Normschiff Geratebau Wertheim) and measured with a mercury manometer.

Procedure: Operation described in ref. 3. The equilibrium temperatures were measured with an accuracy of ± 0.01 K with a digital thermometer, Comark, Model 6900, calibrated against ITS-90. Compositions were determined by densimetric analysis, using an Anton Paar, Model DMA-55 vibrating-tube digital densimeter. Pressure was maintained constant to within 0.02 kPa, indicated by an electronic pressure gauge (MKS Baratron).

Materials: 1. Fluka AG (Buchs, St. Gallen, Switzerland), "puriss p.a." grade material, purity > 99.8 mole %, degassed ultrasonically before use and stored in the dark for several days over molecular sieves type 3A (Fluka AG); n_D 298.15 K = 1.3594, ρ (298.15 K)/kg·m⁻³ = 784.94.
2. Aldrich Chemicals Co., Inc. (Milwaukee, WI, USA), highest commercial purity grade material, degassed ultrasonically before use and stored in the dark for several days over molecular sieves type 3A (Fluka AG); n_D 298.15 K = 1.3747, ρ (298.15 K)/kg·m⁻³ = 899.22.

Errors: | δT (estd.)|/K = 0.02; | δP (estd.)|/Pa = 20; | δx_1 | = 0.003; | δy_1 | = 0.01.



Points, direct experimental T values.

REFERENCES

- Int. DATA Ser., Ser. A, Guideline 3k, 1994, 22(4).
- Galvan, S.; Ortega, J.; Susial, P.; Pena, J. A. J. Chem. Eng. Jpn. 1994, 27, 529.
- Ortega, J.; Pena, J. A.; de Alfonso, C. J. Chem. Eng. Data 1986, 31, 339.

SELECTED DATA ON MIXTURES

International DATA Series*

3m. LIQUID-VAPOR EQUILIBRIUM

The Texas A&M University System, College Station, TX 77843-3111

Published by Thermodynamics Research Center

Components: 1. Ethanol, C_2H_5OH [64-17-5]2. Propyl methanoate, $C_4H_9CO_2$ [110-74-7]

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

Variables: T , temperature y_i , mole fraction of component i in vapor phase x_i , mole fraction of component i in liquid phase P , pressureParameters: Method: Calculation from direct experimental liquid-vapor equilibrium temperature, T_{exp} data at variable x_i and constant P ; ref. 1

Author(s) Ortega, J. (Laboratorio de Termodinamica y Fisicoquimica, 35071-University of Las Palmas de G. C., Canary Islands, Spain)

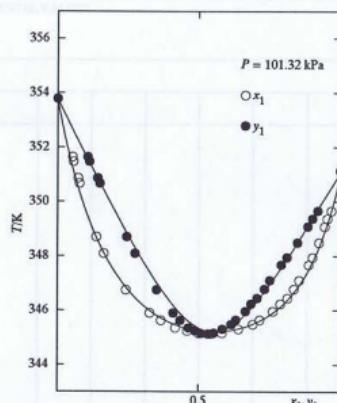
Compiled by: Oracz, P. (Wydział Chemii, Uniwersytet Warszawski, ul. Pasteura 1, 02-093 Warszawa, Poland)

SOURCE OF DATA

Galvan, S.; Ortega, J.; Susial, P.; Pena, J. A. (Laboratorio de Termodinamica y Fisicoquimica, 35071-University of Las Palmas de G. C., Canary Islands, Spain); FIRST PUBLISHED RESULTS

Notes: The table reports smoothed values of T and calcd. values of y_1

x_1	$P/kPa = 101.32$					
	T/K	y_1				
0.00	353.79	0				
0.05	351.43	0.1153				
0.10	349.72	0.2014				
0.15	348.45	0.2686				
0.20	347.50	0.3229				
0.25	346.79	0.3681				
0.30	346.25	0.4067				
0.40	345.58	0.4709				
0.50	345.28	0.5251				
0.60	345.28	0.5760				
0.70	345.57	0.6307				
0.75	345.86	0.6622				
0.80	346.28	0.6991				
0.85	346.90	0.7442				
0.90	347.79	0.8025				
0.95	349.12	0.8825				
1.00	351.13	1				

Std. dev. of \bar{T} , rel. std. dev. 100($\delta\bar{T}/\bar{T}$), and abs. max. dev. $\delta_m(\bar{T})/K$
at $P/kPa = 101.32$ are resp.: 0.143, 0.499, 0.337.Points, direct experimental T values, curves, $T(x_1)$ and $T(y_1)$, calculated from the equations.

