BLAA0930

Excess volumes of alpha, omega-dichloroalkanes (C2-C6) + some normal alkane (C5-C17) mixtures

Blanco, A.M. and Ortega, J.*

Universidad de Las Palmas de Gran Canaria, Escuela Superior de Ingenieros Industriales, Catedra de Termodinamica y Fisicoquimica, Las Palmas de Gran Canaria, Islas Canarias, Spain

INTRODUCTION

In order to understand the relationship between the structure of organic compounds and the thermodynamic properties of their mixtures, systematic information on the behavior of substances with different structural characteristics is required (1).

The literature includes several studies of the properties of systems containing alpha, omega-dichloroalkanes + n-alkanes (2 to 8). The application of group-contribution methods (7) to the excess enthalpies revealed differences between the compounds with one Cl-atom and two Cl-atoms (proximity effect). There is also evidence for enthalpic effects in mixtures containing long-chain molecules due to changes in the conformational equilibrium of the molecules (7). In order to examine these effects in more detail, we reported (9) the excess enthalpies of 35 mixtures of alpha, omega-dichloroalkanes + n-alkanes (pentane, heptane, nonane, undecane, tridecane, pentadecane, or heptadecane).

In this paper we report molar excess volumes V^E calculated from densities measured by means of a vibrating tube densimeter (Anton Paar, Graz, Austria), for the above 35 mixtures at 298.15 K at atmospheric pressure. As far as we know, there appears to be no comprehensive set of measurements published previously.

The V^E results reported by Lainez *et al.* (10, 11) for 1,2-dichloroethane + heptane, + decane, + tetradecane, or + hexadecane at 298.15 K are 5 to 10 % lower than our direct or interpolated measurements in the central range of concentration. The volumetric data of Chaudhari and Katti (12) for 1,2-dichloroethane + hexane, + heptane, or + octane and those of Valero *et al.* (13) for +1,2-dichloroethane + hexane or + hexadecane, at 298.15 K, agree well with our values. The volumetric results of Krishnaiah and Naidu (14) and Vij and Mahl (15) for 1,2-dichloroethane + hexane, + heptane, + octane or + nonane taken at 303.15 K are in acceptable agreement with the values at 298.15 K. Banos *et al.* (16) have reported V^E results for 1,3-dichloropropane + hexane or + hexadecane at 298.15 K in excellent agreement with our values. The values of Royo *et al.* (17) for 1,3-dichloropropane + hexane at 303.15 K are also acceptable.

The V^E values reported by Lainez *et al.* (11, 18) for 1,4-dichlorobutane + heptane, + decane, or + tetradecane at 298.15 K are in fair agreement with our direct or interpolated results.

The V^E values reported by Lainez *et al.* (11, 19) for 1,6-dichlorohexane + octane at 298.15 K are in qualitative agreement with our interpolated data.

*Author to whom correspondence should be addressed.

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0147-1503/93/0303-197\$2.20

Components:	1. 1,2-Dichloroethane, $C_2H_4Cl_2$
	2. Pentane, C_5H_{12}
State:	Binary system, single-phase liquid; pure components, both liquid
Variables:	V^E, molar excess volume
	x_i, mole fraction of component i
Parameters:	T, temperature
Constants:	P, pressure
Method:	Calculation of V^E from density measurements at constant T and P and variable x_i; ref. 1

Author(s): Blanco, A. M.; Ortega, J. (Universidad de Las Palmas de Gran Canaria, Escuela Superior de Ingenieros Industriales, Cátedra de Termodinámica y Fisicoquímica, Las Palmas de Gran Canaria, Islas Canarias, Spain)

Edited by: Kehiaian, H. V. (Institut de Topologie et de Dynamique des Systèmes, Université Paris VII, CNRS, 1, Rue Guy de la Brosse, 75005 Paris, France)

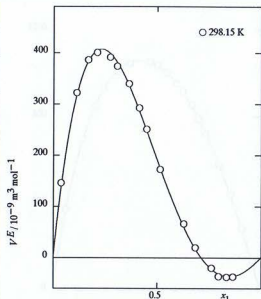## DIRECT EXPERIMENTAL VALUES

Notes: P, atm.

T/K = 298.15

x_1	$V^E/10^{-9}$ $m^3 mol^{-1}$
0.0373	145.5
0.1125	322.2
0.1679	385.9
0.2112	400.7
0.2750	391.0
0.3088	373.6
0.3650	339.5
0.4147	292.4
0.4505	250.8
0.5148	172.1
0.6289	65.4
0.6835	18.9
0.7601	−20.3
0.7939	−36.9
0.8324	−38.0
0.8634	−37.6

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

SMOOTHING EQUATION

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

Coeffs. a_i in the smoothing eq., std. deviation σ_d, and max. deviation δ_m detd. by least-squares method.

T/K	a_1	a_2	a_3	a_4	a_5	σ_d	δ_m
				$10^{-9} m^3 mol^{-1}$			
298.15	768 (10)	−2260 (19)	1065 (47)			5.6	10

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

$\delta_m = \max |V_{calc}^E - V^E|$; $\sigma_d = [\Sigma(V_{calc}^E - V^E)^2/(N - n)]^{1/2}$

N, no. of direct exptl. values; n, no. of coeffs. a_i
All direct exptl. values equally weighted

AUXILIARY INFORMATION

Apparatus: Vibrating tube densimeter, (Anton Paar, Graz, Austria), Model DMA 602/60. Temp. was controlled to within 0.01 K using a Heto thermostat and was measured by means of a calibrated Pt resistance thermometer.

Procedure: Density, ρ, was calcd. from period of vibration, τ: $\rho = a + b\tau^2$. Consts. a and b were detd. by calibrating the app. (ref. 2) with doubly distd. and degassed H_2O, ρ(298.15 K)/kg m^{-3} = 997.043 (ref. 3) and nonane (Fluka AG, Buchs, Switzerland, 'purum', Lot No. 74252, of stated purity > 99 mole %), ρ(298.15 K)/kg m^{-3} = 713.855 (ref. 4). Mixts. were prepd. by weighing. V^E was calcd. from $V^E = V - (x_1 V_1^* + x_2 V_2^*)$, where $V = (x_1 M_1 + x_2 M_2)/\rho$ is the molar vol. of the mixt. and $V_i^* = V(x_i = 1)$ and M_i are, resp., the molar vol. and the molar mass of component i.

Materials: 1. Fluka AG (Buchs, St. Gallen, Switzerland) 'puriss' grade material of stated GLC purity > 99.5 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; ρ_1(298.15 K)/kg m^{-3} = 1245.74; n(D, 298.15 K) = 1.4422; $M_1/10^{-3}$kg mol^{-1} = 98.95916. 2. Fluka AG (Buchs, Switzerland) 'puriss' grade material of stated GLC purity > 99.5 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; ρ_2(298.15 K)/kg m^{-3} = 621.31; n(D, 298.15 K) = 1.3547; $M_2/10^{-3}$kg mol^{-1} = 72.15028. Materials were degassed ultrasonically before use.

Errors: δT(reproducibility)/K < 0.01; δT(IPTS-68)/K = 0.01; δx_1 = 0.0001; $\delta V^E/10^{-9}$m^{3}mol^{-1} < 5.

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Received: March 15, 1993

Published: July 31, 1993

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Int. DATA Ser., Sci. Data Mixtures, Ser. A 1993, 21(3), 195-231

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Components:	1. 1,2-Dichloroethane, $C_2H_4Cl_2$
	2. Heptane, C_7H_{16}
State:	Binary system, single-phase liquid; pure components, both liquid
Variables:	V^E, molar excess volume
	x_i, mole fraction of component i
Parameters:	T, temperature
Constants:	P, pressure
Method:	Calculation of V^E from density measurements at constant T and P and variable x_i; ref. 1

Author(s): Blanco, A. M.; Ortega, J. (Universidad de Las Palmas de Gran Canaria, Escuela Superior de Ingenieros Industriales, Cátedra de Termodinámica y Fisicoquímica, Las Palmas de Gran Canaria, Islas Canarias, Spain)

Edited by: Kehiaian, H. V. (Institut de Topologie et de Dynamique des Systèmes, Université Paris VII, CNRS, 1, Rue Guy de la Brosse, 75005 Paris, France)
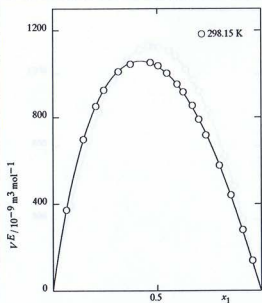
DIRECT EXPERIMENTAL VALUES

Notes: P, atm.

T/K = 298.15

x_1	$V^E/10^{-9}$ $m^3 mol^{-1}$
0.0639	370.9
0.1475	696.6
0.2072	850.8
0.2452	922.8
0.3148	1010.4
0.3734	1044.0
0.4685	1051.3
0.5056	1036.2
0.5465	1002.8
0.5968	952.1
0.6257	915.8
0.6697	853.9
0.7004	789.4
0.7343	716.5
0.7996	576.1
0.8549	439.6
0.9121	279.6
0.9577	138.2

Points, direct experimental V^E values; curves, V^E_{calc} calculated from the smoothing equation.

SMOOTHING EQUATION

$$V^E_{calc} = x_1 x_2 \sum_{i=1}^{n} a_i (x_1 - x_2)^{i-1}$$

Coeffs. a_i in the smoothing eq., std. deviation σ_d and max. deviation δ_m detd. by least-squares anal.

T/K	a_1	a_2	a_3	a_4	a_5	σ_d	δ_m
			$10^{-9} m^3 mol^{-1}$				
298.15	4140.6 (8.3)	−1116 (32)	790 (40)	−613 (86)		5.0	11

The std. deviations σa_i of the coeffs. a_i are given in parentheses

$\delta_m = \max |V^E_{calc} - V^E|$; $\sigma_d = [\Sigma(V^E_{calc} - V^E)^2/(N-n)]^{1/2}$

N, no. of direct exptl. values; n, no. of coeffs. a_i

All direct exptl. values equally weighted

AUXILIARY INFORMATION

Apparatus: Vibrating tube densimeter, (Anton Paar, Graz, Austria), Model DMA 602/60. Temp. was controlled to within 0.01 K using a Heto thermostat and was measured by means of a calibrated Pt resistance thermometer.

Procedure: Density, ρ, was calcd. from period of vibration, τ: $\rho = a + b\tau^2$. Consts. a and b were detd. by calibrating the app. (ref. 2) with doubly distd. and degassed H_2O, ρ(298.15 K)/kg m^{-3} = 997.043 (ref. 3) and nonane (Fluka AG, Buchs, Switzerland, 'purum', Lot No. 74252, of stated purity > 99 mole %), ρ(298.15 K)/kg m^{-3} = 713.855 (ref. 4). Mixts. were prepd. by weighing. V^E was calcd. from $V^E = V - (x_1 V_1^* + x_2 V_2^*)$, where $V = (x_1 M_1 + x_2 M_2)/\rho$ is the molar vol. of the mixt. and $V_i^* = V(x_i = 1)$ and M_i are, resp., the molar vol. and the molar mass of component i.

Materials: 1. Fluka AG (Buchs, St. Gallen, Switzerland) 'puriss' grade material of stated GLC purity > 99.5 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; ρ_1(298.15 K)/kg m^{-3} = 1245.74; n(D, 298.15 K) = 1.4422; $M_1/10^{-3}$ kg mol^{-1} = 98.95916.
2. Fluka AG (Buchs, St. Gallen, Switzerland) 'puriss' grade material of stated GLC purity > 99.5 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; ρ_2(298.15 K)/kg m^{-3} = 679.46; n(D, 298.15 K) = 1.3851; $M_2/10^{-3}$ kg mol^{-1} = 100.20404.
Materials were degassed ultrasonically before use.

Errors: δT(reproducibility)/K < 0.01; δT(IPTS-68)/K < 0.01; $\delta x_1 = 0.0001$; $\delta V^E/10^{-9}$ m^3 mol^{-1} < 5.

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4. *Anton Paar Information Bull. No. 6*, March 1982.

Received: March 15, 1993

Published: July 31, 1993

***Ser. A. Thermodynamic Properties of Non-reacting Binary Systems of Organic Substances**

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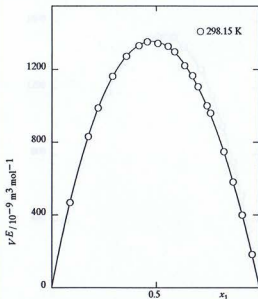|	
Components: 1. 1,2-Dichloroethane, $C_2H_4Cl_2$	**Author(s):** Blanco, A. M.; Ortega, J. (Universidad de Las Palmas de Gran Canaria, Escuela Superior de Ingenieros Industriales, Cátedra de Termodinámica y Fisicoquímica, Las Palmas de Gran Canaria, Islas Canarias, Spain)
2. Nonane, C_9H_{20}	
State: Binary system, single-phase liquid; pure components, both liquid	**Edited by:** Kehiaian, H. V. (Institut de Topologie et de Dynamique des Systèmes, Université Paris VII, CNRS, 1, Rue Guy de la Brosse, 75005 Paris, France)
Variables: V^E, molar excess volume	
x_i, mole fraction of component i	
Parameters: T, temperature	
Constants: P, pressure	**SOURCE OF DATA**
Method: Calculation of V^E from density measurements at constant T and P and variable x_i; ref. 1	Blanco, A. M.; Ortega, J. (University of Las Palmas de Gran Canaria, Canary Islands, Spain); FIRST PUBLISHED RESULTS

0141-1503/93/0303-199$22.20

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Int. DATA Ser., Sel. Data Mixtures, Ser. A 1993, 21(3), 195-231

DIRECT EXPERIMENTAL VALUES

Notes: P, atm.

$T/K = 298.15$

x_1	$V_1^E / 10^{-9}$ m^{3}mol^{-1}
0.0865	467.1
0.1745	824.6
0.2224	989.4
0.2914	1162.6
0.3573	1274.7
0.4177	1330.8
0.4575	1353.9
0.5090	1344.4
0.5578	1327.8
0.5897	1298.6
0.6394	1221.9
0.6770	1166.5
0.7040	1106.0
0.7470	1001.7
0.7639	960.6
0.8284	747.5
0.8728	581.8
0.9169	398.6
0.9638	181.7

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

SMOOTHING EQUATION

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

Coeffs. a_i in the smoothing eq., std. deviation σ_d and max. deviation δ_m detd. by least-squares anal.

T/K	a_1	a_2	a_3	a_4	a_5	σ_d	δ_m
				10^{-9} m^{3}mol^{-1}			
298.15	5415.2 (6.3)	−384 (13)	263 (31)			4.0	7.3

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

$\delta_m = \max |V_{calc}^E - V^E|$; $\sigma_d = [\Sigma (V_{calc}^E - V^E)^2/(N-n)]^{1/2}$

N, no. of direct exptl. values; n, no. of coeffs. a_i
All direct exptl. values equally weighted

AUXILIARY INFORMATION

Apparatus: Vibrating tube densimeter, (Anton Paar, Graz, Austria), Model DMA 602/60. Temp. was controlled to within 0.01 K using a Heto thermostat and was measured by means of a calibrated Pt resistance thermometer.

Procedure: Density, ρ, was calcd. from period of vibration, τ: $\rho = a + b\tau^2$. Consts. a and b were detd. by calibrating the app. (ref. 2) with doubly distd. and degassed H_2O, $\rho(298.15$ K)/kg m^{-3} = 997.043 (ref. 3) and nonane (Fluka AG, Buchs, Switzerland, 'purum', Lot No. 74252, of stated purity > 99 mole %), $\rho(298.15$ K)/kg m^{-3} = 713.855 (ref. 4). Mixts. were prepd. by weighing. V^E was calcd. from $V^E = V - (x_1 V_1^* + x_2 V_2^*)$, where $V = (x_1 M_1 + x_2 M_2)/\rho$ is the molar vol. of the mixt. and $V_i^* = V/(x_i = 1)$ are, resp., the molar vol. and the molar vol. of component i.

Materials: 1. Fluka AG (Buchs, St. Gallen, Switzerland) 'puriss' grade material of stated purity > 99.5 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; $\rho_1(298.15$ K)/kg m^{-3} = 1245.74; $n(D, 298.15$ K) = 1.4422; $M_1/10^{-3}$kg mol^{-1} = 98.959916.
2. Fluka AG (Buchs, St. Gallen, Switzerland) 'purum' grade material of stated GLC purity > 99 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; $\rho_2(298.15$ K)/kg m^{-3} = 713.85; $n(D, 298.15$ K) = 1.4033; $M_2/10^{-3}$ kg mol^{-1} = 128.2578.
Materials were degassed ultrasonically before use.

Errors: δT(reproducibility)/K < 0.01; δT(IPTS-68)/K = 0.01; $\delta x_1 = 0.0001$; $\delta V^E/10^{-9}$m^{3}mol^{-1} < 5.

REFERENCES

1. *Int. DATA Ser., Ser. A, Guideline 2c*, 1979.
2. Ortega, J.; Matos, J. S.; Paz Andrade, M. I.; Jiménez, E. J. *J. Chem. Thermodyn.* 1985, *17*, 1127.
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*Ser. A. Thermodynamic Properties of Non-reacting Binary Systems of Organic Substances

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Components: 1. 1,2-Dichloroethane, $C_2H_4Cl_2$
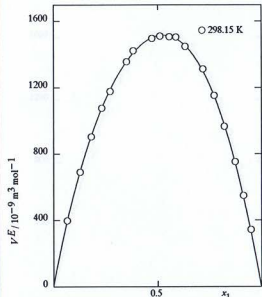   2. Undecane, $C_{11}H_{24}$

Author(s): Blanco, A. M.; Ortega, J. (Universidad de Las Palmas de Gran Canaria, Escuela Superior de Ingenieros Industriales, Cátedra de Termodinámica y Fisicoquímica, Las Palmas de Gran Canaria, Islas Canarias, Spain)

Edited by: Kehiaian, H. V. (Institut de Topologie et de Dynamique des Systèmes, Université Paris VII, CNRS, 1, Rue Guy de la Brosse, 75005 Paris, France)

State: Binary system, single-phase liquid; pure components, both liquid
Variables: V^E, molar excess volume
         x_i, mole fraction of component i
Parameters: T, temperature
Constants: P, pressure
Method: Calculation of V^E from density measurements at constant T and P and variable x_i; ref. 1

DIRECT EXPERIMENTAL VALUES

Notes: P, atm.

T/K = 298.15

x_1	$V^E/10^{-9}$ m^3 mol^{-1}
0.0649	396.7
0.1263	689.2
0.1803	904.0
0.2314	1078.0
0.2717	1179.1
0.3505	1357.3
0.3830	1422.9
0.4727	1498.1
0.5111	1512.1
0.5561	1508.2
0.5882	1505.0
0.6332	1450.4
0.7192	1313.1
0.7731	1154.3
0.8222	967.1
0.8745	753.2
0.9147	548.5
0.9497	341.3

SMOOTHING EQUATION

$$V^E_{calc} = x_1 x_2 \sum_{i=1}^{n} a_i (x_1 - x_2)^{i-1}$$

Coeffs. a_i in the smoothing eq., std. deviation σ_d and max. deviation δ_m detd. by least-squares anal.

T/K	a_1	a_2	a_3	a_4	a_5	σ_d	δ_m
			10^{-9} m^3 mol^{-1}				
298.15	6052 (12)	585 (49)	893 (55)	−330 (120)		7.3	14

The std. deviations σ_{ij} of the coeffs. a_i are given in parentheses

$\delta_m = \max |V^E_{calc} - V^E|$; $\sigma_d = [\Sigma (V^E_{calc} - V^E)^2/(N-n)]^{1/2}$

N, no. of direct exptl. values; n, no. of coeffs. a_i
All direct exptl. values equally weighted

Points, direct experimental V^E values; curves, V^E_{calc} calculated from the smoothing equation.

AUXILIARY INFORMATION

Apparatus: Vibrating tube densimeter, (Anton Paar, Graz, Austria), Model DMA 602/60. Temp. was controlled to within 0.01 K using a Heto thermostat and was measured by means of a calibrated Pt resistance thermometer.

Procedure: Density, ρ, was calcd. from period of vibration, τ: $\rho = a + b\tau^2$. Consts. a and b were detd. by calibrating the app. (ref. 2) with doubly distd. and degassed H_2O, ρ(298.15 K)/kg m^{-3} = 997.043 (ref. 3) and nonane (Fluka AG, Buchs, Switzerland, 'purum', Lot No. 74252, of stated purity > 99 mole %), ρ(298.15 K)/kg m^{-3} = 713.855 (ref. 4). Mixts. were prepd. by weighing. V^E was calcd. from $V^E = V - (x_1 V_1^* + x_2 V_2^*)$, where $V = (x_1 M_1 + x_2 M_2)/\rho$ is the molar vol. of the mixt. and $V_i^* = V_i x_i = 1$ and M_i are, resp., the molar vol. and the molar mass of component i.