AUXILIARY INFORMATION

Measurements: The T_{exp} data at 101.32 kPa are reported in ref. 2.Computations: The 30 T_{exp} data at 101.32 kPa were reduced using the modified Wilson eq., ref. 3, for the partial molar excess Gibbs energies μ_i^E .Corrections: Vapor pressure equation parameters were taken from ref. 4 and parameters A_i were modified according to the experimental VLE data. 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 coeff. B_{ij}^E (ref. 5) and the molar volumes under saturation pressure V_i^0 (ref. 6).Errors: Std. dev. $\sigma(T) = [\sum(T - T_{exp})^2/(N-n-2)]^{1/2}$,
Rel. std. dev. 100($\delta\bar{T}/\bar{T}$) = $100[\sum((P - P_{exp})/P_{exp})^2/(N-n-2)]^{1/2}$,
 N , no. of exp. points, ref. 2,
 n , no. of coefficients in the smoothing equation.

$$\text{EQUATIONS}$$

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

$$c_1 = \exp \left[-(a_1 + \frac{a_2}{T})T \right] \quad c_2 = \exp \left[-(a_3 + \frac{a_4}{T})T \right]$$

$$P = P_1 + P_2 = \sum_{i=1}^2 x_i P_i^0 \exp \left[\frac{[A_i^E - (B_{ii} - V_i^0)(P - P_i^0) - 2PB_{12}^E(1-y)]^2}{RT} \right]$$

$$\mu_i^E = G^E - x_i (\partial G^E / \partial x_i)_{T,P} \quad \mu_2^E = G^E - x_1 (\partial G^E / \partial x_1)_{T,P}$$

$$B_{12}^E = B_{12} - (B_{11} + B_{22})/2; \quad y_1 = P_1/P; \quad P_i^0/kPa = \exp [A_i + B_i/(C_i + T/K)]$$

COEFFICIENTS IN THE EQUATIONS

P/kPa	a_1/K	a_2/K^2	a_3/K	a_4/K^2
101.32	311.29 (10.5)	0 (0)	118.27 (8.1)	0 (0)

The std. deviations $\sigma(a_i)$ of the coeffs. a_i are given in parentheses.

P/kPa	A_1	B_1	C_1	A_2	B_2	C_2
101.32	15.9543	-3247.7	-64.64	13.77542	-2607.22	-69.07

REFERENCES

- Int. DATA Ser., Ser. A, Guideline 3m, 1995, 23(2).
- Ortega, J. Int. DATA Ser., Ser. Data Mixtures, Ser. A 1995, 23, 94.
- Wilson, G. M. J. Am. Chem. Soc. 1964, 86, 127.
- IR Thermodynamic Tables - Hydrocarbons & Non-Hydrocarbons, 1976, k-5000, 1969, k-5520, Thermodynamics Research Center, The Texas A&M University System, College Station, TX, USA.
- Tsonopoulos, C. AIChE J. 1974, 20, 263; 1975, 21, 827.
- Yen, L. C.; Woods, S. S. AIChE J. 1966, 12, 95.

SELECTED DATA ON MIXTURES

International DATA Series*

3k. LIQUID-VAPOR EQUILIBRIUM

Published by Thermodynamics Research Center

The Texas A&M University System, College Station, TX 77843-3111

Components: 1. Ethanol, C₂H₅O [64-17-5]2. Propyl ethanoate, C₃H₁₀O₂ [109-60-4]

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 Termodinamica y Fisicoquimica, 35071 - University of Las Palmas de G. C., Canary Islands, Spain)

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

SOURCE OF DATA

Ortega, J.; Ocon, J.; Pena, J. A.; de Alfonso, C.; Paz-Andrade, M. I.; Fernandez, J. (Laboratorio de Termodinamica y Fisicoquimica, 35071 - University of Las Palmas de G. C., Canary Islands, Spain); ref. 2

DIRECT EXPERIMENTAL VALUES

 $P/kPa = 101.32$

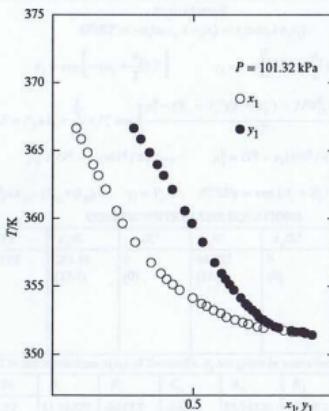
x_1	T/K	y_1	x_1	T/K	y_1								
0.0842	366.70	0.2885	0.5294	353.80	0.6869								
0.1016	365.90	0.3143	0.5479	353.60	0.6959								
0.1239	364.90	0.3444	0.5717	353.30	0.7102								
0.1452	364.00	0.3726	0.5984	353.10	0.7239								
0.1626	363.20	0.3947	0.6184	352.80	0.7340								
0.1892	362.20	0.4269	0.6497	352.60	0.7499								
0.2270	360.60	0.4710	0.6771	352.40	0.7623								
0.2499	359.70	0.4950	0.6963	352.30	0.7723								
0.2938	358.30	0.5340	0.7292	352.10	0.7909								
0.3506	356.80	0.5772	0.7505	352.00	0.8043								
0.3854	356.00	0.6017	0.8235	351.80	0.8486								
0.4061	355.60	0.6158	0.8502	351.70	0.8665								
0.4274	355.20	0.6297	0.8839	351.70	0.8907								
0.4530	354.80	0.6450	0.8986	351.60	0.9017								
0.4983	354.20	0.6699	0.9228	351.50	0.9224								

AUXILIARY INFORMATION

Apparatus: The apparatus was a glass ebulliometer employing continuous circulation of the liquid and vapor phases with a charge 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 vacuum pump and the pressure controlled by a Vakumat electronic instrument (Normschliff Gerätebau Wertheim) and measured with a mercury manometer.