Materials: 1. Fluka AG (Buchs, St. Gallen, Switzerland) 'puriss' grade material of stated GLC purity > 99.5 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; ρ_1(298.15 K)/kg m^{-3} = 1245.74; n(D, 298.15 K) = 1.4422; $M_1/10^{-3}$kg mol^{-1} = 98.95916.
2. Fluka AG (Buchs, St. Gallen, Switzerland) 'purum' grade material of stated GLC purity > 97 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; ρ_2(298.15 K)/kg m^{-3} = 736.80; n(D, 298.15 K) = 1.4154; $M_2/10^{-3}$ kg mol^{-1} = 156.31156.
Materials were degassed ultrasonically before use.

Errors: δT(reproducibility)/K < 0.01; δT(IPTS-68)/K = 0.01; δx_1 = 0.0001; $\delta V^E/10^{-9}$ m^3 mol^{-1} < 5.

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4. *Anton Paar Information Bull. No. 6*, March 1982.

Received: March 15, 1993   Published: July 31, 1993

Ser. A. Thermodynamic Properties of Non-reacting Binary Systems of Organic Substances

Components:
1. 1,2-Dichloroethane, $C_2H_4Cl_2$
2. Tridecane, $C_{13}H_{28}$

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

Variables: V^E, molar excess volume
x_i, mole fraction of component i

Parameters: T, temperature

Constants: P, pressure

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

Author(s): Blanco, A. M.; Ortega, J. (Universidad de Las Palmas de Gran Canaria, Escuela Superior de Ingenieros Industriales, Cátedra de Termodinámica y Fisicoquímica, Las Palmas de Gran Canaria, Islas Canarias, Spain)

Edited by: Kehiaian, H. V. (Institut de Topologie et de Dynamique des Systèmes, Université Paris VII, CNRS, 1, Rue Guy de la Brosse, 75005 Paris, France)
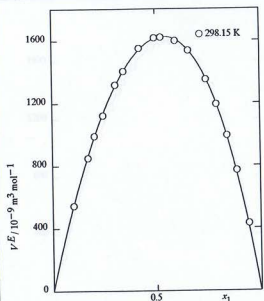
SOURCE OF DATA

Blanco, A. M.; Ortega, J. (University of Las Palmas de Gran Canaria, Canary Islands, Spain); FIRST PUBLISHED RESULTS

DIRECT EXPERIMENTAL VALUES

Notes: P, atm.

$T/K = 298.15$

x_1	$V^E/10^{-9}$ $m^3 mol^{-1}$
0.1015	544.1
0.1711	847.2
0.2041	987.8
0.2469	1120.9
0.3063	1315.2
0.3462	1402.3
0.4225	1548.9
0.4968	1613.6
0.5263	1619.0
0.5968	1596.3
0.6598	1535.1
0.7419	1349.4
0.7920	1191.2
0.8427	990.7
0.8883	768.5
0.9440	427.5

Points, direct experimental V^E values; curves, V^E_{calc} calculated from the smoothing equation.

SMOOTHING EQUATION

$$V^E_{calc} = x_1 x_2 \sum_{i=1}^{n} a_i (x_1 - x_2)^{i-1}$$

Coeffs. a_i in the smoothing equation, std. deviation σ_d, and max. deviation δ_m detd. by least-squares anal.

T/K	a_1	a_2	a_3	a_4	a_5	σ_d	δ_m
			$10^{-9} m^3 mol^{-1}$				
298.15	6450 (11)	895 (45)	600 (50)	420 (120)		6.2	12

The std. deviations σa_i of the coeffs. a_i are given in parentheses

$\delta_m = \max | V^E_{calc} - V^E |$; $\sigma_d = [\Sigma(V^E_{calc} - V^E)^2/(N-n)]^{1/2}$

N, no. of direct exptl. values; n, no. of coeffs. a_i
All direct exptl. values equally weighted

AUXILIARY INFORMATION

Apparatus: Vibrating tube densimeter, (Anton Paar, Graz, Austria), Model DMA 602/60. Temp. was controlled to within 0.01 K using a Heto thermostat and was measured by means of a calibrated Pt resistance thermometer.

Procedure: Density, ρ, was calcd. from period of vibration, τ: $\rho = a + b\tau^2$. Consts. a and b were detd. by calibrating the app. (ref. 2) with doubly distd. and degassed H_2O, $\rho_1(298.15 K)/kg m^{-3} = 997.043$ (ref. 3) and nonane (Fluka AG, Buchs, Switzerland, 'purum', Lot No. 74252, of stated purity > 99 mole %), $\rho_1(298.15 K)/kg m^{-3} = 713.855$ (ref. 4). Mixts. were prepd. by weighing. V^E was calcd. from $V^E = V - (x_1 V_1^* + x_2 V_2^*)$, where $V = (x_1 M_1 + x_2 M_2)/\rho$ is the molar vol. of the mixt. and $V_i^* = V_i(x_i = 1)$ and M_i are, resp., the molar vol. and the molar mass of component i.

Materials: 1. Fluka AG (Buchs, St. Gallen, Switzerland) 'puriss' grade material of stated GLC purity > 99.5 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; $\rho_1(298.15 K)/kg m^{-3} = 1245.74$; $n(D, 298.15 K) = 1.4422$; $M_1/10^{-3} kg mol^{-1} = 98.95916$.
2. Fluka AG (Buchs, St. Gallen, Switzerland) 'puriss' grade material of stated GLC purity > 99.5 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; $\rho_2(298.15 K)/kg m^{-3} = 752.79$; $n(D, 298.15 K) = 1.4238$; $M_2/10^{-3} kg mol^{-1} = 184.36532$.
Materials were degassed ultrasonically before use.

Errors: $\delta T(\text{reproducibility})/K < 0.01$; $\delta T(\text{IPTS-68})/K = 0.01$; $\delta x_1 = 0.0001$; $\delta V^E/10^{-9} m^3 mol^{-1} < 5$.

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2. Ortega, J.; Matos, J. S.; Paz Andrade, M. I.; Jiménez, E. J. J. Chem. Thermodyn. 1985, 17, 1127.
3. Riddick, J. A.; Bunger, W. B. Organic Solvents, II, in Techniques of Chemistry, Weissberger, A., Editor, Wiley-Interscience, New York, 1970.
4. Anton Paar Information Bull. No. 6, March 1982.

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Components:	1. 1,2-Dichloroethane, $C_2H_4Cl_2$
	2. Pentadecane, $C_{15}H_{32}$
State:	Binary system, single-phase liquid; pure components, both liquid
Variables:	V^E, molar excess volume
	x_i, mole fraction of component i
Parameters:	T, temperature
Constants:	P, pressure
Method:	Calculation of V^E from density measurements at constant T and P and variable x_i; ref. 1

Author(s): Blanco, A. M.; Ortega, J. (Universidad de Las Palmas de Gran Canaria, Escuela Superior de Ingenieros Industriales, Cátedra de Termodinámica y Fisicoquímica, Las Palmas de Gran Canaria, Islas Canarias, Spain)

Edited by: Kehiaian, H. V. (Institut de Topologie et de Dynamique des Systèmes, Université Paris VII, CNRS, 1, Rue Guy de la Brosse, 75005 Paris, France)
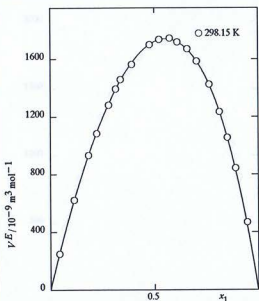
SOURCE OF DATA

Blanco, A. M.; Ortega, J. (University of Las Palmas de Gran Canaria, Canary Islands, Spain); FIRST PUBLISHED RESULTS

DIRECT EXPERIMENTAL VALUES

Notes: P, atm.

T/K = 298.15

x_1	$V^E/10^{-9}$ m^3mol^{-1}
0.0426	247.5
0.1144	619.1
0.1833	903.4
0.2246	1083.0
0.2810	1277.9
0.3150	1391.1
0.3372	1455.2
0.3918	1560.4
0.4778	1696.2
0.5235	1731.9
0.5742	1739.5
0.6120	1712.7
0.6594	1667.2
0.7031	1580.9
0.7638	1420.8
0.8129	1230.8
0.8517	1052.1
0.8914	841.2
0.9462	466.6

Points, direct experimental V^E values; curves, V^E_{calc} calculated from the smoothing equation.

SMOOTHING EQUATION

$$V^E_{calc} = x_1 x_2 \sum_{i=1}^{n} a_i (x_1 - x_2)^{i-1}$$

Coeffs. a_i in the smoothing eq., std. deviation σ_d, and max. deviation δ_m detd. by least-squares anal.

T/K	a_1	a_2	a_3	a_4	a_5	σ_d	δ_m
				$10^{-9}m^3mol^{-1}$			
298.15	6861 (11)	1423 (40)	792 (50)	330 (110)		6.4	9.2

The std. deviations σn_i of the coeffs. a_i are given in parentheses

$\delta_m = \max |V^E_{calc} - V^E|$; $\sigma_d = [\Sigma(V^E_{calc} - V^E)^2/(N-n)]^{1/2}$

N, no. of direct exptl. values; n, no. of coeffs. a_i

All direct exptl. values equally weighted

AUXILIARY INFORMATION

Apparatus: Vibrating tube densimeter, (Anton Paar, Graz, Austria), Model DMA 602/60. Temp. was controlled to within 0.01 K using a Heto thermostat and was measured by means of a calibrated Pt resistance thermometer.

Procedure: Density, ρ, was calcd. from period of vibration, τ: $\rho = a + b\tau^2$. Consts. a and b were detd. by calibrating the app. (ref. 2) with doubly distd. and degassed H_2O, ρ(298.15 K)/kg m^{-3} = 997.043 (ref. 3) and nonane (Fluka AG, Buchs, Switzerland, 'purum', Lot No. 74252, of stated purity > 99 mole %), ρ(298.15 K)/kg m^{-3} = 713.855 (ref. 4). Mixts. were prepd. by weighing. V^E was calcd. from $V^E = V - (x_1V^*_1 + x_2V^*_2)$, where $V = (x_1M_1 + x_2M_2)/\rho$ is the molar vol. of the mixt. and $V^*_i = V(x_i = 1)$ and M_i are, resp., the molar vol. and the molar mass of component i.

Materials: 1. Fluka AG (Buchs, St. Gallen, Switzerland) 'puriss' grade material of stated GLC purity > 99.5 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; ρ_1(298.15 K)/kg m^{-3} = 1245.74; n(D, 298.15 K) = 1.4422; M_1/10^{-3}kg mol^{-1} = 98.95916.

2. Fluka AG (Buchs, St. Gallen, Switzerland) 'purum' grade material of stated GLC purity > 98 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; ρ_2(298.15 K)/kg m^{-3} = 764.80; n(D, 298.15 K) = 1.4298; M_2/10^{-3}kg mol^{-1} = 212.41908. Materials were degassed ultrasonically before use.

Errors: δT(reproducibility)/K < 0.01; δT(IPTS-68)/K = 0.01; $\delta x_1 = 0.0001$; $\delta V^E/10^{-9}$ m^{3}mol^{-1} < 5.

REFERENCES

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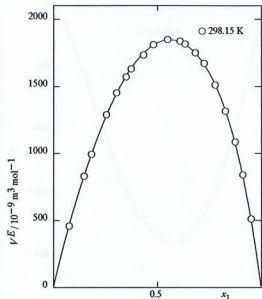4. *Anton Paar Information Bull. No. 6*, March 1982.

Received: March 15, 1993

Published: July 31, 1993

*Ser. A. Thermodynamic Properties of Non-reacting Binary Systems of Organic Substances

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0147-1503/93/0303-20352.20

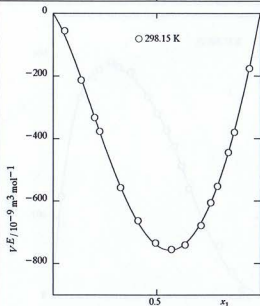|	
Components: 1. 1,2-Dichloroethane, $C_2H_4Cl_2$ 2. Heptadecane, $C_{17}H_{36}$ **State:** Binary system, single-phase liquid; pure components, both liquid **Variables:** V^E, molar excess volume x_i, mole fraction of component i **Parameters:** T, temperature **Constants:** P, pressure **Method:** Calculation of V^E from density measurements at constant T and P and variable x_i; ref. 1	**Author(s):** Blanco, A. M.; Ortega, J. (Universidad de Las Palmas de Gran Canaria, Escuela Superior de Ingenieros Industriales, Cátedra de Termodinámica y Fisicoquímica, Las Palmas de Gran Canaria, Islas Canarias, Spain) **Edited by:** Kehiaian, H. V. (Institut de Topologie et de Dynamique des Systèmes, Université Paris VII, CNRS, 1, Rue Guy de la Brosse, 75005 Paris, France) **SOURCE OF DATA** Blanco, A. M.; Ortega, J. (University of Las Palmas of Gran Canaria, Canary Islands, Spain); FIRST PUBLISHED RESULTS

DIRECT EXPERIMENTAL VALUES

Notes: P, atm.

$T/K = 298.15$

x_1	$V^E/10^{-9}$ m^{3}mol^{-1}					
0.0757	457.1
0.1469	828.1
0.1823	992.5
0.2543	1288.1
0.3040	1451.2
0.3505	1569.7
0.3747	1630.3
0.4324	1731.5
0.4812	1808.5
0.5488	1848.3
0.6079	1835.0
0.6328	1815.1
0.6829	1748.3
0.7252	1670.8
0.7773	1508.8
0.8264	1314.3
0.8744	1084.0
0.9115	838.5
0.9519	509.1

Points, direct experimental V^E values; curves, V^E_{calc} calculated from the smoothing equation.

○ 298.15 K

SMOOTHING EQUATION

$$V^E_{calc} = x_1 x_2 \sum_{i=1}^{n} a_i (x_1 - x_2)^{i-1}$$

Coeffs. a_i in the smoothing eq., std. deviation σ_d, and max. deviation δ_m detd. by least-squares anal.

T/K	a_1	a_2	a_3	a_4	a_5	σ_d	δ_m
				10^{-9}m^{3}mol^{-1}			
298.15	7289 (14)	1511 (43)	1196 (150)	1136 (110)	810 (260)	7.1	12

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

$\delta_m = \max |V^E_{calc} - V^E|$; $\sigma_d = [\Sigma (V^E_{calc} - V^E)^2/(N-n)]^{1/2}$

N, no. of direct exptl. values; n, no. of coeffs. a_i
All direct exptl. values equally weighted

AUXILIARY INFORMATION

Apparatus: Vibrating tube densimeter, (Anton Paar, Graz, Austria), Model DMA 602/60. Temp. was controlled to within 0.01 K using a Heto thermostat and was measured by means of a calibrated Pt resistance thermometer.

Procedure: Density, ρ, was calcd. from period of vibration, τ: $\rho = a + b\tau^2$. Consts. a and b were detd. by calibrating the app. (ref. 2) with doubly distd. and degassed H$_2$O, ρ(298.15 K)/kg m^{-3} = 997.043 (ref. 3) and nonane (Fluka AG, Buchs, Switzerland, 'purum', Lot No. 74252, of stated purity > 99 mole %), ρ(298.15 K)/kg m^{-3} = 713.855 (ref. 4). Mixts. were prepd. by weighing. V^E was calcd. from $V^E = V - (x_1V_1^* + x_2V_2^*)$, where $V = (x_1M_1 + x_2M_2)/\rho$ is the molar vol. of the mixt. and $V_i^* = V_i(x_i = 1)$ and M_i are, resp., the molar vol. and the molar mass of component i.

Materials: 1. Fluka AG (Buchs, St. Gallen, Switzerland) 'puriss' grade material of stated GLC purity > 99.5 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification: ρ_1(298.15 K)/kg m^{-3} = 1245.74; n(D, 298.15 K) = 1.4422; $M_1/10^{-3}$kg mol^{-1} = 98.95916.
2. Fluka AG (Buchs, St. Gallen, Switzerland) 'purum' grade material of stated GLC purity ~ 99 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification: ρ_2(298.15 K)/kg m^{-3} = 774.33; n(D, 298.15 K) = 1.4347; $M_2/10^{-3}$kg mol^{-1} = 240.47284. Materials were degassed ultrasonically before use.

Errors: δT(reproducibility)/K < 0.01; δT(IPTS-68)/K = 0.01; $\delta x_1 = 0.0001$; $\delta V^E/10^{-9}$m^{3}mol^{-1} < 5.

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3. Riddick, J. A.; Bunger, W. B. *Organic Solvents, II*, in *Techniques of Chemistry*, Weissberger, A., Editor, Wiley-Interscience, New York, 1970.
4. *Anton Paar Information Bull. No. 6*, March 1982.

Received: March 15, 1993   Published: July 31, 1993

*Ser. A. Thermodynamic Properties of Non-reacting Binary Systems of Organic Substances

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0147-1503/93/9303-20452.20

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| Components: | 1. 1,3-Dichloropropane, $C_3H_6Cl_2$ |
| | 2. Pentane, C_5H_{12} |

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

Variables: V^E, molar excess volume

x_i, mole fraction of component i

Parameters: T, temperature

Constants: P, pressure

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

Author(s): Blanco, A. M.; Ortega, J. (Universidad de Las Palmas de Gran Canaria, Escuela Superior de Ingenieros Industriales, Cátedra de Termodinámica y Fisicoquimica, Las Palmas de Gran Canaria, Islas Canarias, Spain)

Edited by: Kehiaian, H. V. (Institut de Topologie et de Dynamique des Systèmes, Université Paris VII, CNRS, 1, Rue Guy de la Brosse, 75005 Paris, France)
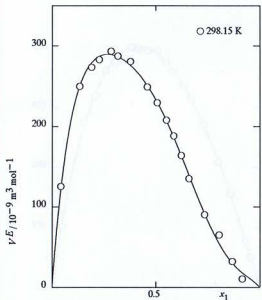
SOURCE OF DATA

Blanco, A. M.; Ortega, J. (University of Las Palmas of Gran Canaria, Canary Islands, Spain); FIRST PUBLISHED RESULTS

DIRECT EXPERIMENTAL VALUES

Notes: P, atm.

$T/K = 298.15$

x_1	$V_1^E/10^{-9}$ m^3·mol^{-1}
0.0551	−56.1
0.1356	−212.9
0.2002	−332.9
0.2259	−376.8
0.3247	−557.3
0.4103	−663.5
0.4946	−734.0
0.5715	−754.8
0.6376	−740.8
0.7153	−678.1
0.7603	−605.6
0.7931	−552.6
0.8449	−444.6
0.8745	−379.6
0.9475	−175.7

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

SMOOTHING EQUATION

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

Coeffs. a_i in the smoothing eqn., std. deviation σ_d, and max. deviation δ_m detd. by least-squares anal.

T/K	a_1	a_2	a_3	a_4	a_5	σ_d	δ_m
				10^{-9}m^3·mol^{-1}			
298.15	−2963 (12)	−990 (46)	678 (50)	−310 (120)		6.0	13

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

$\delta_m = \max |V_{calc}^E - V^E|$; $\sigma_d = [\Sigma(V_{calc}^E - V^E)^2/(N-n)]^{1/2}$

N, no. of direct exptl. values; n, no. of coeffs. a_i

All direct exptl. values equally weighted

AUXILIARY INFORMATION

Apparatus: Vibrating tube densimeter, (Anton Paar, Graz, Austria), Model DMA 602/60. Temp. was controlled to within 0.01 K using a Heto thermostat and was measured by means of a calibrated Pt resistance thermometer.

Procedure: Density, ρ, was calcd. from period of vibration, τ: $\rho = a + b\tau^2$. Consts. a and b were detd. by calibrating the app. (ref. 2) with doubly distd. and degassed H$_2$O, ρ(298.15 K)/kg m^{-3} = 997.043 (ref. 3) and nonane (Fluka AG, Buchs, Switzerland, 'purum', Lot No. 74252, of stated purity > 99 mole %), ρ(298.15 K)/kg m^{-3} = 713.855 (ref. 4). Mixts. were prepd. by weighing. V^E was calcd. from $V^E = V - (x_1V_1^* + x_2V_2^*)$, where $V = (x_1M_1 + x_2M_2)/\rho$ is the molar vol. of the mixt. and $V_i^* = V_i(x_i = 1)$ and M_i are, resp., the molar vol. and the molar mass of component i.