Procedure: Operation described in ref. 3. The equilibrium temperatures were measured with an accuracy of ± 0.1 K with a digital thermometer, Bailey Instruments, calibrated against IPTS-68. Compositions were determined by densimetric analysis, using a Anton Paar, Model DMA-55 vibrating-tube digital densimeter. Pressure was maintained constant to within 0.07 kPa.

Materials: 1. Fluka AG (Buchs, St. Gallen, Switzerland), "puriss p.a." grade material, purity > 99.8 mole %, degassed ultrasonically before use and stored in the dark for several days over molecular sieves type 4A (Fluka AG); $\rho(298.15\text{ K})/\text{kg m}^{-3} = 880.97$.
 2. Fluka AG (Buchs, St. Gallen, Switzerland), purity > 95 mole %, washed with sodium carbonate, treated with calcium chloride, dried with potassium carbonate, and fractionally, distd. through a 120-plate lab. column; degassed ultrasonically before use and stored in the dark for several days over molecular sieves type 4A (Fluka AG); $\rho(298.15\text{ K})/\text{kg m}^{-3} = 883.91$.

Errors: $|\delta T(\text{estd.})|/K = 0.1$; $|\delta P(\text{estd.})|/P\text{a} = 70$; $|\delta x_1| = 0.003$; $|\delta y_1| = 0.02$.Points, direct experimental T values.

REFERENCES

- Int. DATA Ser., Ser. A, Guideline 3k, 1994, 22(4).
- Ortega, J.; Ocon, J.; Pena, J. A.; de Alfonso, C.; Paz-Andrade, M. I.; Fernandez, J. Can. J. Chem. Eng. 1987, 65, 982.
- Ortega, J.; Pena, J. A.; de Alfonso, C. J. Chem. Eng. Data 1986, 31, 339.

SELECTED DATA ON MIXTURES

International DATA Series*

3m. LIQUID-VAPOR EQUILIBRIUM

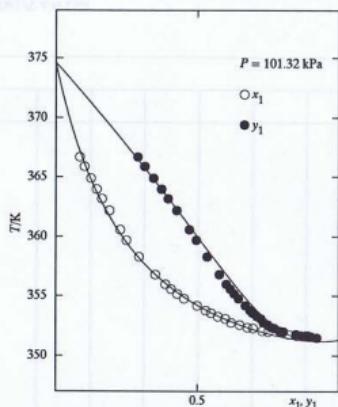
The Texas A&M University System, College Station, TX 77843-3111

Published by Thermodynamics Research Center

Components:	1. Ethanol, C_2H_5OH [64-17-5] 2. Propyl ethanoate, $C_3H_10O_2$ [109-60-4]	Author(s): Ortega, J. (Laboratorio de Termodinamica y Fisicoquimica, 35071 -University of Las Palmas de G. C., of table 3c: Canary Islands, Spain)
State:	Binary system, single-phase liquid in equilibrium with vapor; pure components, both liquid in equilibrium with vapor	Compiled by: Oracz, P. (Wydział Chemiczny, Uniwersytet Warszawski, ul. Pasteura 1, 02-093 Warszawa, Poland)
Variables:	T , temperature y_i , mole fraction of component i in vapor phase x_i , mole fraction of component i in liquid phase	SOURCE OF DATA
Parameters:	P , pressure	Ortega, J.; Ocon, J.; Pena, J. A.; de Alfonso, C.; Paz-Andrade, M. I.; Fernandez, J. (Laboratorio de Termodinamica y Fisicoquimica, 35071 -University of Las Palmas de G. C., Canary Islands, Spain); FIRST PUBLISHED RESULTS
Method:	Calculation from direct experimental liquid-vapor equilibrium temperature, T_{exp} data at variable x_i and constant P ; ref. 1	

Notes: The table reports smoothed values of T and calcd. values of y_1

x_1	$P/kPa=101.32$							
	T/K	y_1						
0.00	374.64	0						
0.05	369.85	0.1749						
0.10	366.28	0.2971						
0.15	363.52	0.3876						
0.20	361.33	0.4577						
0.25	359.56	0.5139						
0.30	358.10	0.5605						
0.40	355.88	0.6342						
0.50	354.29	0.6924						
0.60	353.13	0.7428						
0.70	352.27	0.7909						
0.75	351.93	0.8160						
0.80	351.66	0.8428						
0.85	351.45	0.8726						
0.90	351.32	0.9069						
0.95	351.30	0.9481						
1.00	351.43	1						

Std. dev. $\sigma(T)/K$, rel. std. dev. $100\sigma(\delta P/P)$, and abs. max. dev. $\delta_m(T)/K$ at $P/kPa = 101.32$ are resp.: 0.216, 0.761, 0.697.Points, direct experimental T values, curves, $T(x_1)$ and $T(y_1)$, calculated from the equations.