Materials: 1. Aldrich Chem. Co., Inc. (Milwaukee, WI, USA) material, of stated purity ~ 99 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; ρ_1(298.15 K)/kg m^{-3} = 1178.45; n(D, 298.15 K) = 1.4455; $M_1/10^{-3}$kg mol^{-1} = 112.986604.
2. Fluka AG (Buchs, St. Gallen, Switzerland) 'puriss' grade material of stated GLC purity > 99.5 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; ρ_2(298.15 K)/kg m^{-3} = 621.31; n(D, 298.15 K) = 1.3547; $M_2/10^{-3}$kg mol^{-1} = 72.15028. Materials were degassed ultrasonically before use.

Errors: δT(reproducibility)/K < 0.01; δT(IPTS-68)/K = 0.01; δx_i = 0.0001; $\delta V^E/10^{-9}$m^{3}mol^{-1} < 5.

REFERENCES

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4. *Anton Paar Information Bull. No. 6,* March 1982.

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Int. DATA Ser., Sel. Data Mixtures, Ser. A 1993, 21(3), 195-231

Components: 1. 1,3-Dichloropropane, $C_3H_6Cl_2$ 2. Heptane, C_7H_{16}	**Author(s):** Blanco, A. M.; Ortega, J. (Universidad de Las Palmas de Gran Canaria, Escuela Superior de Ingenieros Industriales, Cátedra de Termodinámica y Fisicoquímica, Las Palmas de Gran Canaria, Islas Canarias, Spain)
State: Binary system, single-phase liquid; pure components, both liquid	**Edited by:** Kehiaian, H. V. (Institut de Topologie et de Dynamique des Systèmes, Université Paris VII, CNRS, 1, Rue Guy de la Brosse, 75005 Paris, France)
Variables: V^E, molar excess volume x_i, mole fraction of component i	
Parameters: T, temperature	**SOURCE OF DATA**
Constants: P, pressure	Blanco, A. M.; Ortega, J. (University of Las Palmas de Gran Canaria, Canary Islands, Spain); FIRST PUBLISHED RESULTS
Method: Calculation of V^E from density measurements at constant T and P and variable x_i; ref. 1	

DIRECT EXPERIMENTAL VALUES

Notes: P, atm.

$T/K = 298.15$.

x_1	$V^E/10^{-9}$ $m^3 mol^{-1}$
0.0409	125.3
0.1329	249.9
0.1904	273.5
0.2269	283.3
0.2831	293.6
0.3154	287.5
0.3779	284.8
0.4598	249.0
0.5071	229.6
0.5508	207.8
0.5867	188.2
0.6246	163.7
0.6605	134.8
0.7358	90.0
0.8048	64.6
0.8686	31.9
0.9168	10.3

Points, direct experimental V^E values; curves, V^E_{calc} calculated from the smoothing equation.

○ 298.15 K

SMOOTHING EQUATION

$$V^E_{calc} = x_1 x_2 \sum_{i=1}^{n} a_i (x_1 - x_2)^{i-1}$$

Coeffs. a_i in the smoothing eq., std. deviation σ_d and max. deviation δ_m detd. by least-squares anal.

T/K	a_1	a_2	a_3	a_4	a_5	σ_d	δ_m
				$10^{-9} m^3 mol^{-1}$			
298.15	935 (10)	−924 (36)	−6 (120)	−689 (98)	980 (210)	5.3	9.7

The std. deviations σa_i of the coeffs. a_i are given in parentheses

$\delta_m = \max |V^E_{calc} - V^E|$; $\sigma_d = [\Sigma (V^E_{calc} - V^E)^2 / (N-n)]^{1/2}$

N, no. of direct exptl. values; n, no. of coeffs. a_i
All direct exptl. values equally weighted

AUXILIARY INFORMATION

Apparatus: Vibrating tube densimeter, (Anton Paar, Graz, Austria), Model DMA 602/60. Temp. was controlled to within 0.01 K using a Heto thermostat and was measured by means of a calibrated Pt resistance thermometer.

Procedure: Density, ρ, was calcd. from period of vibration, τ: $\rho = a + b\tau^2$. Const. a and b were detd. by calibrating the app. (ref. 2) with doubly distd. and degassed H_2O, $\rho(298.15 K)/kg m^{-3} = 997.043$ (ref. 3) and nonane (Fluka AG, Buchs, Switzerland, 'purum', Lot No. 74252, of stated purity > 99 mole %), $\rho(298.15 K)/kg m^{-3} = 713.855$ (ref. 4). Mixts. were prepd. by weighing. V^E was calcd. from $V^E = V - (x_1 V^*_1 + x_2 V^*_2)$, where $V = (x_1 M_1 + x_2 M_2)/\rho$ is the molar vol. of the mixt. and $V^*_i = V (x_i = 1)$ and M_i are, resp., the molar vol. and the molar mass of component i.

Materials: 1. Aldrich Chem. Co., Inc. (Milwaukee, WI, USA) material, of stated purity ~ 90 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; $\rho_1(298.15 K)/kg m^{-3} = 1178.45$; $n(D, 298.15 K) = 1.4455$; $M_1/10^{-3} kg mol^{-1} = 112.98604$. 2. Fluka AG (Buchs, St. Gallen, Switzerland) 'puriss' grade material of stated GLC purity > 99.5 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; $\rho(298.15 K)/kg m^{-3} = 679.46$; $n(D, 298.15 K) = 1.3851$; $M_2/10^{-3} kg mol^{-1} = 100.20404$. Materials were degassed ultrasonically before use.

Errors: $\delta T(reproducibility)/K < 0.01$; $\delta T(IPTS-68)/K < 0.01$; $\delta x_1 = 0.0001$; $\delta V^E/10^{-9} m^3 mol^{-1} < 5$.

REFERENCES

1. *Int. DATA Ser., Ser. A, Guideline 2c*, 1979.
2. Ortega, J.; Matos, J. S.; Paz Andrade, M. I.; Jiménez, E. J. *J. Chem. Thermodyn.* **1985**, *17*, 1127.
3. Riddick, J. A.; Bunger, W. B. *Organic Solvents, II*, in *Techniques of Chemistry*, Weissberger, A., Editor, Wiley-Interscience, New York, 1970.
4. *Anton Paar Information Bull. No. 6*, March 1982.

| Components: | 1. 1,3-Dichloropropane, $C_3H_6Cl_2$ |
| | 2. Nonane, C_9H_{20} |

Author(s): Blanco, A. M.; Ortega, J. (Universidad de Las Palmas de Gran Canaria, Escuela Superior de Ingenieros Industriales, Cátedra de Termodinámica y Fisicoquímica, Las Palmas de Gran Canaria, Islas Canarias, Spain)

Edited by: Kehiaian, H. V. (Institut de Topologie et de Dynamique des Systèmes, Université Paris VII, CNRS, 1, Rue Guy de la Brosse, 75005 Paris, France)

State: Binary system, single-phase liquid; pure components, both liquid
Variables: V^E_i, molar excess volume
x_i, mole fraction of component i
Parameters: T, temperature
Constants: P, pressure
Method: Calculation of V^E from density measurements at constant T and P and variable x_i; ref. 1
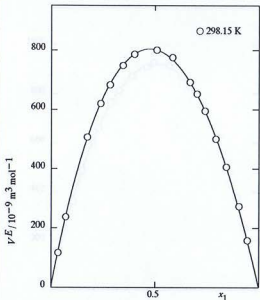
SOURCE OF DATA

Blanco, A. M.; Ortega, J. (University of Las Palmas of Gran Canaria, Canary Islands, Spain); FIRST PUBLISHED RESULTS

DIRECT EXPERIMENTAL VALUES

Notes: P, atm.

$T/K = 298.15$.

x_1	$V^E_1/10^{-9}$ $m^3 mol^{-1}$				
0.0494	151.0				
0.1548	410.2				
0.2085	477.6				
0.2596	540.3				
0.3036	561.5				
0.3820	598.7				
0.4183	594.3				
0.4627	589.6				
0.5102	587.9				
0.5495	564.2				
0.5820	538.1				
0.6348	504.2				
0.6705	470.1				
0.7213	410.7				
0.7336	405.3				
0.8012	312.6				
0.8579	234.1				
0.9294	117.9				
0.9553	75.1				
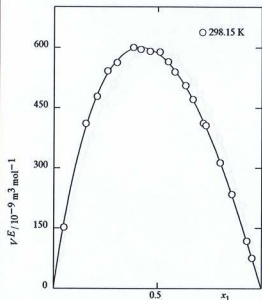
○ 298.15 K

Points, direct experimental V^E values; curves, V^E_{calc} calculated from the smoothing equation.

SMOOTHING EQUATION

$$V^E_{calc} = x_1 x_2 \sum_{i=1}^{n} a_i (x_1 - x_2)^{i-1}$$

Coeffs. a_i in the smoothing equation, std. deviation σ_d, and max. deviation δ_m detd. by least-squares anal.

T/K	a_1	a_2	a_3	a_4	a_5	σ_d	δ_m
				$10^{-9} m^3 mol^{-1}$			
298.15	2336.9 (8.4)	−706 (34)	332 (44)	−262 (94)		5.4	10

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

$$\delta_m = \max |V^E_{calc} - V^E| \; ; \; \sigma_d = [\Sigma(V^E_{calc} - V^E)^2/(N-n)]^{1/2}$$

N, no. of direct exptl. values; n, no. of coeffs. a_i
All direct exptl. values equally weighted

AUXILIARY INFORMATION

Apparatus: Vibrating tube densimeter, (Anton Paar, Graz, Austria), Model DMA 602/60. Temp. was controlled to within 0.01 K using a Heto thermostat and was measured by means of a calibrated Pt resistance thermometer.

Procedure: Density, ρ, was calcd. from period of vibration, τ: $\rho = a + b\tau^2$. Consts. a and b were detd. by calibrating the app. (ref. 2) with doubly distd. and degassed H_2O, $\rho(298.15 K)/kg\ m^{-3} = 997.043$ (ref. 3) and nonane (Fluka AG, Buchs, Switzerland, 'purum', Lot No. 74252, of stated purity > 99 mole %), $\rho(298.15 K)/kg\ m^{-3} = 713.855$ (ref. 4). Mixts. were prepd. by weighing. V^E was calcd. from $V^E = V - (x_1 V^*_1 + x_2 V^*_2)$, where $V = (x_1 M_1 + x_2 M_2)/\rho$ is the molar vol. of the mixt. and $V^*_i = V(x_i = 1)$ and M_i are, resp., the molar vol. and the molar mass of component i.

Materials: 1. Aldrich Chem. Co., Inc. (Milwaukee, WI, USA) material, of stated purity ~ 99 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; $\rho_1(298.15 K)/kg\ m^{-3} = 1178.45$; $n(D, 298.15 K) = 1.4455$; $M_1/10^{-3} kg\ mol^{-1} = 112.98604$.
2. Fluka AG (Buchs, St. Gallen, Switzerland) 'purum' grade material of stated GLC purity > 99 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; $\rho_2(298.15 K)/kg\ m^{-3} = 713.85$; $n(D, 298.15 K) = 1.4033$; $M_2/10^{-3} kg\ mol^{-1} = 128.2578$.
Materials were degassed ultrasonically before use.

Errors: δT(reproducibility)/K < 0.01; δT(IPTS-68)/K = 0.01; $\delta x_1 = 0.0001$; $\delta V^E/10^{-9} m^3 mol^{-1} < 5$.

REFERENCES

1. *Int. DATA Ser., Ser. A, Guideline 2c*, 1979.
2. Ortega, J.; Matos, J. S.; Paz Andrade, M. I.; Jiménez, E. J. *J. Chem. Thermodyn.* 1985, 17, 1127.
3. Riddick, J. A.; Bunger, W. B. *Organic Solvents, II*, in *Techniques of Chemistry*, Weissberger, A., Editor, Wiley-Interscience, New York, 1970.
4. *Anton Paar Information Bull. No. 6*, March 1982.

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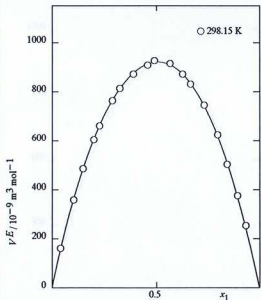|	
Components: 1. 1,3-Dichloropropane, $C_3H_6Cl_2$ 2. Undecane, $C_{11}H_{24}$	**Author(s):** Blanco, A. M.; Ortega, J. (Universidad de Las Palmas de Gran Canaria, Escuela Superior de Ingenieros Industriales, Cátedra de Termodinámica y Fisicoquímica, Las Palmas de Gran Canaria, Islas Canarias, Spain)
State: Binary system, single-phase liquid; pure components, both liquid	**Edited by:** Kehiaian, H. V. (Institut de Topologie et de Dynamique des Systèmes, Université Paris VII, CNRS, 1, Rue Guy de la Brosse, 75005 Paris, France)
Variables: V^E, molar excess volume x_i, mole fraction of component i	
Parameters: T, temperature	**SOURCE OF DATA**
Constants: P, pressure	Blanco, A. M.; Ortega, J. (University of Las Palmas de Gran Canaria, Canary Islands, Spain); FIRST PUBLISHED RESULTS
Method: Calculation of V^E from density measurements at constant T and P and variable x_i; ref. 1	

DIRECT EXPERIMENTAL VALUES

Notes: P, atm.

T/K = 298.15

x_1	$V^E/10^{-9}$ $m^3 mol^{-1}$
0.0333	116.1
0.0700	237.0
0.1739	506.1
0.2396	619.8
0.2836	682.9
0.3449	747.9
0.4000	785.8
0.5088	799.8
0.5845	774.9
0.6687	691.3
0.7022	652.5
0.7404	595.0
0.7925	500.0
0.8439	405.0
0.9047	273.2
0.9461	157.5

Points, direct experimental V^E values; curves, V^E_{calc} calculated from the smoothing equation.

SMOOTHING EQUATION

$$V^E_{calc} = x_1 x_2 \sum_{i=1}^{n} a_i (x_1 - x_2)^{i-1}$$

Coeffs. a_i in the smoothing eq., std. deviation σ_d, and max. deviation δ_m detd. by least-squares anal.

T/K	a_1	a_2	a_3	a_4	a_5	σ_d	δ_m
				$10^{-9} m^3 mol^{-1}$			
298.15	3206.4 (8.6)	−307 (15)	188 (38)			4.3	8.3

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

$$\delta_m = \max |V^E_{calc} - V^E|; \quad \sigma_d = [\Sigma(V^E_{calc} - V^E)^2/(N-n)]^{1/2}$$

N, no. of direct exptl. values; n, no. of coefs. a_i

All direct exptl. values equally weighted

AUXILIARY INFORMATION

Apparatus: Vibrating tube densimeter, (Anton Paar, Graz, Austria), Model DMA 602/60. Temp. was controlled to within 0.01 K using a Heto thermostat and was measured by means of a calibrated Pt resistance thermometer.

Procedure: Density, ρ, was calcd. from period of vibration, τ: $\rho = a + b\tau^2$. Consts. a and b were detd. by calibrating the app. (ref. 2) with doubly distd. and degassed H_2O, $\rho(298.15 \text{ K})/kg \cdot m^{-3} = 997.043$ (ref. 3) and nonane (Fluka AG, Buchs, Switzerland, 'purum', Lot No. 74252, of stated purity > 99 mole %), $\rho(298.15 \text{ K})/kg \cdot m^{-3} = 713.855$ (ref. 4). Mixts. were prepd. by weighing. V^E was calcd. from $V^E = V - (x_1V_1^* + x_2V_2^*)$, where $V = (x_1M_1 + x_2M_2)/\rho$ is the molar vol. of the mixt. and $V_i^* = V_i (x_i = 1)$ and M_i are, resp., the molar vol. and the molar mass of component i.

Materials: 1. Aldrich Chem. Co., Inc. (Milwaukee, WI, USA) material, of stated purity ~ 99 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; $\rho_1(298.15 \text{ K})/kg \cdot m^{-3} = 1178.45$; $n(D, 298.15 \text{ K}) = 1.4455$; $M_1/10^{-3}kg \cdot mol^{-1} = 112.98604$.
2. Fluka AG (Buchs, St. Gallen, Switzerland) 'purum' grade material of stated GLC purity > 97 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; $\rho_2(298.15 \text{ K})/kg \cdot m^{-3} = 736.80$; $n(D, 298.15 \text{ K}) = 1.4154$; $M_2/10^{-3}kg \cdot mol^{-1} = 156.31156$.
Materials were degassed ultrasonically before use.

Errors: $\delta T(\text{reproducibility})/K < 0.01$; $\delta T(\text{IPTS-68})/K = 0.01$; $\delta x_1 = 0.0001$; $\delta V^E/10^{-9}m^3mol^{-1} < 5$.

REFERENCES

1. *Int. DATA Ser., Ser. A, Guideline 2c*, 1979.
2. Ortega, J.; Matos, J. S.; Paz Andrade, M. I.; Jiménez, E. J. *J. Chem. Thermodyn.* **1985**, *17*, 1127.
3. Riddick, J. A.; Bunger, W. B. *Organic Solvents, II*, in *Techniques of Chemistry*, Weissberger, A., Editor, Wiley-Interscience, New York, 1970.
4. *Anton Paar Information Bull. No. 6*, March 1982.

*****Ser. A. Thermodynamic Properties of Non-reacting Binary Systems of Organic Substances**

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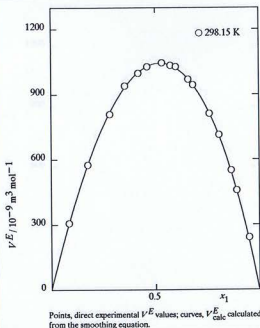|	
Components: 1. 1,3-Dichloropropane, $C_3H_6Cl_2$ 2. Tridecane, $C_{13}H_{28}$ **State:** Binary system, single-phase liquid; pure components, both liquid **Variables:** V^E, molar excess volume x_i, mole fraction of component i **Parameters:** T, temperature **Constants:** P, pressure **Method:** Calculation of V^E from density measurements at constant T and P and variable x_i; ref. 1	**Author(s):** Blanco, A. M.; Ortega, J. (Universidad de Las Palmas de Gran Canaria, Escuela Superior de Ingenieros Industriales, Cátedra de Termodinámica y Fisicoquímica, Las Palmas de Gran Canaria, Islas Canarias, Spain) **Edited by:** Kehiaian, H. V. (Institut de Topologie et de Dynamique des Systèmes, Université Paris VII, CNRS, 1, Rue Guy de la Brosse, 75005 Paris, France) **SOURCE OF DATA** Blanco, A. M.; Ortega, J. (University of Las Palmas de Gran Canaria, Canary Islands, Spain); FIRST PUBLISHED RESULTS

DIRECT EXPERIMENTAL VALUES

Notes: P, atm.

$T/K = 298.15$

x_1	$V^E/10^{-9}$ $m^3 \cdot mol^{-1}$
0.0394	159.6
0.1031	357.5
0.1492	485.8
0.2002	603.0
0.2282	660.2
0.2893	762.2
0.3255	812.7
0.3903	870.6
0.4573	908.1
0.4907	925.9
0.5656	913.6
0.6274	871.2
0.6652	830.5
0.7309	744.0
0.7954	622.8
0.8427	501.7
0.8928	374.5
0.9336	251.9

Points, direct experimental V^E values; curves, V^E_{calc} calculated from the smoothing equation.

SMOOTHING EQUATION

$$V^E_{calc} = x_1 x_2 \sum_{i=1}^{n} a_i (x_1 - x_2)^{i-1}$$

Coeffs. a_i in the smoothing eq., std. deviation σ_d, and max. deviation δ_m detd. by least-squares anal.

T/K	a_1	a_2	a_3	a_4	a_5	σ_d	δ_m
			$10^{-9} m^3 \cdot mol^{-1}$				
298.15	3680.7 (8.8)	101 (34)	332 (39)	−160 (86)		5.1	9.3

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

$$\delta_m = \max |V^E_{calc} - V^E| \; ; \; \sigma_d = [\Sigma (V^E_{calc} - V^E)^2/(N-n)]^{1/2}$$

N, no. of direct exptl. values; n, no. of coeffs. a_i
All direct exptl. values equally weighted

AUXILIARY INFORMATION

Apparatus: Vibrating tube densimeter, (Anton Paar, Graz, Austria), Model DMA 602/60. Temp. was controlled to within 0.01 K using a Heto thermostat and was measured by means of a calibrated Pt resistance thermometer.