AUXILIARY INFORMATION

Measurements: The T_{exp} data at 101.32 kPa are reported in ref. 2.Computations: The 31 T_{exp} data at 101.32 kPa were reduced using the modified Wilson eq., ref. 3, for the partial molar excess Gibbs energies μ_i^E .Corrections: Vapor pressure equation parameters were taken from ref. 4 and parameters A_i were modified according to the experimental VLE data. 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 coeffs. B_{ij} (ref. 5) and the molar volumes under saturation pressure V_i^0 (ref. 6).Errors: Std. dev. $\sigma(T) = [\Sigma(T-T_{exp})^2/(N-n)]^{1/2}$,
Rel. std. dev. $100\sigma(\delta P/P) = 100[\Sigma((P-P_{exp})/P_{exp})^2/(N-n)]^{1/2}/P$,
 N , no. of exp. points, ref. 2,
 n , no. of coefficients in the smoothing equation.

EQUATIONS

$$GE/PRT = -x_1 \ln(x_1 + c_2 x_2) - x_2 \ln(x_2 + c_1 x_1)$$

$$c_1 = \exp \left[-(a_1 + \frac{a_2}{T})/T \right] \quad c_2 = \exp \left[-(a_3 + \frac{a_4}{T})/T \right]$$

$$P = P_1 + P_2 = \sum_{i=1}^2 x_i P_i^0 \exp \left[\frac{\mu_i^E - (B_{ii} - V_i^0)(P - P_i^0) - 2PB_{12}^E(1-y_i)^2}{RT} \right]$$

$$\mu_i^E = G^E - x_2 \partial G^E / \partial x_2 |_{T,P} \quad \mu_2^E = G^E - x_1 \partial G^E / \partial x_1 |_{T,P}$$

$$B_{12}^E = B_{12} - (B_{11} + B_{22})/2; \quad y_i = P_i/P; \quad P_i^0/kPa = \exp [A_i + B_i/(C_i + T/K)]$$

COEFFICIENTS IN THE EQUATIONS

P/kPa	a_1/K	a_2/K^2	a_3/K	a_4/K^2
101.32	281.41 (17.5)	0 (0)	48.952 (12.3)	0 (0)

The std. deviations $\sigma(a_i)$ of the coeffs. a_i are given in parantheses.

P/kPa	A_1	B_1	C_1	A_2	B_2	C_2
101.32	15.94229	-3247.7	-64.64	13.94326	-2840.15	-70.07

REFERENCES

- Int. DATA Ser., Ser. A, Guideline 3m, 1995, 23(2).
- Ortega, J. Int. DATA Ser., Sel. Data Mixtures, Ser. A 1995, 23, 96.
- Wilson, G. M. J. Am. Chem. Soc. 1964, 86, 127.
- TRC Thermodynamic Tables - Hydrocarbons & Non-Hydrocarbons, k-5000, 1969, k-5550, Thermodynamics Research Center, The Texas A&M University System, College Station, TX, USA.
- Tsonopoulos, C. AIChE J. 1974, 20, 263; 1975, 21, 827.
- Yen, L. C.; Woods, S. S. AIChE J. 1964, 12, 95.

SELECTED DATA ON MIXTURES

International DATA Series*

3k. LIQUID-VAPOR EQUILIBRIUM

The Texas A&M University System, College Station, TX 77843-3111

Published by Thermodynamics Research Center

Components:	1. Ethanol, C_2H_5O [64-17-5] 2. Propyl propanoate, $C_6H_{12}O_2$ [106-36-5]	Author(s):	Ortega, J. (Laboratorio de Termodinamica y Fisicoquimica, 35071 -University of Las Palmas de G. C., Canary Islands, Spain)
State:	Binary system, single-phase liquid in equilibrium with vapor; pure components, both liquid in equilibrium with vapor	Edited by:	Mączyński, A. (Instytut Chemii Fizycznej, Polska Akademia Nauk, ul. Kasprzaka 44/52, 01-224 Warszawa, Poland)
Variables:	T , temperature x_i , mole fraction of component i in liquid phase y_i , mole fraction of component i in vapor phase		SOURCE OF DATA
Parameters:	P , pressure		Ortega, J.; Galvan, S. (Laboratorio de Termodinamica y Fisicoquimica, 35071 -University of Las Palmas de G. C., Canary Islands, Spain); ref. 1
Method:	Direct measurement of T , x_i , and y_i at constant P ; ref. 1		