Procedure: Density, ρ, was calcd. from period of vibration, τ; $\rho = a + b\tau^2$. Consts. a and b were detd. by calibrating the app. (ref. 2) with doubly distd. and degassed H_2O, $\rho(298.15 \, K)/kg \cdot m^{-3} = 997.043$ (ref. 3) and nonane (Fluka AG, Buchs, Switzerland, 'purum', Lot No. 74252, of stated purity > 99 mole %), $\rho(298.15 \, K)/kg \cdot m^{-3} = 713.855$ (ref. 4). Mixts. were prepd. by weighing. V^E was calcd. from $V^E = V - (x_1 V^*_1 + x_2 V^*_2)$, where $V = (x_1 M_1 + x_2 M_2)/\rho$ is the molar vol. of the mixt. and $V^*_i = V(x_i = 1)$ and M_i are, resp., the molar vol. and the molar mass of component i.

Materials: 1. Aldrich Chem. Co., Inc. (Milwaukee, WI, USA) material, of stated purity ~ 99 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; $\rho_1(298.15 \, K)/kg \cdot m^{-3} = 1178.45$; $n(D, 298.15 \, K) = 1.4455$; $M_1/10^{-3} kg \cdot mol^{-1} = 112.98604$.
2. Fluka AG (Buchs, Switzerland) 'puriss' grade material of stated GLC purity > 99.5 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; $\rho(298.15 \, K)/kg \cdot m^{-3} = 752.79$; $n(D, 298.15 \, K) = 1.4238$; $M_2/10^{-3} kg \cdot mol^{-1} = 184.36532$. Materials were degassed ultrasonically before use.

Errors: δT(reproducibility)/K < 0.01; δT(IPTS-68)/K = 0.01; $\delta x_1 = 0.0001$; $\delta V^E/10^{-9} m^3 \cdot mol^{-1} < 5$.

REFERENCES
1. *Int. DATA Ser., Ser. A, Guideline 2c*, 1979.
2. Ortega, J.; Matos, J. S.; Paz Andrade, M. I.; Jiménez, E. J. *J. Chem. Thermodyn.* **1985**, *17*, 1127.
3. Riddick, J. A.; Bunger, W. B. *Organic Solvents, II*, in *Techniques of Chemistry*, Weissberger, A., Editor, Wiley-Interscience, New York, 1970.
4. *Anton Paar Information Bull. No. 6*, March 1982.

***Ser. A. Thermodynamic Properties of Non-reacting Binary Systems of Organic Substances**

Published by Thermodynamics Research Center

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

Author(s): Blanco, A. M.; Ortega, J. (Universidad de Las Palmas de Gran Canaria, Escuela Superior de Ingenieros Industriales, Cátedra de Termodinámica y Fisicoquímica, Las Palmas de Gran Canaria, Islas Canarias, Spain)

Edited by: Kehiaian, H. V. (Institut de Topologie et de Dynamique des Systèmes, Université Paris VII, CNRS, 1, Rue Guy de la Brosse, 75005 Paris, France)

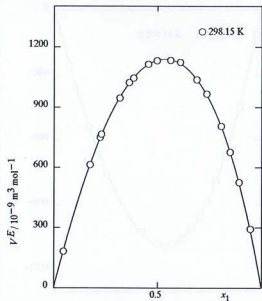| Components: | 1. 1,3-Dichloropropane, $C_3H_6Cl_2$ |
	2. Pentadecane, $C_{15}H_{32}$
State:	Binary system, single-phase liquid; pure components, both liquid
Variables:	V^E, molar excess volume
	x_i, mole fraction of component i
Parameters:	T, temperature
Constants:	P, pressure
Method:	Calculation of V^E from density measurements at constant T and P and variable x_i; ref. 1

DIRECT EXPERIMENTAL VALUES

Notes: P, atm.

$T/K = 298.15$

x_1	$V^E/10^{-9}$ m^3mol^{-1}
0.0849	305.5
0.1757	575.3
0.2823	809.0
0.3552	939.5
0.4192	997.0
0.4624	1027.6
0.5329	1045.2
0.5744	1034.3
0.6011	1028.1
0.6613	970.1
0.6831	943.5
0.7619	812.0
0.8077	714.0
0.8667	549.8
0.8925	457.6
0.9511	240.4

Points, direct experimental V^E values; curves, V^E_{calc} calculated from the smoothing equation.

SMOOTHING EQUATION

$$V^E_{calc} = x_1 x_2 \sum_{i=1}^{n} a_i(x_1 - x_2)^{i-1}$$

Coeffs. a_i in the smoothing eq., std. deviation σ_d and max. deviation δ_m detd. by least-squares anal.

T/K	a_1	a_2	a_3	a_4	a_5	σ_d	δ_m
				$10^{-9}m^3mol^{-1}$			
298.15	4165.5 (8.2)	395 (34)	320 (41)	284 (87)		4.9	8.2

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

$\delta_m = \max |V^E_{calc} - V^E|$; $\sigma_d = [\Sigma(V^E_{calc} - V^E)^2/(N - n)]^{1/2}$

N, no. of direct exptl. values; n, no. of coeffs. a_i
All direct exptl. values equally weighted

AUXILIARY INFORMATION

Apparatus: Vibrating tube densimeter, (Anton Paar, Graz, Austria), Model DMA 602/60. Temp. was controlled to within 0.01 K using a Heto thermostat and was measured by means of a calibrated Pt resistance thermometer.

Procedure: Density, ρ, was calcd. from period of vibration, τ: $\rho = a + b\tau^2$. Consts. a and b were detd. by calibrating the app. (ref. 2) with doubly distd. and degassed H_2O, $\rho(298.15 \text{ K})/kg \text{ m}^{-3} = 997.043$ (ref. 3) and nonane (Fluka AG, Buchs, Switzerland, 'purum', Lot No. 74252, of stated purity > 99 mole %), $\rho(298.15 \text{ K})/kg \text{ m}^{-3} = 713.855$ (ref. 4). Mixts. were prepd. by weighing. V^E was calcd. from $V^E = V - (x_1V_1^* + x_2V_2^*)$, where $V = (x_1M_1 + x_2M_2)/\rho$ is the molar vol. of the mixt. and $V_i^* = V(x_i = 1)$ and M_i are, resp., the molar vol. and the molar mass of component i.

Materials: 1. Aldrich Chem. Co., Inc. (Milwaukee, WI, USA) material, of stated purity ~ 99 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; $\rho_1(298.15 \text{ K})/kg \text{ m}^{-3} = 1178.45$; $n(D, 298.15 \text{ K}) = 1.4455$; $M_1/10^{-3}kg \text{ mol}^{-1} = 112.98604$.
2. Fluka AG (Buchs, St. Gallen, Switzerland) 'purum' grade material of stated GLC purity > 98 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; $\rho_2(298.15 \text{ K})/kg \text{ m}^{-3} = 764.80$; $n(D, 298.15 \text{ K}) = 1.4298$; $M_2/10^{-3}kg \text{ mol}^{-1} = 212.41908$.
Materials were degassed ultrasonically before use.

Errors: δT(reproducibility)/K < 0.01; δT(IPTS-68)/K = 0.01; $\delta x_1 = 0.0001$; $\delta V^E/10^{-9}m^3mol^{-1} < 5$.

REFERENCES

1. Int. DATA Ser., Ser. A, Guideline 2c, 1979.
2. Ortega, J.; Matos, J. S.; Paz Andrade, M. I.; Jiménez, E. J. J. Chem. Thermodyn. 1985, 17, 1127.
3. Riddick, J. A.; Bunger, W. B. Organic Solvents, II, in Techniques of Chemistry, Weissberger, A., Editor, Wiley-Interscience, New York, 1970.
4. Anton Paar Information Bull. No. 6, March 1982.

*Ser. A. Thermodynamic Properties of Non-reacting Binary Systems of Organic Substances

Published by Thermodynamics Research Center   The Texas A&M University System, College Station, TX 77843-3111

Components:	1. 1,3-Dichloropropane, $C_3H_6Cl_2$
	2. Heptadecane, $C_{17}H_{36}$
State:	Binary system, single-phase liquid; pure components, both liquid
Variables:	V_m^E, molar excess volume
	x_i, mole fraction of component i
Parameters:	T, temperature
Constants:	P, pressure
Method:	Calculation of V^E from density measurements at constant T and P and variable x_i; ref. 1

Author(s): Blanco, A. M.; Ortega, J. (Universidad de Las Palmas de Gran Canaria, Escuela Superior de Ingenieros Industriales, Cátedra de Termodinámica y Fisicoquímica, Las Palmas de Gran Canaria, Islas Canarias, Spain)

Edited by: Kehiaian, H. V. (Institut de Topologie et de Dynamique des Systèmes, Université Paris VII, CNRS, 1, Rue Guy de la Brosse, 75005 Paris, France)
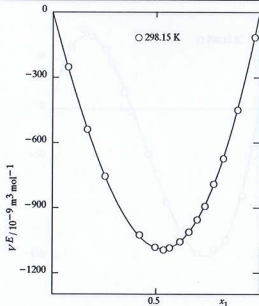
SOURCE OF DATA

DIRECT EXPERIMENTAL VALUES

Notes: P, atm.

$T/K = 298.15$

x_1	$V_m^E/10^{-9}$ m^{3}mol^{-1}
0.0463	180.0
0.1749	610.9
0.2234	747.5
0.2304	763.2
0.3189	942.7
0.3641	1019.5
0.3853	1042.1
0.4558	1110.7
0.4971	1130.0
0.5616	1131.0
0.6106	1121.3
0.6900	1034.5
0.7375	964.2
0.8064	803.8
0.8503	673.7
0.8930	523.7
0.9466	291.5

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

SMOOTHING EQUATION

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

Coeffs. a_i in the smoothing eq., std. deviation σ_d and max. deviation δ_m detd. by least-squares anal.

T/K	a_1	a_2	a_3	a_4	a_5	σ_d	δ_m
			10^{-9}m^{3}mol^{-1}				
298.15	4526.8 (5.8)	605 (23)	497 (28)	345 (64)		3.4	6.5

The std. deviations σa_i of the coeffs. a_i are given in parentheses

$\delta_m = \max |V_{calc}^E - V^E|$; $\sigma_d = [\Sigma(V_{calc}^E - V^E)^2/(N - n)]^{1/2}$

N, no. of direct exptl. values; n, no. of coeffs. a_i
All direct exptl. values equally weighted

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AUXILIARY INFORMATION

Apparatus: Vibrating tube densimeter, (Anton Paar, Graz, Austria), Model DMA 602/60. Temp. was controlled to within 0.01 K using a Heto thermostat and was measured by means of a calibrated Pt resistance thermometer.

Procedure: Density, ρ, was calcd. from period of vibration, τ: $\rho = a + b\tau^2$. Consts. a and b were detd. by calibrating the app. (ref. 2) with doubly distd. and degassed H$_2$O, ρ(298.15 K)/kg m^{-3} = 997.043 (ref. 3) and nonane (Fluka AG, Buchs, Switzerland, 'purum', Lot No. 74252, of stated purity > 99 mole %), ρ(298.15 K)/kg m^{-3} = 713.855 (ref. 4). Mixts. were prepd. by weighing. V^E was calcd. from $V^E = V - (x_1V_1^* + x_2V_2^*)$, where $V = (x_1M_1 + x_2M_2)/\rho$ is the molar vol. of the mixt. and $V_i^* = V(x_i = 1)$ and M_i are, resp., the molar vol. and the molar mass of component i.

Materials: 1. Aldrich Chem. Co., Inc. (Milwaukee, WI, USA) material, of stated purity ~ 99 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; ρ_1(298.15 K)/kg m^{-3} = 1178.45; n(D, 298.15 K) = 1.4455; $M_1/10^{-3}$kg mol^{-1} = 112.98604.
2. Fluka AG (Buchs, St. Gallen, Switzerland) 'purum' grade material of stated GLC purity ~ 99 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; ρ_2(298.15 K)/kg m^{-3} = 774.33; n(D, 298.15 K) = 1.4347; $M_2/10^{-3}$kg mol^{-1} = 240.47284. Materials were degassed ultrasonically before use.

Errors: δT(reproducibility)/K < 0.01; δT(IPTS-68)/K = 0.01; $\delta x_1 = 0.0001$; $\delta V_m^E/10^{-9}$m^{3}mol^{-1} < 5.

REFERENCES

1. *Int. DATA Ser., Ser. A, Guideline 2c*, 1979.
2. Ortega, J.; Matos, J. S.; Paz Andrade, M. L.; Jiménez, E. *J. Chem. Thermodyn.* 1985, *17*, 1127.
3. Riddick, J. A.; Bunger, W. B. *Organic Solvents, II*, in *Techniques of Chemistry*, Weissberger, A., Editor, Wiley-Interscience, New York, 1970.
4. Anton Paar Information Bull. No. 6, March 1982.

Received: March 15, 1993   Published: July 31, 1993

Left margin: 0141-1503503903-2113220

Components:	1. 1,4-Dichlorobutane, $C_4H_8Cl_2$
	2. Pentane, C_5H_{12}
State:	Binary system, single-phase liquid; pure components, both liquid
Variables:	V^E, molar excess volume
	x_i, mole fraction of component i
Parameters:	T, temperature
Constants:	P, pressure
Method:	Calculation of V^E from density measurements at constant T and P and variable x_i; ref. 1

Author(s): Blanco, A. M.; Ortega, J. (Universidad de Las Palmas de Gran Canaria, Escuela Superior de Ingenieros Industriales, Cátedra de Termodinámica y Fisicoquímica, Las Palmas de Gran Canaria, Islas Canarias, Spain)

Edited by: Kehiaian, H. V. (Institut de Topologie et de Dynamique des Systèmes, Université Paris VII, CNRS, 1, Rue Guy de la Brosse, 75005 Paris, France)
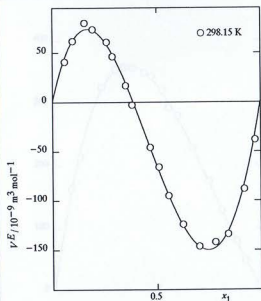
SOURCE OF DATA

Blanco, A. M.; Ortega, J. (University of Las Palmas de Gran Canaria, Canary Islands, Spain); FIRST PUBLISHED RESULTS

DIRECT EXPERIMENTAL VALUES

Notes: P, atm.

$T/K = 298.15$

x_1	$V^E/10^{-9}$ $m^3 mol^{-1}$
0.0751	−253.4
0.1690	−540.1
0.2545	−756.7
0.4211	−1028.0
0.4961	−1085.1
0.5359	−1096.1
0.5661	−1087.2
0.6157	−1059.3
0.6595	−1015.1
0.6989	−957.5
0.7368	−895.7
0.7777	−793.4
0.8239	−675.8
0.8924	−450.9
0.9744	−115.5

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

(Graph: $V^E/10^{-9} m^3 mol^{-1}$ vs x_1; ○ 298.15 K)

SMOOTHING EQUATION

$$V^E_{calc} = x_1 x_2 \sum_{i=1}^{n} a_i (x_1 - x_2)^{i-1}$$

Coeffs. a_i in the smoothing eq., std. deviation σ_d, and max. deviation δ_m detd. by least-squares anal.

T/K	a_1	a_2	a_3	a_4	a_5	σ_d	δ_m
	10^{-9} m^3 mol^{-1}						
298.15	−4345.6 (5.9)	−623 (13)	228 (29)			3.3	6.0

The std. deviations σa_i of the coeffs. a_i are given in parentheses

$\delta_m = \max |V^E_{calc} - V^E|$; $\sigma_d = [\Sigma (V^E_{calc} - V^E)^2/(N - n)]^{1/2}$

N, no. of direct exptl. values; n, no. of coeffs. a_i
All direct exptl. values equally weighted

AUXILIARY INFORMATION

Apparatus: Vibrating tube densimeter, (Anton Paar, Graz, Austria), Model DMA 602/60. Temp. was controlled to within 0.01 K using a Heto thermostat and was measured by means of a calibrated Pt resistance thermometer.

Procedure: Density, ρ, was calcd. from period of vibration, τ: $\rho = a + b\tau^2$. Consts. a and b were detd. by calibrating the app. (ref. 2) with doubly distd. and degassed H_2O, ρ(298.15 K)/kg m^{-3} = 997.043 (ref. 3) and nonane (Fluka AG, Buchs, Switzerland, 'purum', Lot No. 74252, of stated purity > 99 mole %), ρ(298.15 K)/kg m^{-3} = 713.855 (ref. 4). Mixts. were prepd. by weighing. V^E was calcd. from $V^E = V − (x_1 V^*_1 + x_2 V^*_2)$, where $V = (x_1 M_1 + x_2 M_2)/\rho$ is the molar vol. of the mixt. and $V^*_i = V(x_i = 1)$ and M^*_i are, resp., the molar vol. and the molar mass of component i.

Materials: 1. Aldrich Chem. Co., Inc. (Milwaukee, WI, USA) material, of stated purity ~ 99 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; ρ_1(298.15 K)/kg m^{-3} = 1133.06; n(D, 298.15 K) = 1.4524; $M_1/10^{-3}$ kg mol^{-1} = 127.01292.
2. Fluka AG (Buchs, St. Gallen, Switzerland) 'puriss' grade material of stated GLC purity > 99.5 mole %, dried over mol. sieve 3A (from Fluka) and used without further purification; ρ_2(298.15 K)/kg m^{-3} = 621.31; n(D, 298.15 K) = 1.3547; $M_2/10^{-3}$ kg mol^{-1} = 72.15028.
Materials was degassed ultrasonically before use.

Errors: δT(reproducibility)/K < 0.01; δT(IPTS-68)/K = 0.01; $\delta x_1 = 0.0001$; $\delta V^E/10^{-9} m^3 mol^{-1} < 5$.

REFERENCES

1. *Int. DATA Ser., Ser. A, Guideline 2c,* 1979.
2. Ortega, J.; Matos, J. S.; Paz Andrade, M. I.; Jiménez, E. *J. Chem. Thermodyn.* 1985, 17, 1127.
3. Riddick, J. A.; Bunger, W. B. *Organic Solvents, II,* in *Techniques of Chemistry,* Weissberger, A., Editor, Wiley-Interscience, New York, 1970.
4. *Anton Paar Information Bull. No. 6,* March 1982.

Right margin: 211 — *Int. DATA Ser., Sel. Data Mixtures, Ser. A* 1993, 21(3), 195-231

*Ser. A. Thermodynamic Properties of Non-reacting Binary Systems of Organic Substances

0147-1503/93/093-212/$2.20

| Components: | 1. 1,4-Dichlorobutane, $C_4H_8Cl_2$ |
| | 2. Heptane, C_7H_{16} |

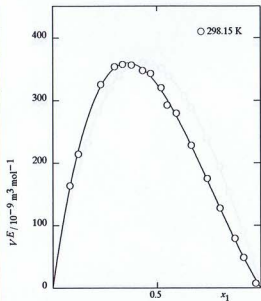| State: | Binary system, single-phase liquid; pure components, both liquid |
Variables:	V^E, molar excess volume
	x_i, mole fraction of component i
Parameters:	T, temperature
Constants:	P, pressure
Method:	Calculation of V^E from density measurements at constant T and P and variable x_i; ref. 1

Author(s): Blanco, A. M.; Ortega, J. (Universidad de Las Palmas de Gran Canaria, Escuela Superior de Ingenieros Industriales, Cátedra de Termodinámica y Fisicoquímica, Las Palmas de Gran Canaria, Islas Canarias, Spain)

Edited by: Kehiaian, H. V. (Institut de Topologie et de Dynamique des Systèmes, Université Paris VII, CNRS, 1, Rue Guy de la Brosse, 75005 Paris, France)

DIRECT EXPERIMENTAL VALUES

Notes: P, atm.

T/K = 298.15

x_1	$V^E/10^{-9}$ $m^3 mol^{-1}$
0.0592	40.5
0.0976	61.4
0.1553	73.2
0.1936	60.5
0.2614	60.5
0.2885	45.9
0.3511	16.4
0.3821	–3.2
0.4678	–46.3
0.5104	–66.0
0.5559	–95.0
0.6257	–124.2
0.7041	–146.3
0.7803	–142.0
0.8420	–133.8
0.9210	–88.2
0.9734	–38.3

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

SMOOTHING EQUATION

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

Coeffs. a_i in the smoothing eq., std. deviation σ_d and max. deviation δ_m detd. by least-squares anal.

T/K	a_1	a_2	a_3	a_4	a_5	σ_d	δ_m
				$10^{-9} m^3 mol^{-1}$			
298.15	–257.1 (7.1)	–1125 (15)	81 (33)			4.1	6.5

The std. deviations σa_i of the coeffs. a_i are given in parentheses

$\delta_m = \max |V_{calc}^E - V^E|$; $\sigma_d = [\Sigma(V_{calc}^E - V^E)^2/(N-n)]^{1/2}$

N, no. of direct exptl. values; n, no. of coeffs.
All direct exptl. values equally weighted

AUXILIARY INFORMATION

Apparatus: Vibrating tube densimeter, (Anton Paar, Graz, Austria), Model DMA 602/60. Temp. was controlled to within 0.01 K using a Heto thermostat and was measured by means of a calibrated Pt resistance thermometer.