DIRECT EXPERIMENTAL VALUES

$P/kPa = 101.32$					
x_1	T/K	y_1	x_1	T/K	y_1
0.0000	395.65	0.0000	0.6109	356.30	0.8480
0.0100	393.42	0.0431	0.6437	355.63	0.8597
0.0445	387.57	0.2275	0.6757	355.13	0.8697
0.0864	381.58	0.3902	0.7102	354.61	0.8808
0.1372	374.65	0.5369	0.7480	354.10	0.8919
0.2077	368.90	0.6396	0.7940	353.61	0.9040
0.2719	365.25	0.6996	0.8263	353.10	0.9184
0.3134	363.57	0.7267	0.8574	352.71	0.9302
0.3580	362.07	0.7524	0.8859	352.37	0.9423
0.4015	360.57	0.7739	0.9102	352.13	0.9527
0.4542	359.21	0.7952	0.9348	351.86	0.9648
0.4835	358.70	0.8058	0.9583	351.63	0.9773
0.5009	358.31	0.8118	0.9813	351.40	0.9903
0.5333	357.60	0.8223	1.0000	351.13	1.0000

AUXILIARY INFORMATION

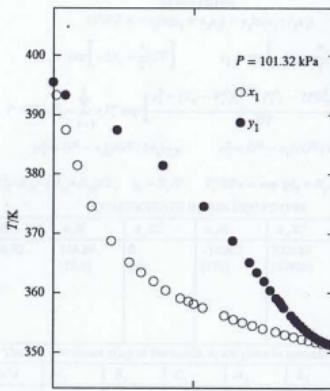
Apparatus: The apparatus was a glass ebulliometer employing continuous circulation of the liquid and vapor phases with a charge capacity of approx. 50 cm^3 , ref. 3. Turbulent mixing of the phases enabled equilibrium to be reached in a relatively short time. The ebulliometer was connected to vacuum pump and the pressure controlled by a Vakuumat electronic instrument (Normschiff Geratebau Wertheim) and measured with a mercury manometer.

Procedure: Operation described in ref. 3. The equilibrium temperatures were measured with an accuracy of $\pm 0.01\text{ K}$ with a digital thermometer, Comark, Model 6900, calibrated against ITS-90. Compositions were determined by densimetric analysis, using an Anton Paar, Model DMA-55 vibrating-tube digital densimeter having a precision of $\pm 0.02\text{ kg m}^{-3}$. Pressure was maintained constant to within 0.02 kPa, indicated by an electronic pressure gauge (MKS Baratron).

Materials: 1. Fluka AG (Buchs, St. Gallen, Switzerland), "puriss p.a." grade material, purity > 99.8 mole %, degassed ultrasonically before use and stored in the dark for several days over molecular sieves type 3A (Fluka AG); $n(D, 298.15\text{ K}) = 1.3594$, $\rho(298.15\text{ K})/\text{kg m}^{-3} = 784.94$.

2. Fluka AG (Buchs, St. Gallen, Switzerland), "puriss p.a." grade material, purity > 99 mole %, degassed ultrasonically before use and stored in the dark for several days over molecular sieves type 3A (Fluka AG); $n(D, 298.15\text{ K}) = 1.3918$, $\rho(298.15\text{ K})/\text{kg m}^{-3} = 785.65$.

Errors: $| \delta T(\text{estd.}) | / K = 0.01$; $| \delta P(\text{estd.}) | / \text{Pa} = 20$; $| \delta x_1 | = 0.005$; $| \delta y_1 | = 0.007$.

Points, direct experimental T values.

REFERENCES

- Int. DATA Ser., Ser. A, Guideline 3k, 1994, 22(4).
- Ortega, J.; Galvan, S. J. Chem. Eng. Data 1994, 39, 907.
- Ortega, J.; Pena, J. A.; de Alfonso, C. J. Chem. Eng. Data 1986, 31, 339.

SELECTED DATA ON MIXTURES

International DATA Series*

3m. LIQUID-VAPOR EQUILIBRIUM

The Texas A&M University System, College Station, TX 77843-3111

Published by Thermodynamics Research Center

Components: 1. Ethanol, C_2H_5O /64-17-5
2. Propyl propanoate, $C_6H_{12}O_2$ /106-36-5

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

Variables: T , temperature

y_i , mole fraction of component i in vapor phase

x_i , mole fraction of component i in liquid phase

Parameters: P , pressure

Method: Calculation from direct experimental liquid-vapor equilibrium temperature, T_{exp} , data at variable x_i and constant P ; ref. 1

Author(s) Ortega, J. (Laboratorio de Termodinamica y Fisicoquimica, 35071 - University of Las Palmas de G. C., of table 3c: Canary Islands, Spain)