Procedure: Density, ρ, was calcd. from period of vibration, τ: $\rho = a + b\tau^2$. Consts. a and b were detd. by calibrating the app. (ref. 2) with doubly distd. and degassed H_2O, ρ_1(298.15 K)/kg m^{-3} = 997.043 (ref. 3) and nonane (Fluka AG, Buchs, Switzerland, 'purum', Lot No. 74252, of stated purity > 99 mole %), ρ(298.15 K)/kg m^{-3} = 713.855 (ref. 4). Mixts. were prepd. by weighing. V^E was calcd. from $V^E = V - (x_1 V_1^* + x_2 V_2^*)$, where $V = (x_1 M_1 + x_2 M_2)/\rho$ is the molar vol. of the mixt. and $V_i^* = V_i(x_i = 1)$ and M_i are, resp., the molar vol. and the molar mass of component i.

Materials: 1. Aldrich Chem. Co., Inc. (Milwaukee, WI, USA) material, of stated purity ~ 99 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; ρ_1(298.15 K)/kg m^{-3} = 1133.06; n(D, 298.15 K) = 1.4524; $M_1/10^{-3}$ kg mol^{-1} = 127.01292.
2. Fluka AG (Buchs, St. Gallen, Switzerland) 'puriss' grade material of stated GLC purity > 99.5 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; ρ_2(298.15 K)/kg m^{-3} = 679.46; n(D, 298.15 K) = 1.3851; $M_2/10^{-3}$ kg mol^{-1} = 100.20404.
Materials were degassed ultrasonically before use.

Errors: δT(reproducibility)/K < 0.01; δT(IPTS-68)/K = 0.01; $\Delta x_1 = 0.0001$; $\delta V^E/10^{-9} m^3 mol^{-1}$ < 5.

REFERENCES

1. *Int. DATA Ser., Ser. A, Guideline 2c,* 1979.
2. Ortega, J.; Matos, J. S.; Paz Andrade, M. I.; Jiménez, E. J. *J. Chem. Thermodyn.* 1985, 17, 1127.
3. Riddick, J. A.; Bunger, W. B. *Organic Solvents, II,* in *Techniques of Chemistry,* Weissberger, A., Editor, Wiley-Interscience, New York, 1970.
4. *Anton Paar Information Bull. No. 6*, March 1982.

Received: March 15, 1993

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Int. DATA Ser., Sel. Data Mixtures, Ser. A 1993, 21(3), 195-231

0147-1503/93/9303-0213S2.20

Components:	1. 1,4-Dichlorobutane, $C_4H_8Cl_2$
	2. Nonane, C_9H_{20}
State:	Binary system, single-phase liquid; pure components, both liquid
Variables:	V^E, molar excess volume
	x_i, mole fraction of component i
Parameters:	T, temperature
Constants:	P, pressure
Method:	Calculation of V^E from density measurements at constant T and P and variable x_i; ref. 1

Author(s): Blanco, A. M.; Ortega, J. (Universidad de Las Palmas de Gran Canaria, Escuela Superior de Ingenieros Industriales, Cátedra de Termodinámica y Fisicoquímica, Las Palmas de Gran Canaria, Islas Canarias, Spain)

Edited by: Kehiaian, H. V. (Institut de Topologie et de Dynamique des Systèmes, Université Paris VII, CNRS, 1, Rue Guy de la Brosse, 75005 Paris, France)
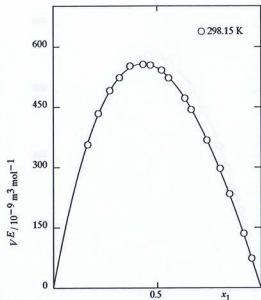
SOURCE OF DATA

Blanco, A. M.; Ortega, J. (University of Las Palmas de Gran Canaria, Canary Islands, Spain); FIRST PUBLISHED RESULTS

DIRECT EXPERIMENTAL VALUES

Notes: P, atm.

T/K = 298.15

x_1	$V^E/10^{-9}$ m^3mol^{-1}
0.0815	163.4
0.1217	213.5
0.2304	324.7
0.2964	353.0
0.3349	356.9
0.3781	356.0
0.4318	346.9
0.4702	342.3
0.5214	319.8
0.5497	292.0
0.5941	279.3
0.6673	227.6
0.7444	174.7
0.8054	127.0
0.8771	78.5
0.9192	48.2
0.9769	7.3

○ 298.15 K

Points, direct experimental V^E values; curves, V^E_{calc} calculated from the smoothing equation.

SMOOTHING EQUATION

$$V^E_{calc} = x_1 x_2 \sum_{i=1}^{n} a_i (x_1 - x_2)^{i-1}$$

Coeffs. a_i in the smoothing eq., std. deviation σ_{ph} and max. deviation δ_m detd. by least-squares anal.

T/K	a_1	a_2	a_3	a_4	a_5	σ_d	δ_m
				$10^{-9} m^3 mol^{-1}$			
298.15	1303.3 (6.6)	−878 (16)	133 (34)			4.2	9.3

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

$\delta_m = \max |V^E_{calc} - V^E|$; $\sigma_d = [\Sigma(V^E_{calc} - V^E)^2/(N-n)]^{1/2}$

N, no. of direct exptl. values; n, no. of coeffs. a_i
All direct exptl. values equally weighted

AUXILIARY INFORMATION

Apparatus: Vibrating tube densimeter, (Anton Paar, Graz, Austria), Model DMA 602/60. Temp. was controlled to within 0.01 K using a Heto thermostat and was measured by means of a calibrated Pt resistance thermometer.

Procedure: Density, ρ, was calcd. from period of vibration, τ; $\rho = a + b\tau^2$. Consts. a and b were detd. by calibrating the app. (ref. 2) with doubly distd. and degassed H_2O, ρ(298.15 K)/kg m^{-3} = 997.043 (ref. 3) and nonane (Fluka AG, Buchs, Switzerland, 'purum', Lot No. 74252, of stated purity > 99 mole %), ρ(298.15 K)/kg m^{-3} = 713.835 (ref. 4). Mixts. were prepd. by weighing. V^E was calcd. from $V^E = V − (x_1 V_1^* + x_2 V_2^*)$, where $V = (x_1 M_1 + x_2 M_2)\rho$ is the molar vol. of the mixt. and $V_i^* = V(x_i = 1)$ and M_i are, resp., the molar vol. and the molar mass of component i.

Materials: 1. Aldrich Chem. Co., Inc. (Milwaukee, WI, USA) material, of stated purity ~ 99 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; ρ_1(298.15 K)/kg m^{-3} = 1133.06; n(D, 298.15 K) = 1.4524; $M_1/10^{-3}$kg mol^{-1} = 127.01292.
2. Fluka AG (Buchs, St. Gallen, Switzerland) 'purum' grade material of stated GLC purity > 99 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; ρ_2(298.15 K)/kg m^{-3} = 713.85; n(D, 298.15 K) = 1.4033; $M_2/10^{-3}$kg mol^{-1} = 128.2578.
Materials were degassed ultrasonically before use.

Errors: δT(reproducibility)/K < 0.01; δT(IPTS-68)/K = 0.01; $\Delta x_1 = 0.0001$; $\delta V^E/10^{-9} m^3 mol^{-1} < 5$.

REFERENCES

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2. Ortega, J.; Matos, J. S.; Paz Andrade, M. I.; Jiménez, E. J. *J. Chem. Thermodyn.* **1985**, *17*, 1127.
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4. *Anton Paar Information Bull. No. 6*, March 1982.

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Int. DATA Ser., Sel. Data Mixtures, Ser. A **1993**, *21*(3), 195-231

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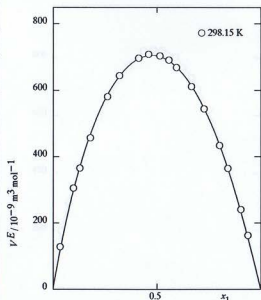|	
Components:	1. 1,4-Dichlorobutane, $C_4H_8Cl_2$ 2. Undecane, $C_{11}H_{24}$
State:	Binary system, single-phase liquid; pure components, both liquid
Variables:	V^E, molar excess volume
	x_i, mole fraction of component i
Parameters:	T, temperature
	P, pressure
Method:	Calculation of V^E from density measurements at constant T and P and variable x_i; ref. 1

Author(s): Blanco, A. M.; Ortega, J. (Universidad de Las Palmas de Gran Canaria, Escuela Superior de Ingenieros Industriales, Cátedra de Termodinámica y Fisicoquímica, Las Palmas de Gran Canaria, Islas Canarias, Spain)

Edited by: Kehiaian, H. V. (Institut de Topologie et de Dynamique des Systèmes, Université Paris VII, CNRS, 1, Rue Guy de la Brosse, 75005 Paris, France)

SOURCE OF DATA

Blanco, A. M.; Ortega, J. (University of Las Palmas de Gran Canaria, Canary Islands, Spain); FIRST PUBLISHED RESULTS

DIRECT EXPERIMENTAL VALUES

Notes: P, atm.

$T/K = 298.15$

x_1	$V^E/10^{-9}$ m^3mol^{-1}
0.1661	355.7
0.2165	433.4
0.2721	490.3
0.3192	522.3
0.3697	551.0
0.4328	554.9
0.4677	553.6
0.5219	540.6
0.5560	521.5
0.6347	471.1
0.6651	443.1
0.7402	367.2
0.8042	296.3
0.8482	233.4
0.9156	134.4
0.9551	72.4

○ 298.15 K

Points, direct experimental V^E values; curves, V^E_{calc} calculated from the smoothing equation.

SMOOTHING EQUATION

$$V^E_{calc} = x_1 x_2 \sum_{i=1}^{n} a_i(x_1 - x_2)^{i-1}$$

Coeffs. a_i in the smoothing eq., std. deviation σ_{ϕ}, and max. deviation δ_m detd. by least-squares anal.

T/K	a_1	a_2	a_3	a_4	a_5	σ_d	δ_m
			10^{-9} m³mol⁻¹				
298.15	2186.6 (4.7)	−588 (10)	65 (24)			2.8	5.5

The std. deviations ω_i of the coeffs. a_i are given in parentheses

$$\delta_m = \max |V^E_{calc} - V^E| \; ; \; \sigma_d = [\Sigma(V^E_{calc} - V^E)^2/(N-n)]^{1/2}$$

N, no. of direct exptl. values; n, no. of coeffs. a_i

All direct exptl. values equally weighted

AUXILIARY INFORMATION

Apparatus: Vibrating tube densimeter, (Anton Paar, Graz, Austria), Model DMA 602/60. Temp. was controlled to within 0.01 K using a Heto thermostat and was measured by means of a calibrated Pt resistance thermometer.

Procedure: Density, ρ, was calcd. from period of vibration, τ: $\rho = a + b\tau^2$. Consts. a and b were detd. by calibrating the app. (ref. 2) with doubly distd. and degassed H_2O, ρ(298.15 K)/kg m⁻³ = 997.043 (ref. 3) and nonane (Fluka AG, Buchs, Switzerland, 'purum', Lot No. 74252, of stated purity > 99 mole %), ρ(298.15 K)/kg m⁻³ = 713.855 (ref. 4). Mixts. were prepd. by weighing. V^E was calcd. from $V^E = V - (x_1V^*_1 + x_2V^*_2)$, where $V = (x_1M_1 + x_2M_2)/\rho$ is the molar vol. of the mixt. and $V^*_i = V_i(x_i = 1)$ and M_i are, resp., the molar vol. and the molar mass of component i.

Materials: 1. Aldrich Chem. Co., Inc. (Milwaukee, WI, USA) material, of stated purity ~ 99 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; ρ_1(298.15 K)/kg m⁻³ = 1133.06; n(D, 298.15 K) = 1.4524; $M_1/10^{-3}$kg mol⁻¹ = 127.01292.
2. Fluka AG (Buchs, St. Gallen, Switzerland) 'purum' grade material of stated GLC purity > 97 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; ρ_2(298.15 K)/kg m⁻³ = 736.80; n(D, 298.15 K) = 1.4154; $M_2/10^{-3}$kg mol⁻¹ = 156.31156. Materials were degassed ultrasonically before use.

Errors: δT(reproducibility)/K < 0.01; δT(IPTS-68)/K = 0.01; $\delta x_1 = 0.0001$; $\delta V^E/10^{-9}$m³mol⁻¹ < 5.

REFERENCES

1. *Int. DATA Ser.*, Ser. A, *Guideline 2c*, 1979.
2. Ortega, J.; Matos, J. S.; Paz Andrade, M. I.; Jiménez, E. J. *J. Chem. Thermodyn.* 1985, 17, 1127.
3. Riddick, J. A.; Bunger, W. B. *Organic Solvents, II*, in *Techniques of Chemistry*, Weissberger, A., Editor, Wiley-Interscience, New York, 1970.
4. *Anton Paar Information Bull. No. 6*, March 1982.

*Ser. A. Thermodynamic Properties of Non-reacting Binary Systems of Organic Substances

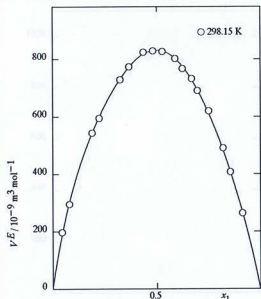|	
Components: 1. 1,4-Dichlorobutane, $C_4H_8Cl_2$	**Author(s):** Blanco, A. M.; Ortega, J. (Universidad de Las Palmas de Gran Canaria, Escuela Superior de Ingenieros Industriales, Cátedra de Termodinámica y Fisicoquímica, Las Palmas de Gran Canaria, Islas Canarias, Spain)
2. Tridecane, $C_{13}H_{28}$	
State: Binary system, single-phase liquid; pure components, both liquid	**Edited by:** Kehiaian, H. V. (Institut de Topologie et de Dynamique des Systèmes, Université Paris VII, CNRS, 1, Rue Guy de la Brosse, 75005 Paris, France)
Variables: V^E, molar excess volume	
x_i, mole fraction of component i	
Parameters: T, temperature	**SOURCE OF DATA**
Constants: P, pressure	
Method: Calculation of V^E from density measurements at constant T and P and variable x_i; ref. 1	Blanco, A. M.; Ortega, J. (University of Las Palmas de Gran Canaria, Canary Islands, Spain); FIRST PUBLISHED RESULTS

DIRECT EXPERIMENTAL VALUES

Notes: P, atm.

$T/K = 298.15$

x_1	$V^E/10^{-9}$ m³mol⁻¹
0.0334	128.0
0.0987	305.1
0.1307	365.2
0.1802	456.9
0.2634	581.4
0.3207	645.1
0.4137	696.9
0.4610	708.9
0.5141	704.3
0.5576	691.8
0.5940	669.2
0.6672	611.4
0.7270	544.5
0.8014	433.5
0.8414	365.0
0.9036	240.3
0.9376	162.3

Points, direct experimental V^E values; curves, V^E_{calc} calculated from the smoothing equation.

SMOOTHING EQUATION

$$V^E_{calc} = x_1 x_2 \sum_{i=1}^{n} a_i (x_1 - x_2)^{i-1}$$

Coeffs. a_i in the smoothing eq., std. deviation σ_d, and max. deviation δ_m detd. by least-squares anal.

T/K	a_1	a_2	a_3	a_4	a_5	σ_d	δ_m
				10^{-9} m³mol⁻¹			
298.15	2816 (11)	−227 (46)	320 (48)	−240 (110)		6.4	15

The std. deviations $\sigma\sigma_i$ of the coeffs. a_i are given in parentheses
$\delta_m = \max |V^E_{calc} - V^E|$; $\sigma_d = [\Sigma (V^E_{calc} - V^E)^2/(N-n)]^{1/2}$
N, no. of direct exptl. values; n, no. of coefs.
All direct exptl. values equally weighted

AUXILIARY INFORMATION

Apparatus: Vibrating tube densimeter, (Anton Paar, Graz, Austria), Model DMA 602/60. Temp. was controlled to within 0.01 K using a Heto thermostat and was measured by means of a calibrated Pt resistance thermometer.

Procedure: Density, ρ, was calcd. from period of vibration, τ: $\rho = a + b\tau^2$. Consts. a and b were detd. by calibrating the app. (ref. 2) with doubly distd. and degassed H_2O, $\rho(298.15 K)/kg·m^{-3} = 997.043$ (ref. 3) and nonane (Fluka AG, Buchs, Switzerland, 'purum', Lot No. 74252, of stated purity > 99 mole %), $\rho(298.15 K)/kg·m^{-3} = 713.855$ (ref. 4). Mixts. were prepd. by weighing. V^E was calcd. from $V^E = V - (x_1 V^*_1 + x_2 V^*_2)$, where $V^*_i = (x_1 M_1 + x_2 M_2)/\rho$ is the molar vol. of the mixt. and $V^*_i = V/x_i$ ($x_i = 1$) and M_i are, resp., the molar vol. and the molar mass of component i.

Materials: 1. Aldrich Chem. Co., Inc. (Milwaukee, WI, USA) material, of stated purity ~ 99 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; $\rho_1(298.15 K)/kg·m^{-3} = 1133.06$; $n(D, 298.15 K) = 1.4524$; $M_1/10^{-3} kg·mol^{-1} = 127.01292$.
2. Fluka AG (Buchs, St. Gallen, Switzerland) 'puriss' grade material of stated GLC purity > 99.5 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; $\rho_2(298.15 K)/kg·m^{-3} = 752.79$; $n(D, 298.15 K) = 1.4238$; $M_2/10^{-3} kg·mol^{-1} = 184.36532$.
Materials were degassed ultrasonically before use.

Errors: $\delta T(\text{reproducibility})/K < 0.01$; $\delta T(\text{IPTS-68})/K = 0.01$; $\delta x_1 = 0.0001$; $\delta V^E/10^{-9} m^3 mol^{-1} < 5$.

REFERENCES

1. Int. DATA Ser., Ser. A, Guideline 2c, 1979.
2. Ortega, J.; Matos, J. S.; Paz Andrade, M. I.; Jiménez, E. J. J. Chem. Thermodyn. 1985, 17, 1127.
3. Riddick, J. A.; Bunger, W. B. Organic Solvents, II, in Techniques of Chemistry, Weissberger, A., Editor, Wiley-Interscience, New York, 1970.
4. Anton Paar Information Bull. No. 6, March 1982.

*Ser. A. Thermodynamic Properties of Non-reacting Binary Systems of Organic Substances

Components:	1. 1,4-Dichlorobutane, $C_4H_8Cl_2$
	2. Pentadecane, $C_{15}H_{32}$

State: Binary system, single-phase liquid; pure components, both liquid
Variables: V^E, molar excess volume
x_i, mole fraction of component i
Parameters: T, temperature
Constants: P, pressure
Method: Calculation of V^E from density measurements at constant T and P and variable x_i; ref. 1

Author(s): Blanco, A. M.; Ortega, J. (Universidad de Las Palmas de Gran Canaria, Escuela Superior de Ingenieros Industriales, Cátedra de Termodinámica y Fisicoquímica, Las Palmas de Gran Canaria, Islas Canarias, Spain)

Edited by: Kehiaian, H. V. (Institut de Topologie et de Dynamique des Systèmes, Université Paris VII, CNRS, 1, Rue Guy de la Brosse, 75005 Paris, France)

SOURCE OF DATA
Blanco, A. M.; Ortega, J. (University of Las Palmas de Gran Canaria, Canary Islands, Spain); FIRST PUBLISHED RESULTS

DIRECT EXPERIMENTAL VALUES

Notes: P, atm.

T/K = 298.15

x_1	$V^E/10^{-9}$ m^{3}mol^{-1}
0.0453	196.2
0.0803	293.6
0.1906	541.3
0.2232	592.6
0.3231	727.0
0.3663	771.2
0.4362	822.3
0.4820	826.0
0.5273	824.4
0.5889	799.9
0.6246	765.0
0.6686	729.8
0.6963	689.1
0.7499	617.8
0.8195	489.2
0.8548	405.9
0.9138	262.9

○ 298.15 K

Points, direct experimental V^E values; curves, V^E_{calc} calculated from the smoothing equation.

SMOOTHING EQUATION

$$V^E_{calc} = x_1 x_2 \sum_{i=1}^{n} a_i (x_1 - x_2)^{i-1}$$

Coeffs. a_i in the smoothing eq., std. deviation σ_d and max. deviation δ_m detd. by least-squares anal.