Compiled by: Oracz, P. (Wydział Chemiczny, Uniwersytet Warszawski, ul. Pasteura 1, 02-093 Warszawa, Poland)

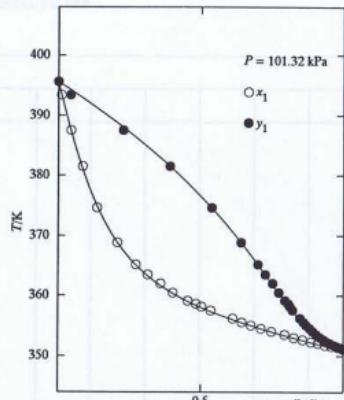
SOURCE OF DATA

Ortega, J.; Galvan, S. (Laboratorio de Termodinamica y Fisicoquimica, 35071 - University of Las Palmas de G. C., Canary Islands, Spain); FIRST PUBLISHED RESULTS

Notes: The table reports smoothed values of T and calcd. values of y_1

	$P/kPa = 101.32$						
x_1	T/K	y_1					
0.00	395.5	0					
0.05	386.69	0.2654					
0.10	379.36	0.4413					
0.15	373.74	0.5550					
0.20	369.54	0.6297					
0.25	366.40	0.6812					
0.30	364.01	0.7187					
0.40	360.61	0.7708					
0.50	358.25	0.8084					
0.60	356.42	0.8406					
0.70	354.88	0.8722					
0.75	354.18	0.8889					
0.80	353.51	0.9067					
0.85	352.87	0.9262					
0.90	352.26	0.9478					
0.95	351.68	0.9722					
1.00	351.13	1					

Std. dev. of $\sigma(T)/K$, rel. std. dev. $100\sigma(\delta P/P)$, and abs. max. dev. $\delta_m(T)/K$
at $P/kPa = 101.32$ are resp.: 0.134, 0.45, 0.328.



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

AUXILIARY INFORMATION

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 eq., ref. 3, for the partial molar excess Gibbs energies μ_i^E .

Corrections: Vapor pressure equation parameters were taken from ref. 4 and parameters A_i were modified according to the experimental VLE data. 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. 5) and the molar volumes under saturation pressure V_i^0 (ref. 6).

Errors: Std. dev. of $\sigma(T) = [2(T - T_{exp})^2/(N-n-2)]^{1/2}$,
Rel. std. dev. $100\sigma(\delta P/P) = 100[\sum((P - P_{exp})/P_{exp})^2/(N-n-2)]^{1/2}$,
 N , no. of exp. points, ref. 2,
 n , no. of coefficients in the smoothing equation.

EQUATIONS

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

$$c_1 = \exp \left[-(a_1 + \frac{a_2}{T})/T \right]$$

$$c_2 = \exp \left[-(a_1 + \frac{a_2}{T})/T \right]$$

$$P = P_1 + P_2 = \sum_{i=1}^2 x_i P_i^0 \exp \left[\frac{\mu_i^E - (B_{ii} - V_i^0)(P - P_i^0) - 2PB_{12}^E(1-y)^2}{RT} \right]$$

$$\mu_1^E = G^E - x_2 (\partial G^E / \partial x_2)_{T,P} \quad \mu_2^E = G^E - x_1 (\partial G^E / \partial x_1)_{T,P}$$

$$B_{12}^E = B_{12} - (B_{11} + B_{22})/2; \quad y_i = P_i/P; \quad P_i^0/kPa = \exp [A_i + B_i / (C_i + T/K)]$$

COEFFICIENTS IN THE EQUATIONS

P/kPa	a_1/K	a_2/K^2	a_3/K	a_4/K^2	
101.32	145.89 (13.1)	0 (0)	-1808.7 (171)	732440 (67900)	

The std. deviations $\sigma(a_i)$ of the coeffs. a_i are given in parentheses.

P/kPa	A_1	B_1	C_1	A_2	B_2	C_2
101.32	15.9543	-3247.7	-64.64	14.84882	-3558.18	-47.85

REFERENCES

- Int. DATA Ser., Ser. A, Guideline 3m, 1995, 23(2).
- Ortega, J. Int. DATA Ser., Sel. Data Mixtures, Ser. A 1995, 23, 98.
- Wilson, G. M. J. Am. Chem. Soc. 1964, 86, 127.
- TRC Thermodynamic Tables - Hydrocarbons & Non-Hydrocarbons, 1976, k-5000, 1969, k-5580. Thermodynamics Research Center, The Texas A&M University System, College Station, TX, USA.
- Tsonopoulos, C. AIChE J. 1974, 20, 263; 1975, 21, 827.
- Yen, L. C.; Woods, S. S. AIChE J. 1966, 12, 95.