T/K	a_1	a_2	a_3	a_4	a_5	σ_d	δ_m
			10^{-9}m^{3}mol^{-1}				
298.15	3316 (11)	0 (37)	−260 (120)	−532 (99)	1180 (210)	5.7	9.8

The std. deviations σa_i of the coeffs. a_i are given in parentheses

$\delta_m = \max |V^E_{calc} - V^E|$; $\sigma_d = [\Sigma(V^E_{calc} - V^E)^2/(N-n)]^{1/2}$

N, no. of direct exptl. values; n, no. of coeffs.
All direct exptl. values equally weighted

AUXILIARY INFORMATION

Apparatus: Vibrating tube densimeter, (Anton Paar, Graz, Austria), Model DMA 602/60. Temp. was controlled to within 0.01 K using a Heto thermostat and was measured by means of a calibrated Pt resistance thermometer.

Procedure: Density, ρ, was calc. from period of vibration, τ: $\rho = a + b\tau^2$. Consts. a and b were detd. by calibrating the app. (ref. 2) with doubly distd. and degassed H$_2$O, ρ(298.15 K)/kg m^{-3} = 997.043 (ref. 3) and nonane (Fluka AG, Buchs, Switzerland, 'purum', Lot No. 74252, of stated purity > 99 mole %), ρ(298.15 K)/kg m^{-3} = 713.855 (ref. 4). Mixts. were prepd. by weighing. V^E was calc. from $V^E = V - (x_1V_1^* + x_2V_2^*)$, where $V = (x_1M_1 + x_2M_2)/\rho$ is the molar vol. of the mixt. and $V_i^* = V(x_i = 1)$ and M_i are, resp., the molar vol. and the molar mass of component i.

Materials: 1. Aldrich Chem. Co., Inc. (Milwaukee, WI, USA) material, of stated purity ~ 99 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; ρ_1(298.15 K)/kg m^{-3} = 1133.06; n(D, 298.15 K) = 1.4524; $M_1/10^{-3}$kg mol^{-1} = 127.01292.
2. Fluka AG (Buchs, St. Gallen, Switzerland) 'purum' grade material of stated GLC purity > 98 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; ρ_2(298.15 K)/kg m^{-3} = 764.80; n(D, 298.15 K) = 1.4298; $M_2/10^{-3}$ kg mol^{-1} = 212.41908.
Materials were degassed ultrasonically before use.

Errors: δT(reproducibility)/K < 0.01; δT(IPTS-68)/K = 0.01; $\delta x_1 = 0.0001$; $\delta V^E/10^{-9}$m^{3}mol^{-1} < 5.

REFERENCES
1. Int. DATA Ser., Ser. A, Guideline 2c, 1979.
2. Ortega, J.; Matos, J. S.; Paz Andrade, M. I.; Jiménez, E. J. J. Chem. Thermodyn. 1985, 17, 1127.
3. Riddick, J. A.; Bunger, W. B. Organic Solvents, II, in Techniques of Chemistry, Weissberger, A., Editor, Wiley-Interscience, New York, 1970.
4. Anton Paar Information Bull. No. 6, March 1982.

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Components:	1. 1,4-Dichlorobutane, $C_4H_8Cl_2$
	2. Heptadecane, $C_{17}H_{36}$
State:	Binary system, single-phase liquid; pure components, both liquid
Variables:	V^E, molar excess volume
	x_i, mole fraction of component i
Parameters:	T, temperature
Constants:	P, pressure
Method:	Calculation of V^E from density measurements at constant T and P and variable x_i; ref. 1

Author(s): Blanco, A. M.; Ortega, J. (Universidad de Las Palmas de Gran Canaria, Escuela Superior de Ingenieros Industriales, Cátedra de Termodinámica y Fisicoquímica, Las Palmas de Gran Canaria, Islas Canarias, Spain)

Edited by: Kehiaian, H. V. (Institut de Topologie et de Dynamique des Systèmes, Université Paris VII, CNRS, 1, Rue Guy de la Brosse, 75005 Paris, France)
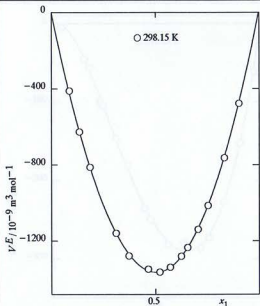
SOURCE OF DATA

Blanco, A. M.; Ortega, J. (University of Las Palmas de Gran Canaria, Canary Islands; Spain); FIRST PUBLISHED RESULTS

DIRECT EXPERIMENTAL VALUES

Notes: P, atm.

T/K = 298.15

x_1	$V_1^E/10^{-9}$ $m^3 mol^{-1}$
0.1227	414.9
0.1637	526.8
0.2785	764.9
0.3662	896.5
0.3952	896.6
0.4646	920.7
0.5244	934.1
0.5609	924.6
0.6164	896.8
0.6526	861.2
0.6912	814.6
0.7546	716.9
0.8019	618.8
0.8545	503.1
0.8965	380.8
0.9585	170.0
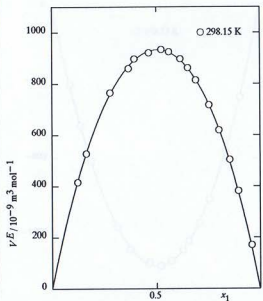
Points, direct experimental V^E values; curves, V_{calc}^E calculated from the smoothing equation.

SMOOTHING EQUATION

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

Coeffs. a_i in the smoothing eq. std. deviation σ_d and max. deviation δ_m detd. by least-squares anal.

T/K	a_1	a_2	a_3	a_4	a_5	σ_d	δ_m
			$10^{-9} m^3 mol^{-1}$				
298.15	3730.1 (8.4)	96 (19)	416 (42)			5.1	7.6

The std. deviations σa_i of the coeffs. a_i are given in parentheses

$\delta_m = \max |V_{calc}^E - V^E|$; $\sigma_d = [\Sigma (V_{calc}^E - V^E)^2/(N - n)]^{1/2}$

N, no. of direct exptl. values; n, no. of coeffs. a_i
All direct exptl. values equally weighted

AUXILIARY INFORMATION

Apparatus: Vibrating tube densimeter, (Anton Paar, Graz, Austria), Model DMA 602/60. Temp. was controlled to within 0.01 K using a Heto thermostat and was measured by means of a calibrated Pt resistance thermometer.

Procedure: Density, ρ, was calcd. from period of vibration, τ: $\rho = a + b\tau^2$. Consts. a and b were detd. by calibrating the app. (ref. 2) with doubly distd. and degassed H_2O, ρ(298.15 K)/kg m^{-3} = 997.043 (ref. 3) and nonane (Fluka AG, Buchs, Switzerland, 'purum', Lot No. 74252, of stated purity > 99 mole %), ρ(298.15 K)/kg m^{-3} = 713.855 (ref. 4). Mixts. were prepd. by weighing. V^E was calcd. from $V^E = V - (x_1 V_1^* + x_2 V_2^*)$, where $V = (x_1 M_1 + x_2 M_2)/\rho$ is the molar vol. of the mixt. and $V_i^* = V_i(x_i = 1)$ and M_i are, resp., the molar vol. and the molar mass of component i.

Materials: 1. Aldrich Chem. Co., Inc. (Milwaukee, WI, USA) material, of stated purity ~ 99 mole %, dried over mol. sieve type 3A (from Fluka) and used without further purification; ρ_1(298.15 K)/kg m^{-3} = 1133.06; n(D, 298.15 K) = 1.4524; M_1/10^{-3}kg mol^{-1} = 127.01292.
2. Fluka AG (Buchs, St. Gallen, Switzerland) 'purum' grade material of stated GLC purity ~ 99 mole %, dried over mol. sieve type 3A (from Fluka) and used without further purification; ρ_2(298.15 K)/kg m^{-3} = 774.33; n(D, 298.15 K) = 1.4347; M_2/10^{-3}kg mol^{-1} = 240.47284.
Materials were degassed ultrasonically before use.

Errors: δT(reproducibility)/K < 0.01; δT(IPTS-68)/K = 0.01; $\delta x_1 = 0.0001$; δV^E/10^{-9}m^{3}mol^{-1} < 5.

REFERENCES

1. *Int. DATA Ser., Ser. A*, Guideline 2c, 1979.
2. Ortega, J.; Matos, J. S.; Paz Andrade, M. I.; Jiménez, E. J. *J. Chem. Thermodyn.* 1985, 17, 1127.
3. Riddick, J. A.; Bunger, W. B. *Organic Solvents, II*, in *Techniques of Chemistry*, Weissberger, A., Editor, Wiley-Interscience, New York, 1970.
4. *Anton Paar Information Bull. No. 6*, March 1982.

Received: March 15, 1993

Published: July 31, 1993

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*Ser. A. Thermodynamic Properties of Non-reacting Binary Systems of Organic Substances

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Components:	1. 1,5-Dichloropentane, $C_5H_{10}Cl_2$
	2. Pentane, C_5H_{12}
State:	Binary system, single-phase liquid; pure components, both liquid
Variables:	V^E, molar excess volume
	x_i, mole fraction of component i
Parameters:	T, temperature
Constants:	P, pressure
Method:	Calculation of V^E from density measurements at constant T and P and variable x_i; ref. 1

Author(s): Blanco, A. M.; Ortega, J. (Universidad de Las Palmas de Gran Canaria, Escuela Superior de Ingenieros Industriales, Cátedra de Termodinámica y Fisicoquímica, Las Palmas de Gran Canaria, Islas Canarias, Spain)

Edited by: Kehiaian, H. V. (Institut de Topologie et de Dynamique des Systèmes, Université Paris VII, CNRS, 1, Rue Guy de la Brosse, 75005 Paris, France)
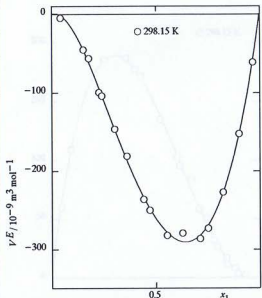
SOURCE OF DATA

Blanco, A. M.; Ortega, J. (University of Las Palmas de Gran Canaria, Canary Islands, Spain); FIRST PUBLISHED RESULTS

DIRECT EXPERIMENTAL VALUES

Notes: P, atm.

T/K = 298.15

x_1	$V^E/10^{-9}$ m³mol⁻¹			
0.0865	−412.2			
0.1345	−626.1			
0.1848	−813.4			
0.3104	−1160.4			
0.3716	−1279.4			
0.4652	−1348.4			
0.5204	−1362.5			
0.5718	−1337.5			
0.6252	−1280.1			
0.6564	−1235.3			
0.7073	−1139.6			
0.7541	−1014.6			
0.8329	−764.2			
0.9039	−477.1			

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

SMOOTHING EQUATION

$$V^E_{calc} = x_1 x_2 \sum_{i=1}^{n} a_i(x_1 - x_2)^{i-1}$$

Coeffs. a_i in the smoothing eq., std. deviation σ_d and max. deviation δ_m detd. by least-squares anal.

T/K	a_1	a_2	a_3	a_4	a_5	σ_d	δ_m
				10^{-9}m³mol⁻¹			
298.15	−5458.5 (9.9)	−79 (21)	64 (47)			5.5	11

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

$\delta_m = \max |V^E_{calc} - V^E|$; $\sigma_d = [\Sigma(V^E_{calc} - V^E)^2/(N-n)]^{1/2}$

N, no. of direct exptl. values; n, no. of coeffs. a_i
All direct exptl. values equally weighted

AUXILIARY INFORMATION

Apparatus: Vibrating tube densimeter, (Anton Paar, Graz, Austria), Model DMA 602/60. Temp. was controlled to within 0.01 K using a Heto thermostat and was measured by means of a calibrated Pt resistance thermometer.

Procedure: Density, ρ, was calcd. from period of vibration, τ: $\rho = a + b\tau^2$. Consts. a and b were detd. by calibrating the app. (ref. 2) with doubly distd. and degassed H_2O, ρ(298.15 K)/kg m⁻³ = 997.043 (ref. 3) and nonane (Fluka AG, Buchs, Switzerland, 'purum', Lot No. 74252, of stated purity > 99 mole %), ρ(298.15 K)/kg m⁻³ = 713.855 (ref. 4). Mixts. were prepd. by weighing. V^E was calcd. from $V^E = V - (x_1V_1^* + x_2V_2^*)$, where $V = (x_1M_1 + x_2M_2)/\rho$ is the molar vol. of the mixt. and $V_i^* = V_i(x_i = 1)$ and M_i are, resp., the molar vol. and the molar mass of component i.

Materials: 1. Aldrich Chem. Co., Inc. (Milwaukee, WI, USA) material, of stated purity ~ 99 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; ρ_1(298.15 K)/kg m⁻³ = 1095.27; n(D, 298.15 K) = 1.4545; $M_1/10^{-3}$kg mol⁻¹ = 141.0398.
2. Fluka AG (Buchs, St. Gallen, Switzerland) 'puriss' grade material of stated GLC purity > 99.5 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; ρ_2(298.15 K)/kg m⁻³ = 621.31; n(D, 298.15 K) = 1.3547; $M_2/10^{-3}$kg mol⁻¹ = 72.15028.
Materials were degassed ultrasonically before use.

Errors: δT(reproducibility)/K < 0.01; δT(IPTS-68)/K = 0.01; $\delta x_1 = 0.0001$; $\delta V^E/10^{-9}$m³mol⁻¹ < 5.

REFERENCES

1. *Int. DATA Ser., Ser. A*, Guideline 2c, 1979.
2. Ortega, J.; Matos, J. S.; Paz Andrade, M. I.; Jiménez, E. J. *J. Chem. Thermodyn.* 1985, 17, 1127.
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4. *Anton Paar Information Bull. No. 6*, March 1982.

Received: March 15, 1993   Published: July 31, 1993

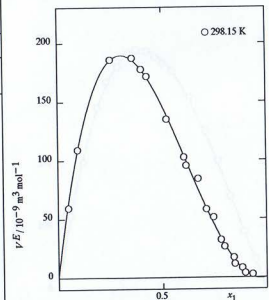| Components: | 1. 1,5-Dichloropentane, $C_5H_{10}Cl_2$ |
	2. Heptane, C_7H_{16}
State:	Binary system, single-phase liquid; pure components, both liquid
Variables:	V^E, molar excess volume
	x_i, mole fraction of component i
Parameters:	T, temperature
Constants:	P, pressure
Method:	Calculation of V^E from density measurements at constant T and P and variable x_i; ref. 1

Author(s): Blanco, A. M.; Ortega, J. (Universidad de Las Palmas de Gran Canaria, Escuela Superior de Ingenieros Industriales, Cátedra de Termodinámica y Fisicoquímica, Las Palmas de Gran Canaria, Islas Canarias, Spain)

Edited by: Kehiaian, H. V. (Institut de Topologie et de Dynamique des Systèmes, Université Paris VII, CNRS, 1, Rue Guy de la Brosse, 75005 Paris, France)

SOURCE OF DATA

Blanco, A. M.; Ortega, J. (University of Las Palmas de Gran Canaria, Canary Islands, Spain); FIRST PUBLISHED RESULTS

DIRECT EXPERIMENTAL VALUES

Notes: P, atm.

$T/K = 298.15$

x_1	$V^E/10^{-9}$ m^3mol^{-1}
0.0417	−5.1
0.1523	−45.8
0.1771	−56.6
0.2275	−99.9
0.2410	−104.7
0.3030	−181.5
0.3610	−181.5
0.4409	−236.9
0.4697	−250.7
0.5524	−282.8
0.6289	−279.9
0.7128	−286.8
0.7510	−273.8
0.8233	−227.7
0.9007	−153.0
0.9676	−61.6

$V^E / 10^{-9} \, m^3 \, mol^{-1}$ vs x_1, ○ 298.15 K

Points, direct experimental V^E values; curves, V^E_{calc} calculated from the smoothing equation.

SMOOTHING EQUATION

$$V^E_{calc} = x_1 x_2 \sum_{i=1}^{n} a_i (x_1 - x_2)^{i-1}$$

Coeffs. a_i in the smoothing eq., std. deviation σ_d, and max. deviation δ_m detd. by least-squares anal.

T/K	a_1	a_2	a_3	a_4	a_5	σ_d	δ_m
			$10^{-9} m^3 mol^{-1}$				
298.15	−1044.7 (9.1)	−797 (35)	112 (41)	−232 (96)		4.9	11

The std. deviations σa_i of the coeffs. a_i are given in parentheses.

$\delta_m = \max |V^E_{calc} - V^E|$; $\sigma_d = [\Sigma (V^E_{calc} - V^E)^2/(N-n)]^{1/2}$

N, no. of direct exptl. values; n, no. of coeffs. a_i
All direct exptl. values equally weighted

AUXILIARY INFORMATION

Apparatus: Vibrating tube densimeter, (Anton Paar, Graz, Austria). Model DMA 602/60. Temp. was controlled to within 0.01 K using a Heto thermostat and was measured by means of a calibrated Pt resistance thermometer.

Procedure: Density, ρ, was calcd. from period of vibration, τ: $\rho = a + b\tau^2$. Consts. a and b were detd. by calibrating the app. (ref. 2) with doubly distd. and degassed H_2O, $\rho(298.15 \text{ K})/kg \cdot m^{-3} = 997.043$ (ref. 3) and nonane (Fluka AG, Buchs, Switzerland, 'purum', Lot No. 74252, of stated purity > 99 mole %), $\rho(298.15 \text{ K})/kg \cdot m^{-3} = 713.855$ (ref. 4). Mixts. were prepd. by weighing. V^E was calcd. from $V^E = V - (x_1 V_1^* + x_2 V_2^*)$, where $V = (x_1 M_1 + x_2 M_2)/\rho$ is the molar vol. of the mixt. and $V_i^* = V(x_i = 1)$ are, resp., the molar vol. and the molar mass of component i.

Materials: 1. Aldrich Chem. Co., Inc. (Milwaukee, WI, USA) material, of stated purity ~ 99 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; $\rho_1(298.15 \text{ K})/kg \cdot m^{-3} = 1095.27$; $n(D, 298.15 \text{ K}) = 1.4545$; $M_1/10^{-3}kg \cdot mol^{-1} = 141.0398$.
2. Fluka AG (Buchs, St. Gallen, Switzerland) 'puriss' grade material of stated GLC purity > 99.5 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; $\rho_2(298.15 \text{ K})/kg \cdot m^{-3} = 679.46$; $n(D, 298.15 \text{ K}) = 1.3851$; $M_2/10^{-3}kg \cdot mol^{-1} = 100.20404$.
Materials were degassed ultrasonically before use.

Errors: δT(reproducibility)/K < 0.01; δT(IPTS-68)/K = 0.01; $\delta x_1 = 0.0001$; $\delta V^E/10^{-9}m^3mol^{-1} < 5$.

REFERENCES
1. *Int. DATA Ser., Ser. A, Guideline 2c*, 1979.
2. Ortega, J.; Matos, J. S.; Paz Andrade, M. I.; Jiménez, E. J. *J. Chem. Thermodyn.* 1985, 17, 1127.
3. Riddick, J. A.; Bunger, W. B. *Organic Solvents, II*, in *Techniques of Chemistry*, Weissberger, A., Editor, Wiley-Interscience, New York, 1970.
4. *Anton Paar Information Bull. No. 6*, March 1982.

*Ser. A. Thermodynamic Properties of Non-reacting Binary Systems of Organic Substances

Published by Thermodynamics Research Center

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

Author(s): Blanco, A. M.; Ortega, J. (Universidad de Las Palmas de Gran Canaria, Escuela Superior de Ingenieros Industriales, Cátedra de Termodinámica y Fisicoquímica, Las Palmas de Gran Canaria, Islas Canarias, Spain)

Edited by: Kehiaian, H. V. (Institut de Topologie et de Dynamique des Systèmes, Université Paris VII, CNRS, 1, Rue Guy de la Brosse, 75005 Paris, France)

Components:
1. 1,5-Dichloropentane, $C_5H_{10}Cl_2$
2. Nonane, C_9H_{20}

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

Variables: V^E, molar excess volume

x_i mole fraction of component i

Parameters:

Constants: P, temperature

Constants: P, pressure

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

SOURCE OF DATA

Blanco, A. M.; Ortega, J. (University of Las Palmas de Gran Canaria, Canary Islands, Spain); FIRST PUBLISHED RESULTS

DIRECT EXPERIMENTAL VALUES

Notes: P, atm.

$T/K = 298.15$

x_1	$V^E/10^{-9}$ m^3mol^{-1}
0.0496	59.0
0.0950	105.8
0.2553	185.4
0.3596	183.6
0.4017	177.4
0.4278	171.2
0.5222	134.6
0.6052	102.2
0.6168	95.2
0.6729	83.9
0.7111	57.7
0.7460	50.8
0.7801	31.8
0.7982	25.8
0.8419	16.7
0.8475	11.0
0.8819	7.7
0.8960	3.4
0.9316	2.3

Points, direct experimental V^E values; curves, V^E_{calc} calculated from the smoothing equation.