SELECTED DATA ON MIXTURES

International DATA Series*

3k. LIQUID-VAPOR EQUILIBRIUM

Published by Thermodynamics Research Center

The Texas A&M University System, College Station, TX 77843-3111

Components: 1. Ethanol, C_2H_5O [64-17-5]
 2. Propyl butanoate, $C_7H_{14}O_2$ [105-66-8]

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 Termodinamica y Fisicoquimica, 35071 -University of Las Palmas de G. C., Canary Islands, Spain)

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

SOURCE OF DATA

Ortega, J.; Galvan, S. (Laboratorio de Termodinamica y Fisicoquimica, 35071 -University of Las Palmas de G. C., Canary Islands, Spain); ref. 2

DIRECT EXPERIMENTAL VALUES

 $P/kPa = 101.32$

x_1	T/K	y_1	x_1	T/K	y_1								
0.0000	416.65	0.0000	0.4690	361.55	0.8898								
0.0036	415.85	0.0347	0.4839	360.88	0.8951								
0.0286	410.67	0.1991	0.5240	359.88	0.9041								
0.0481	405.22	0.3196	0.5621	359.05	0.9123								
0.0720	397.09	0.4625	0.5998	358.22	0.9204								
0.0949	391.95	0.5574	0.6313	357.85	0.9250								
0.1282	385.45	0.6512	0.6636	356.93	0.9330								
0.1464	382.50	0.6892	0.7229	355.84	0.9447								
0.1733	378.50	0.7298	0.7517	355.39	0.9504								
0.1987	376.25	0.7588	0.7785	354.98	0.9554								
0.2265	373.55	0.7833	0.8030	354.53	0.9624								
0.2796	370.15	0.8188	0.8329	354.08	0.9676								
0.3291	367.45	0.8445	0.8695	353.58	0.9751								
0.3791	364.35	0.8682	0.9069	353.11	0.9826								
0.4254	362.75	0.8806	0.9406	352.35	0.9891								
0.4540	361.88	0.8871	1.0000	351.13	1.0000								

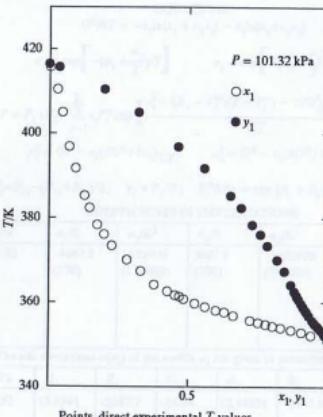
AUXILIARY INFORMATION

Apparatus: The apparatus was a glass ebulliometer employing continuous circulation of the liquid and vapor phases with a charge capacity of approx. 50 cm^3 , ref. 3. Turbulent mixing of the phases enabled equilibrium to be reached in a relatively short time. The ebulliometer was connected to vacuum pump and the pressure controlled by a Vakuumat electronic instrument (Normschliff Geratebau Wertheim) and measured with a mercury manometer.

Procedure: Operation described in ref. 3. The equilibrium temperatures were measured with an accuracy of $\pm 0.01\text{ K}$ with a digital thermometer, Comark, Model 6900, calibrated against ITS-90. Compositions were determined by densimetric analysis, using an Anton Paar, Model DMA-55 vibrating-tube digital densimeter. Pressure was maintained constant to within 0.02 kPa , indicated by an electronic pressure gauge (MKS Baratron).

Materials: 1. Fluka AG (Buchs, St. Gallen, Switzerland), "puriss p.a." grade material, purity > 99.8 mole %, degassed ultrasonically before use and stored in the dark for several days over molecular sieves type 3A (Fluka AG); $n(D, 298.15\text{ K}) = 1.3594$, $\rho(298.15\text{ K})/\text{kg m}^{-3} = 784.94$.
 2. Fluka AG (Buchs, St. Gallen, Switzerland), "purum" grade material, purity > 99 mole %, degassed ultrasonically before use and stored in the dark for several days over molecular sieves type 3A (Fluka AG); $n(D, 298.15\text{ K}) = 1.3976$, $\rho(298.15\text{ K})/\text{kg m}^{-3} = 868.07$.

Errors: $|\delta T(\text{estd.})|/K = 0.02$; $|\delta P(\text{estd.})|/\text{Pa} = 20$; $|\delta x_1| = 0.003$; $|\delta y_1| = 0.02$.

Points, direct experimental T values.

REFERENCES

- Int. DATA Ser., Ser. A, Guideline 3k, 1994, 22(4).
- Ortega, J.; Galvan, S. J. Chem. Eng. Data in press.
- Ortega, J.; Pena, J. A.; de Alfonso, C. J. Chem. Eng. Data 1986, 31, 339.