○ 298.15 K

SMOOTHING EQUATION

$$V^E_{calc} = x_1 x_2 \sum_{i=1}^{n} a_i(x_1 - x_2)^{i-1}$$

Coeffs. a_i in the smoothing eq., std. deviation σ_d, and max. deviation δ_m detd. by least-squares anal.

T/K	a_1	a_2	a_3	a_4	a_5	σ_d	δ_m
						$10^{-9}m^3mol^{-1}$	
298.15	587.8 (5.8)	−756 (13)	86 (28)			3.4	9.0

The std. deviations σ_j of the coeffs. a_i are given in parentheses

$$\delta_m = \max |V^E_{calc} - V^E| \; ; \; \sigma_d = [\Sigma(V^E_{calc} - V^E)^2/(N-n)]^{1/2}$$

N, no. of direct exptl. values; n, no. of coeffs. a_i
All direct exptl. values equally weighted

AUXILIARY INFORMATION

Apparatus: Vibrating tube densimeter, (Anton Paar, Graz, Austria), Model DMA 602/60. Temp. was controlled to within 0.01 K using a Heto thermostat and was measured by means of a calibrated Pt resistance thermometer.

Procedure: Density, ρ, was calcd. from period of vibration, τ: $\rho = a + b\tau^2$. Consts. a and b were detd. by calibrating the app. (ref. 2) with doubly distd. and degassed H_2O, $\rho(298.15$ K/kg m^{-3} = 997.043 (ref. 3) and nonane (Fluka AG, Buchs, Switzerland, 'purum', Lot No. 74252, of stated purity > 99 mole %), $\rho(298.15$ K/kg m^{-3} = 713.855 (ref. 4). Mixts. were prepd. by weighing. V^E was calcd. from $V^E = V - (x_1V^*_1 + x_2V^*_2)$, where $V = (x_1M_1 + x_2M_2)/\rho$ is the molar vol. of the mixt. and $V^*_i = V(x_i = 1)$ and M_i are, resp., the molar vol. and the molar mass of component i.

Materials: 1. Aldrich Chem. Co., Inc. (Milwaukee, WI, USA) material, of stated purity ~ 99 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; $\rho_1(298.15$ K/kg m^{-3} = 1095.27; $n(D, 298.15$ K) = 1.4545; $M_1/10^{-3}$kg mol^{-1} = 141.0398.
2. Fluka AG (Buchs, St. Gallen, Switzerland) 'purum' grade material of stated GLC purity > 99 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; $\rho_2(298.15$ K/kg m^{-3} = 713.855; $n(D, 298.15$ K) = 1.4033; $M_2/10^{-3}$kg mol^{-1} = 128.2578.
Materials were degassed ultrasonically before use.

Errors: δT(reproducibility)/K < 0.01; δT(IPTS-68)/K = 0.01; $\Delta x_1 = 0.0001$; $\delta V^E/10^{-9}m^3mol^{-1}$ < 5.

REFERENCES

1. *Int. DATA Ser., Ser. A*, Guideline 2c, 1979.
2. Ortega, J.; Matos, J. S.; Paz Andrade, M. I.; Jiménez, E. J. *J. Chem. Thermodyn.* 1985, 17, 1127.
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*Ser. A. Thermodynamic Properties of Non-reacting Binary Systems of Organic Substances

0147-1503/93/9303-0221$2.20

Components:	1. 1,5-Dichloropentane, $C_5H_{10}Cl_2$
	2. Undecane, $C_{11}H_{24}$
State:	Binary system, single-phase liquid; pure components, both liquid
Variables:	V_m^E, molar excess volume
	x_i, mole fraction of component i
Parameters:	T, temperature
Constants:	P, pressure
Method:	Calculation of V^E from density measurements at constant T and P and variable x_i; ref. 1

Author(s): Blanco, A. M.; Ortega, J. (Universidad de Las Palmas de Gran Canaria, Escuela Superior de Ingenieros Industriales, Cátedra de Termodinámica y Fisicoquímica, Las Palmas de Gran Canaria, Islas Canarias, Spain)

Edited by: Kehiaian, H. V. (Institut de Topologie et de Dynamique des Systèmes, Université Paris VII, CNRS, 1, Rue Guy de la Brosse, 75005 Paris, France)
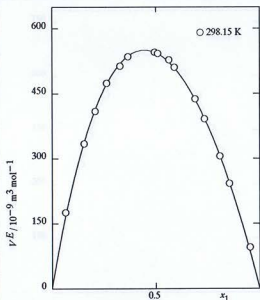
SOURCE OF DATA

Blanco, A. M.; Ortega, J. (University of Las Palmas de Gran Canaria, Canary Islands, Spain); FIRST PUBLISHED RESULTS

DIRECT EXPERIMENTAL VALUES

Notes: P, atm.

$T/K = 298.15$

x_1	$V_m^E/10^{-9}$ m^3mol^{-1}
0.0599	117.3
0.1239	203.8
0.1914	290.9
0.2362	332.8
0.2913	355.4
0.3429	377.4
0.3800	382.1
0.4308	380.1
0.4709	371.1
0.5073	361.0
0.5519	348.2
0.6360	307.1
0.7130	252.9
0.7711	205.5
0.8293	148.1
0.8951	91.4
0.9488	47.7
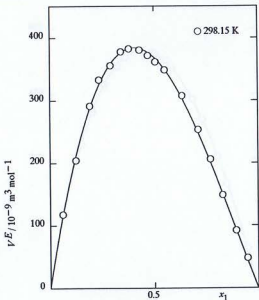
○ 298.15 K

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

SMOOTHING EQUATION

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

Coeffs. a_i in the smoothing eq., std. deviation σ_d and max. deviation δ_m detd. by least-squares anal.

T/K	a_1	a_2	a_3	a_4	a_5	σ_d	δ_m
					$10^{-9} m^3 mol^{-1}$		
298.15	1475.3 (5.6)	−613 (15)				4.4	8.3

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

$\delta_m = \max |V_{calc}^E - V^E|$; $\sigma_d = [\Sigma(V_{calc}^E - V^E)^2/(N-n)]^{1/2}$

N, no. of direct exptl. values; n, no. of coeffs. a_i
All direct exptl. values equally weighted

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AUXILIARY INFORMATION

Apparatus:	Vibrating tube densimeter, (Anton Paar, Graz, Austria), Model DMA 602/60. Temp. was controlled to within 0.01 K using a Heto thermostat and was measured by means of a calibrated Pt resistance thermometer.
Procedure:	Density, ρ, was calcd. from period of vibration, τ: $\rho = a + b\tau^2$. Consts. a and b were detd. by calibrating the app. (ref. 2) with doubly distd. and degassed H_2O, $\rho(298.15 K)/kg\ m^{-3} = 997.043$ (ref. 3) and nonane (Fluka AG, Buchs, Switzerland, 'purum', Lot No. 74252, of stated purity > 99 mole %), $\rho(298.15 K)/kg\ m^{-3} = 713.855$ (ref. 4). Mixts. were prepd. by weighing. V^E was calcd. from $V^E = V - (x_1V_1^* + x_2V_2^*)$, where $V = (x_1M_1 + x_2M_2)/\rho$ is the molar vol. of the mixt. and $V_i^* = V_i(x_i = 1)$ and M_i are, resp., the molar vol. and the molar mass of component i.
Materials:	1. Aldrich Chem. Co., Inc. (Milwaukee, WI, USA) material, of stated purity ~ 99 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification: $\rho_1(298.15 K)/kg\ m^{-3} = 1095.27$; $n(D, 298.15 K) = 1.4545$; $M_1/10^{-3}kg\ mol^{-1} = 141.0398$.
	2. Fluka AG (Buchs, St. Gallen, Switzerland) 'purum' grade material of stated GLC purity > 97 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification: $\rho_2(298.15 K)/kg\ m^{-3} = 736.80$; $n(D, 298.15 K) = 1.4154$; $M_2/10^{-3}kg\ mol^{-1} = 156.31156$. Materials were degassed ultrasonically before use.
Errors:	δT(reproducibility)/K < 0.01; δT(IPTS-68)/K = 0.01; $\delta x_1 = 0.0001$; $\delta V^E/10^{-9}m^3mol^{-1} < 5$.

REFERENCES

1. *Int. DATA Ser., Ser. A, Guideline 2c*, 1979.
2. Ortega, J.; Matos, J. S.; Paz Andrade, M. I.; Jiménez, E. J. *J. Chem. Thermodyn.* 1985, 17, 1127.
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*Ser. A. Thermodynamic Properties of Non-reacting Binary Systems of Organic Substances

Published by Thermodynamics Research Center

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

| Components: | 1. 1,5-Dichloropentane, $C_5H_{10}Cl_2$ |
| | 2. Tridecane, $C_{13}H_{28}$ |

Author(s): Blanco, A. M.; Ortega, J. (Universidad de Las Palmas de Gran Canaria, Escuela Superior de Ingenieros Industriales, Cátedra de Termodinámica y Fisicoquímica, Las Palmas de Gran Canaria, Islas Canarias, Spain)

Edited by: Kehiaian, H. V. (Institut de Topologie et de Dynamique des Systèmes, Université Paris VII, CNRS, 1, Rue Guy de la Brosse, 75005 Paris, France)

| State: | Binary system, single-phase liquid; pure components, both liquid |
Variables:	V^E, molar excess volume
	x_i, mole fraction of component i
Parameters:	T, temperature
Constants:	P, pressure
Method:	Calculation of V^E from density measurements at constant T and P and variable x_i; ref. 1

SOURCE OF DATA

Blanco, A. M.; Ortega, J. (University of Las Palmas de Gran Canaria, Canary Islands, Spain); FIRST PUBLISHED RESULTS

DIRECT EXPERIMENTAL VALUES

Notes: P, atm.

T/K = 298.15

x_1	$V^E/10^{-9}$ m^{3}mol^{-1}
0.0651	175.7
0.1552	334.5
0.2080	414.0
0.2640	474.6
0.3278	513.8
0.3668	535.5
0.4942	545.9
0.5107	543.2
0.5638	528.1
0.5897	410.9
0.6900	437.8
0.7347	392.1
0.8080	345.8
0.8553	242.6
0.9532	95.1

Points, direct experimental V^E values; curves, V^E_{calc} calculated from the smoothing equation.

SMOOTHING EQUATION

$$V^E_{calc} = x_1 x_2 \sum_{i=1}^{n} a_i (x_1 - x_2)^{i-1}$$

Coeffs. a_i in the smoothing eq., std. deviation σ_d and max. deviation δ_m detd. by least-squares anal.

T/K	a_1	a_2	a_3	a_4	a_5	σ_d	δ_m
				10^{-9}m^{3}mol^{-1}			
298.15	2178.8 (8.2)	−432 (17)	211 (40)			4.7	10

The std. deviations σa_i of the coeffs. a_i are given in parentheses

$\delta_m = \max |V^E_{calc} - V^E|$; $\sigma_d = [\Sigma(V^E_{calc} - V^E)^2/(N - n)]^{1/2}$

N, no. of direct exptl. values; n, no. of coefs. a_i
All direct exptl. values equally weighted

AUXILIARY INFORMATION

Apparatus: Vibrating tube densimeter, (Anton Paar, Graz, Austria), Model DMA 602/60. Temp. was controlled to within 0.01 K using a Heto thermostat and was measured by means of a calibrated Pt resistance thermometer.

Procedure: Density, ρ, was calcd. from period of vibration, τ; $\rho = a + b\tau^2$. Consts. a and b were detd. by calibrating the app. (ref. 2) with doubly distd. and degassed H$_2$O, ρ(298.15 K)/kg m^{-3} = 997.043 (ref. 3) and nonane (Fluka AG, Buchs, Switzerland, 'purum', Lot No. 74252, of stated purity > 99 mole %), ρ(298.15 K)/kg m^{-3} = 713.855 (ref. 4). Mixts. were prepd. by weighing. V^E was calcd. from $V^E = V - (x_1V^*_1 + x_2V^*_2)$, where $V = (x_1M_1 + x_2M_2)/\rho$ is the molar vol. of the mixt. and $V^*_i = V(x_i = 1)$ and M_i are, resp., the molar vol. and the molar mass of component i.

Materials: 1. Aldrich Chem. Co., Inc. (Milwaukee, WI, USA) material, of stated purity ~ 99 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; ρ_1(298.15 K)/kg m^{-3} = 1095.27; n(D, 298.15 K) = 1.4545; M_1/10^{-3}kg mol^{-1} = 141.0398.
2. Fluka AG (Buchs, St. Gallen, Switzerland) 'puriss' grade material of stated GLC purity > 99.5 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; ρ_2(298.15 K)/kg m^{-3} = 752.79; n(D, 298.15 K) = 1.4238; M_2/10^{-3}kg mol^{-1} = 184.36532.
Materials were degassed ultrasonically before use.

Errors: δT(reproducibility)/K < 0.01; δT(IPTS-68)/K = 0.01; δx_1 = 0.0001; δV^E/10^{-9}m^{3}mol^{-1} < 5.

REFERENCES

1. *Int. DATA Ser., Ser. A, Guideline 2c*, 1979.
2. Ortega, J.; Matos, J. S.; Paz Andrade, M. I.; Jiménez, E. J. *J. Chem. Thermodyn.* 1985, 17, 1127.
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*Ser. A. Thermodynamic Properties of Non-reacting Binary Systems of Organic Substances

| Components: | 1. 1,5-Dichloropentane, $C_5H_{10}Cl_2$ |
| | 2. Pentadecane, $C_{15}H_{32}$ |

State: Binary system, single-phase liquid; pure components, both liquid
Variables: V^E, molar excess volume
x_2, mole fraction of component i
Parameters: T, temperature
Constants: P, pressure
Method: Calculation of V^E from density measurements at constant T and P and variable x_i: ref. 1

Author(s): Blanco, A. M.; Ortega, J. (Universidad de Las Palmas de Gran Canaria, Escuela Superior de Ingenieros Industriales, Cátedra de Termodinámica y Fisicoquímica, Las Palmas de Gran Canaria, Islas Canarias, Spain)

Edited by: Kehiaian, H. V. (Institut de Topologie et de Dynamique des Systèmes, Université Paris VII, CNRS, 1, Rue Guy de la Brosse, 75005 Paris, France)
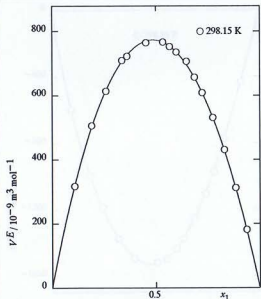
SOURCE OF DATA

Blanco, A. M.; Ortega, J. (University of Las Palmas de Gran Canaria, Canary Islands, Spain); FIRST PUBLISHED RESULTS

DIRECT EXPERIMENTAL VALUES

Notes: P, atm.

$T/K = 298.15$

x_1	$V^E/10^{-9}$ m^3mol^{-1}
0.0380	118.6
0.0767	221.4
0.1394	354.3
0.1802	433.2
0.2610	548.2
0.2859	582.8
0.3656	643.2
0.4039	661.1
0.4602	662.4
0.5396	646.0
0.6323	606.2
0.7031	545.5
0.7663	455.4
0.8163	390.0
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0.9431	136.1
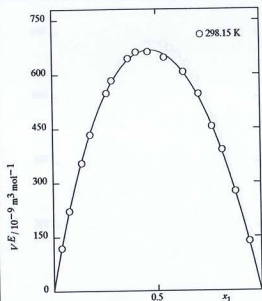
Points, direct experimental V^E values; curves, V_{calc}^E calculated from the smoothing equation.

○ 298.15 K

SMOOTHING EQUATION

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

Coeffs. a_i in the smoothing eq., std. deviation σ_d, and max. deviation δ_m detd. by least-squares anal.

T/K	a_1	a_2	a_3	a_4	a_5	σ_d	δ_m
						$10^{-9} m^3 mol^{-1}$	
298.15	2658.7 (9.7)	−293 (18)	249 (42)			5.1	9.1

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

$\delta_m = \max |V_{calc}^E - V^E|$; $\sigma_d = [\Sigma(V_{calc}^E - V^E)^2/(N - n)]^{1/2}$

N, no. of direct exptl. values; n, no. of coeffs. a_i
All direct exptl. values equally weighted

AUXILIARY INFORMATION

Apparatus: Vibrating tube densimeter, (Anton Paar, Graz, Austria), Model DMA 602/60. Temp. was controlled to within 0.01 K using a Heto thermostat and was measured by means of a calibrated Pt resistance thermometer.

Procedure: Density, ρ, was calcd. from period of vibration, τ: $\rho = a + b\tau^2$. Consts. a and b were detd. by calibrating the app. (ref. 2) with doubly distd. and degassed H_2O, $\rho(298.15$ K)/kg m^{-3} = 997.043 (ref. 3) and nonane (Fluka AG, Buchs, Switzerland, 'purum', Lot No. 74252, of stated purity > 99 mole %), $\rho(298.15$ K)/kg m^{-3} = 713.855 (ref. 4). Mixts. were prepd. by weighing. V^E was calcd. from $V^E = V - (x_1V^*_1 + x_2V^*_2)$, where $V = (x_1M_1 + x_2M_2)/\rho$ is the molar vol. of the mixt. and $V^*_i = V(x_i = 1)$ and M_i are, resp., the molar vol. and the molar mass of component i.

Materials: 1. Aldrich Chem. Co., Inc. (Milwaukee, WI, USA) material, of stated purity ~ 99 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; $\rho_1(298.15$ K)/kg m^{-3} = 1095.27; n(D, 298.15 K) = 1.4545; $M_1/10^{-3}$kg mol^{-1} = 141.0398.
2. Fluka AG (Buchs, St. Gallen, Switzerland) 'purum' grade material of stated GLC purity > 98 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; $\rho_2(298.15$ K)/kg m^{-3} = 764.80; n(D, 298.15 K) = 1.4298; $M_2/10^{-3}$kg mol^{-1} = 212.41908.
Materials were degassed ultrasonically before use.

Errors: δT(reproducibility)/K < 0.01; δT(IPTS-68)/K = 0.01; $\delta x_1 = 0.0001$; $\delta V^E/10^{-9}$m^{3}mol^{-1} < 5.

REFERENCES

1. *Int. DATA Ser., Ser. A*, Guideline 2c, 1979.
2. Ortega, J.; Matos, J. S.; Paz Andrade, M. I.; Jiménez, E. J. *J. Chem. Thermodyn.* 1985, 17, 1127.
3. Riddick, J. A.; Bunger, W. B. *Organic Solvents, II*, in *Techniques of Chemistry*, Weissberger, A., Editor, Wiley-Interscience, New York, 1970.
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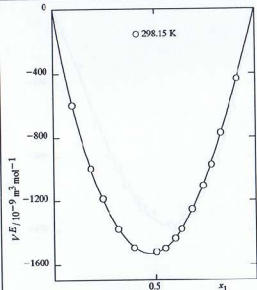|	
Components: 1. 1,5-Dichloropentane, $C_5H_{10}Cl_2$	**Author(s):** Blanco, A. M.; Ortega, J. (Universidad de Las Palmas de Gran Canaria, Escuela Superior de Ingenieros Industriales, Cátedra de Termodinámica y Fisicoquímica, Las Palmas de Gran Canaria, Islas Canarias, Spain)
2. Heptadecane, $C_{17}H_{36}$	
State: Binary system, single-phase liquid; pure components, both liquid	
Variables: V^E, molar excess volume	**Edited by:** Kehiaian, H. V. (Institut de Topologie et de Dynamique des Systèmes, Université Paris VII, CNRS, 1, Rue Guy de la Brosse, 75005 Paris, France)
x_i, mole fraction of component i	
Parameters: T, temperature	
Constants: P, pressure	**SOURCE OF DATA**
Method: Calculation of V^E from density measurements at constant T and P and variable x_i; ref. 1	Blanco, A. M.; Ortega, J. (Universidad de Las Palmas de Gran Canaria, Canary Islands, Spain); FIRST PUBLISHED RESULTS

DIRECT EXPERIMENTAL VALUES

Notes: P, atm.