SELECTED DATA ON MIXTURES

International DATA Series*

3m. LIQUID-VAPOR EQUILIBRIUM

The Texas A&M University System, College Station, TX 77843-3111

Published by Thermodynamics Research Center

Components: 1. Ethanol, C_2H_5O [64-17-5]
 2. Propyl butanoate, $C_9H_{14}O_2$ [105-66-8]

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

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

Parameters: P , pressure

Method: Calculation from direct experimental liquid-vapor equilibrium temperature, T_{exp} , data at variable x_i and constant P ; ref. 1

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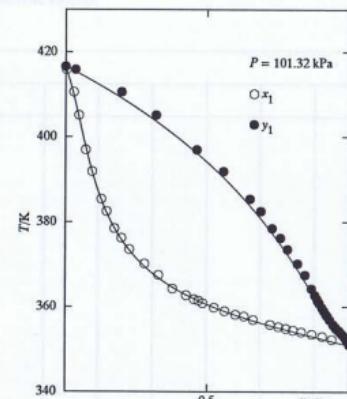
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SOURCE OF DATA

Ortega, J.; Galvan, S. (Laboratorio de Termodinamica y Fisicoquimica, 35071 - University of Las Palmas de G. C., Canary Islands, Spain); FIRST PUBLISHED RESULTS

Notes: The table reports smoothed values of T and calcd. values of y_1

x_1	T/K	y_1				
0.00	416.65	0				
0.05	404.33	0.3082				
0.10	390.94	0.5500				
0.15	381.83	0.6764				
0.20	375.87	0.7460				
0.25	371.66	0.7899				
0.30	368.49	0.8207				
0.40	363.94	0.8621				
0.50	360.74	0.8903				
0.60	358.27	0.9123				
0.70	356.25	0.9315				
0.75	355.33	0.9408				
0.80	354.46	0.9503				
0.85	353.62	0.9603				
0.90	352.79	0.9714				
0.95	351.97	0.9843				
1.00	351.13	1				

Std. dev. of δT , rel. std. dev. 100($\delta P/P$), and abs. max. dev. $\delta_m(T)/K$ at $P/kPa = 101.32$ are resp.: 0.236, 0.835, 0.409.Points, direct experimental T values, curves, $T(x_1)$ and $T(y_1)$, calculated from the equations.

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 eq., ref. 3, for the partial molar excess Gibbs energies μ_i^E .Corrections: Vapor pressure equation parameters were taken from ref. 4 and parameters A_i were modified according to the experimental VLE data. 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 coeffs. B_{ij} (ref. 5) and the molar volumes under saturation pressure V_i^∞ (ref. 6).Errors: Std. dev. $\sigma(T) = [\Sigma(T - T_{exp})^2/(N-n-2)]^{1/2}$,
 Rel. std. dev. 100($\delta P/P$) = $100[\Sigma((P - P_{exp})/P_{exp})^2/(N-n-2)]^{1/2}$,
 N , no. of exp. points, ref. 2,
 n , no. of coefficients in the smoothing equation.

EQUATIONS

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

$$c_1 = \exp \left[-\left(a_1 + \frac{a_2}{T} \right) \right] \quad c_2 = \exp \left[-\left(a_3 + \frac{a_4}{T} \right) \right]$$

$$P = P_1 + P_2 = \sum_{i=1}^2 x_i P_i^0 \exp \left[\frac{\mu_i^E - (B_{ii} - V_i^0)(P - P_i^0) - 2PB_{12}^E(1-y)^2}{RT} \right]$$

$$\mu_i^E = G^E - x_2 (\partial G^E / \partial x_2)_{T,P} \quad \mu_2^E = G^E - x_1 (\partial G^E / \partial x_1)_{T,P}$$

$$B_{12}^E = B_{12} - (B_{11} + B_{22})/2; \quad y_i = P_i/P; \quad P_i^0/kPa = \exp[A_i + B_i/(C_i + T/K)]$$

COEFFICIENTS IN THE EQUATIONS

P/kPa	a_1/K	a_2/K^2	a_3/K	a_4/K^2
101.32	-4467.1 (378)	1675900 (156000)	3887.8 (530)	-1332100 (213000)

The std. deviations $\sigma(a_i)$ of the coeffs. a_i are given in parentheses.

P/kPa	A_1	B_1	C_1	A_2	B_2	C_2
101.32	15.9541	-3247.7	-64.64	12.44054	-2347.46	-116.55

REFERENCES

- Int. DATA Ser., Ser. A, Guideline 3m, 1995, 23(2).
- Ortega, J. Int. DATA Ser., Sel. Data Mixtures, Ser. A 1995, 23, 100.
- Wilson, G. M. J. Am. Chem. Soc. 1964, 86, 127.
- TR Thermodynamic Tables - Hydrocarbons & Non-Hydrocarbons, 1976, k-5000, 1978, k-5620, Thermodynamics Research Center, The Texas A&M University System, College Station, TX, USA.
- Tsonopoulos, C. AIChE J. 1974, 20, 263; 1975, 21, 827.
- Yen, L. C.; Woods, S. S. AIChE J. 1966, 12, 95.