T/K = 298.15

x_1	$V^E/10^{-9}$ m^3mol^{-1}
0.1084	316.7
0.1918	506.0
0.2611	614.6
0.3371	721.0
0.3617	723.4
0.4535	765.4
0.5349	766.8
0.5664	753.2
0.5998	735.9
0.6481	707.3
0.6866	657.4
0.7246	608.7
0.7746	532.1
0.8298	431.4
0.8835	312.5
0.9357	181.5

SMOOTHING EQUATION

$$V^E_{calc} = x_1 x_2 \sum_{i=1}^{n} a_i (x_1 - x_2)^{i-1}$$

Coeffs. a_i in the smoothing eq., std. deviation σ_d, and max. deviation δ_m detd. by least-squares anal.

	a_1	a_2	a_3	a_4	a_5	σ_d	δ_m
T/K			$10^{-9}m^3mol^{-1}$				
298.15	3093.6 (6.4)	−151 (13)	133 (32)			3.8	9.3

The std. deviations σa_j of the coeffs. a_j are given in parentheses
$\delta_m = \max |V^E_{calc} - V^E|$; $\sigma_d = [\Sigma(V^E_{calc} - V^E)^2/(N - n)]^{1/2}$
N, no. of direct exptl. values; n, no. of coeffs. a_i
All direct exptl. values equally weighted

Points, direct experimental V^E values; curves, V^E_{calc} calculated from the smoothing equation.

(Plot: $V^E / 10^{-9} m^3 mol^{-1}$ vs x_1; ○ 298.15 K)

AUXILIARY INFORMATION

Apparatus: Vibrating tube densimeter, (Anton Paar, Graz, Austria), Model DMA 602/60. Temp. was controlled to within 0.01 K using a Heto thermostat and was measured by means of a calibrated Pt resistance thermometer.

Procedure: Density, ρ, was calcd. from period of vibration, τ: $\rho = a + b\tau^2$. Consts. a and b were detd. by calibrating the app. (ref. 2) with doubly distd. and degassed H_2O, $\rho(298.15 K)/kg\ m^{-3} = 997.043$ (ref. 3) and nonane (Fluka AG, Buchs, Switzerland, 'purum', Lot No. 74252, of stated purity > 99 mole %), $\rho(298.15 K)/kg\ m^{-3} = 713.855$ (ref. 4). Mixts. were prepd. by weighing. V^E was calcd. from $V^E = V - (x_1V_1^* + x_2V_2^*)$, where $V = (x_1M_1 + x_2M_2)/\rho$ is the molar vol. of the mixt. and $V_i^* = V(x_i = 1)$ are, resp, the molar vol. and the molar mass of component i.

Materials: 1. Aldrich Chem. Co., Inc. (Milwaukee, WI, USA) material, of stated purity ~ 99 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; $\rho_1(298.15 K)/kg\ m^{-3} = 1095.27$; $n(D, 298.15 K) = 1.4545$; $M_1/10^{-3}kg\ mol^{-1} = 141.0398$.
2. Fluka AG (Buchs, St. Gallen, Switzerland) 'purum' grade material of stated GLC purity ~ 99 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; $\rho_2(298.15 K)/kg\ m^{-3} = 774.33$; $n(D, 298.15 K) = 1.4347$; $M_2/10^{-3}kg\ mol^{-1} = 240.47284$.
Materials were degassed ultrasonically before use.

Errors: δT(reproducibility)/K < 0.01; δT(IPTS-68)/K = 0.01; $\delta x_1 = 0.0001$; $\delta V^E/10^{-9}m^3mol^{-1} < 5$.

REFERENCES

1. *Int. DATA Ser., Ser. A, Guideline 2c*, 1979.
2. Ortega, J.; Matos, J. S.; Paz Andrade, M. I.; Jiménez, E. *J. J. Chem. Thermodyn.* 1985, *17*, 1127.
3. Riddick, J. A.; Bunger, W. B. *Organic Solvents, II*, in *Techniques of Chemistry*, Weissberger, A., Editor, Wiley-Interscience, New York, 1970.
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Received: March 15, 1993   Published: July 31, 1993

***Ser. A. Thermodynamic Properties of Non-reacting Binary Systems of Organic Substances**

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Components:	1. 1,6-Dichlorohexane, $C_6H_{12}Cl_2$
	2. Pentane, C_5H_{12}
State:	Binary system, single-phase liquid; pure components, both liquid
Variables:	V^E, molar excess volume
	x_i mole fraction of component i
Parameters:	T, temperature
Constants:	P, pressure
Method:	Calculation of V^E from density measurements at constant T and P and variable x_i; ref. 1

Author(s): Blanco, A. M.; Ortega, J. (Universidad de Las Palmas de Gran Canaria, Escuela Superior de Ingenieros Industriales, Cátedra de Termodinámica y Fisicoquímica, Las Palmas de Gran Canaria, Islas Canarias, Spain)

Edited by: Kehiaian, H. V. (Institut de Topologie et de Dynamique des Systèmes, Université Paris VII, CNRS, 1, Rue Guy de la Brosse, 75005 Paris, France)
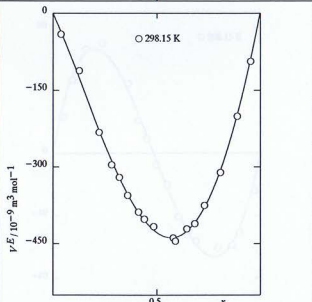
SOURCE OF DATA

Blanco, A. M.; Ortega, J. (University of Las Palmas de Gran Canaria, Canary Islands, Spain); FIRST PUBLISHED RESULTS

DIRECT EXPERIMENTAL VALUES

Notes: P, atm.

$T/K = 298.15$

x_1	$V^E/10^{-9}$ m³·mol⁻¹
0.0906	−599.3
0.1845	−997.5
0.2419	−1189.9
0.3171	−1381.0
0.3949	−1496.6
0.5044	−1523.4
0.5502	−1500.9
0.5973	−1439.8
0.6300	−1381.4
0.6826	−1256.2
0.7358	−1108.7
0.7774	−975.5
0.8254	−775.7
0.9079	−434.7

○ 298.15 K

Points, direct experimental V^E values; curves, V^E_{calc} calculated from the smoothing equation.

SMOOTHING EQUATION

$$V^E_{calc} = x_1 x_2 \sum_{i=1}^{n} a_i (x_1 - x_2)^{i-1}$$

Coeffs. a_i in the smoothing eq., std. deviation σ_d and max. deviation δ_m detd. by least-squares anal.

T/K	a_1	a_2	a_3	a_4	a_5	σ_d	δ_m
			10⁻⁹m³mol⁻¹				
298.15	−6126 (16)	601 (52)	440 (170)	920 (150)	−800 (310)	7.1	10

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

$\delta_m = \max |V^E_{calc} - V^E|$; $\sigma_d = [\Sigma(V^E_{calc} - V^E)^2/(N - n)]^{1/2}$

N, no. of direct exptl. values; n, no. of coeffs. a_i
All direct exptl. values equally weighted

AUXILIARY INFORMATION

Apparatus: Vibrating tube densimeter. (Anton Paar, Graz, Austria), Model DMA 602/60. Temp. was controlled to within 0.01 K using a Heto thermostat and was measured by means of a calibrated Pt resistance thermometer.

Procedure: Density, ρ, was calcd. from period of vibration, τ: $\rho = a + b\tau^2$. Consts. a and b were detd. by calibrating the app. (ref. 2) with doubly distd. and degassed H_2O, $\rho(298.15$ K$)/kg$ m⁻³ = 997.043 (ref. 3) and nonane (Fluka AG, Buchs, Switzerland, 'purum', Lot No. 74252, of stated purity > 99 mole %), $\rho(298.15$ K$)/kg$ m⁻³ = 713.855 (ref. 4). Mixts. were prepd. by weighing. V^E was calcd. from $V^E = V - (x_1 V^*_1 + x_2 V^*_2)$, where $V = (x_1 M_1 + x_2 M_2)/\rho$ is the molar vol. of the mixt. and $V^*_i = V(x_i = 1)$ and M_i are, resp. the molar vol. and the molar mass of component i.

Materials: 1. Aldrich Chem. Co., Inc. (Milwaukee, WI, USA) material, of stated purity ~ 99 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; $\rho_1(298.15$ K$)/kg$ m⁻³ = 1064.65; $n(D, 298.15$ K$) = 1.4555$; $M_1/10^{-3}$kg mol⁻¹ = 155.06668.
2. Fluka AG (Buchs, St. Gallen, Switzerland) 'puriss' grade material of stated OLC purity > 99.5 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; $\rho_2(298.15$ K$)/kg$ m⁻³ = 621.31; $n(D, 298.15$ K$) = 1.3547$; $M_2/10^{-3}$kg mol⁻¹ = 72.15028.
Materials were degassed ultrasonically before use.

Errors: δT(reproducibility)/K < 0.01; δT(IPTS-68)/K = 0.01: $\delta x_1 = 0.0001$; $\delta V^E/10^{-9}$m³mol⁻¹ < 5.

REFERENCES

1. *Int. DATA Ser., Ser. A, Guideline 2c*, 1979.
2. Ortega, J.; Matos, J. S.; Paz Andrade, M. I.; Jiménez, E. J. *J. Chem. Thermodyn.* 1985, 17, 1127.
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Received: March 15, 1993

Published: July 31, 1993

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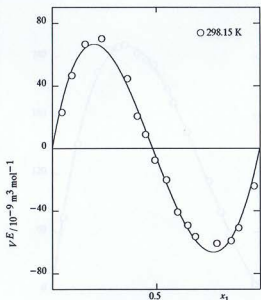|	
Components: 1. 1,6-Dichlorohexane, $C_6H_{12}Cl_2$ 2. Heptane, C_7H_{16} **State:** Binary system, single-phase liquid; pure components, both liquid **Variables:** V^E, molar excess volume x_i, mole fraction of component i **Parameters:** — **Constants:** P, pressure **Method:** Calculation of V^E from density measurements at constant T and P and variable x_i: ref. 1	**Author(s):** Blanco, A. M.; Ortega, J. (Universidad de Las Palmas de Gran Canaria, Escuela Superior de Ingenieros Industriales, Cátedra de Termodinámica y Fisicoquímica, Las Palmas de Gran Canaria, Islas Canarias, Spain) **Edited by:** Kehiaian, H. V. (Institut de Topologie et de Dynamique des Systèmes, Université Paris VII, CNRS, 1, Rue Guy de la Brosse, 75005 Paris, France)

SOURCE OF DATA

Blanco, A. M.; Ortega, J. (University of Las Palmas de Gran Canaria, Canary Islands, Spain); FIRST PUBLISHED RESULTS

DIRECT EXPERIMENTAL VALUES

Notes: P, atm.

T/K = 298.15

x_1	$V^E/10^{-9}$ m^3mol^{-1}
0.0377	−41.2
0.1264	−111.8
0.2242	−232.2
0.2835	−295.8
0.3213	−320.3
0.3608	−355.5
0.4137	−388.1
0.4406	−402.2
0.4861	−416.5
0.5788	−438.7
0.5905	−444.8
0.6452	−420.8
0.6842	−410.7
0.7296	−375.3
0.8074	−311.1
0.8880	−200.6
0.9526	−93.8

○ 298.15 K

Points, direct experimental V^E values; curves, V^E_{calc} calculated from the smoothing equation.

SMOOTHING EQUATION

$$V^E_{calc} = x_1 x_2 \sum_{i=1}^{n} a_i (x_1 - x_2)^{i-1}$$

Coeffs. a_i in the smoothing eq., std. deviation σ_d, and max. deviation δ_m detd. by least-squares anal.

T/K	a_1	a_2	a_3	a_4	a_5	σ_d	δ_m
			$10^{-9} m^3 mol^{-1}$				
298.15	−1711.8 (9.7)	−583 (22)	248 (53)			6.0	14

The std. deviations σa_i of the coeffs. a_i are given in parentheses

$\delta_m = \max |V^E_{calc} - V^E|$; $\sigma_d = [\Sigma(V^E_{calc} - V^E)^2/(N-n)]^{1/2}$

N, no. of direct exptl. values; n, no. of coeffs. a_i
All direct exptl. values equally weighted

AUXILIARY INFORMATION

Apparatus: Vibrating tube densimeter, (Anton Paar, Graz, Austria), Model DMA 602/60. Temp. was controlled to within 0.01 K using a Heto thermostat and was measured by means of a calibrated Pt resistance thermometer.

Procedure: Density, ρ, was calcd. from period of vibration, τ: $\rho = a + b\tau^2$. Consts. a and b were detd. by calibrating the app. (ref. 2) with doubly distd. and degassed H_2O, $\rho(298.15 \text{ K})/kg m^{-3} = 997.043$ (ref. 3) and nonane (Fluka AG, Buchs, Switzerland, 'purum', Lot No. 74252, of stated purity > 99 mole %, $\rho(298.15 \text{ K})/kg m^{-3} = 713.855$ (ref. 4). Mixts. were prepd. by weighing. V^E was calcd. from $V^E = V - (x_1 V^*_1 + x_2 V^*_2)$, where $V = (x_1 M_1 + x_2 M_2)/\rho$ is the molar vol. of the mixt. and $V^*_i = V(x_i = 1)$ are, resp., the molar vol. and the molar mass of component i.

Materials: 1. Aldrich Chem. Co., Inc. (Milwaukee, WI, USA) material, of stated purity ~ 99 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; $\rho_1(298.15 \text{ K})/kg m^{-3} = 1064.65$; $n(D, 298.15 \text{ K}) = 1.4555$; $M_1/10^{-3}kg mol^{-1} = 155.06668$.
 2. Fluka AG (Buchs, St. Gallen, Switzerland) 'purisss' grade material of stated GLC purity > 99.5 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; $\rho_2(298.15 \text{ K})/kg m^{-3} = 679.46$; $n(D, 298.15 \text{ K}) = 1.3851$; $M_2/10^{-3}kg mol^{-1} = 100.20404$. Materials were degassed ultrasonically before use.

Errors: δT(reproducibility)/K < 0.01; δT(IPTS-68)/K = 0.01; $\delta x_1 = 0.0001$; $\delta V^E/10^{-9}m^3mol^{-1} < 5$.

REFERENCES

1. *Int. DATA Ser., Ser. A*, Guideline 2c, 1979.
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Received: March 15, 1993

Published: July 31, 1993

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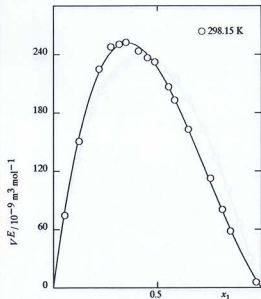|	
Components:	1. 1,6-Dichlorohexane, $C_6H_{12}Cl_2$
	2. Nonane, C_9H_{20}
State:	Binary system, single-phase liquid; pure components, both liquid
Variables:	V^E, molar excess volume
	x_i, mole fraction of component i
Parameters:	T, temperature
Constants:	P, pressure
Method:	Calculation of V^E from density measurements at constant T and P and variable x_i; ref. 1

Author(s): Blanco, A. M.; Ortega, J. (Universidad de Las Palmas de Gran Canaria, Escuela Superior de Ingenieros Industriales, Cátedra de Termodinámica y Fisicoquímica, Las Palmas de Gran Canaria, Islas Canarias, Spain)

Edited by: Kehiaian, H. V. (Institut de Topologie et de Dynamique des Systèmes, Université Paris VII, CNRS, 1, Rue Guy de la Brosse, 75005 Paris, France)

SOURCE OF DATA

Blanco, A. M.; Ortega, J. (University of Las Palmas de Gran Canaria, Canary Islands, Spain); FIRST PUBLISHED RESULTS

DIRECT EXPERIMENTAL VALUES

Notes: P, atm.

$T/K = 298.15$

x_1	$V^E/10^{-9}$ m^3mol^{-1}
0.0456	23.1
0.0939	46.5
0.1582	66.5
0.2372	70.1
0.3605	44.4
0.4088	20.6
0.4491	8.9
0.4933	−7.7
0.5477	−20.2
0.6026	−40.8
0.6515	−49.2
0.6883	−56.4
0.7921	−60.8
0.8610	−59.2
0.8983	−50.9
0.9723	−24.0

Points, direct experimental V^E values; curves, V^E_{calc} calculated from the smoothing equation.

SMOOTHING EQUATION

$$V^E_{calc} = x_1x_2 \sum_{i=1}^{n} a_i(x_1 - x_2)^{i-1}$$

Coeffs. a_i in the smoothing eq., std. deviation σ_d and max. deviation δ_m detd. by least-squares anal.

	a_1	a_2	a_3	a_4	a_5	σ_d	δ_m
T/K				$10^{-9} m^3mol^{-1}$			
298.15	−23.7 (7.2)	−689 (17)	74 (35)			4.4	7.6

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

$$\delta_m = \max |V^E_{calc} - V^E| \; ; \; \sigma_d = [\Sigma(V^E_{calc} - V^E)^2 / (N-n)]^{1/2}$$

N, no. of direct exptl. values; n, no. of coeffs. a_i
All direct exptl. values equally weighted

AUXILIARY INFORMATION

Apparatus: Vibrating tube densimeter, (Anton Paar, Graz, Austria), Model DMA 602/60. Temp. was controlled to within 0.01 K using a Heto thermostat and was measured by means of a calibrated Pt resistance thermometer.

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Materials: 1. Aldrich Chem. Co., Inc. (Milwaukee, WI, USA) material, of stated purity ~ 99 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification: $\rho_1(298.15 K)/kg \, m^{-3} = 1064.65$; $n(D, 298.15 K) = 1.4555$; $M_1/10^{-3}kg \, mol^{-1} = 155.06668$.
2. Fluka AG (Buchs, St. Gallen, Switzerland) 'purum' grade material of stated GLC purity > 99 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification: $\rho_2(298.15 K)/kg \, m^{-3} = 713.85$; $n(D, 298.15 K) = 1.4033$; $M_2/10^{-3}kg \, mol^{-1} = 128.2578$.
Materials were degassed ultrasonically before use.

Errors: δT(reproducibility)/K < 0.01; δT(IPTS-68)/K < 0.01; $\delta x_1 = 0.0001$; $\delta V^E/10^{-9} m^3mol^{-1} < 5$.

REFERENCES

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2. Ortega, J.; Matos, J. S.; Paz Andrade, M. I.; Jiménez, E. J. J. Chem. Thermodyn. 1988, 17, 1127.
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Components:	1. 1,6-Dichlorohexane, $C_6H_{12}Cl_2$
	2. Undecane, $C_{11}H_{24}$
State:	Binary system, single-phase liquid; pure components, both liquid
Variables:	V^E, molar excess volume
	x_i, mole fraction of component i
Parameters:	T, temperature
Constants:	P, pressure
Method:	Calculation of V^E from density measurements at constant T and P and variable x_i; ref. 1

Author(s): Blanco, A. M.; Ortega, J. (Universidad de Las Palmas de Gran Canaria, Escuela Superior de Ingenieros Industriales, Cátedra de Termodinámica y Fisicoquímica, Las Palmas de Gran Canaria, Islas Canarias, Spain)

Edited by: Kehiaian, H. V. (Institut de Topologie et de Dynamique des Systèmes, Université Paris VII, CNRS, 1, Rue Guy de la Brosse, 75005 Paris, France)

DIRECT EXPERIMENTAL VALUES

Notes: P, atm.

$T/K = 298.15$

x_1	$V^E/10^{-9}$ m^{3}mol^{-1}
0.0541	74.3
0.1240	150.7
0.2207	225.0
0.2771	248.0
0.3182	250.5
0.3496	252.5
0.4107	243.4
0.4531	236.5
0.4884	232.2
0.5546	206.6
0.5838	193.1
0.6498	163.0
0.7569	112.5
0.8137	80.1
0.8509	58.0
0.9752	5.6

○ 298.15 K

Points, direct experimental V^E values; curves, V^E_{calc} calculated from the smoothing equation.

SMOOTHING EQUATION

$$V^E_{calc} = x_1 x_2 \sum_{i=1}^{n} a_i (x_1 - x_2)^{i-1}$$

Coeffs. a_i in the smoothing eq., std. deviation σ_d and max. deviation δ_m detd. by least-squares anal.

T/K	a_1	a_2	a_3	a_4	a_5	σ_d	δ_m
				10^{-9} m^{3}mol^{-1}			
298.15	907.1 (5.8)	−650 (13)	57 (30)			3.5	5.9

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

$\delta_m = \max |V^E_{calc} - V^E|$; $\sigma_d = [\Sigma(V^E_{calc} - V^E)^2/(N - n)]^{1/2}$

N, no. of direct exptl. values; n, no. of coeffs.
All direct exptl. values equally weighted

AUXILIARY INFORMATION

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4. Anton Paar Information Bull. No. 6, March 1982.

0147-1503/93/093-22852.20

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Received: March 15, 1993

Published: July 31, 1993

*Ser. A. Thermodynamic Properties of Non-reacting Binary Systems of Organic Substances

| Components: | 1. 1,6-Dichlorohexane, $C_6H_{12}Cl_2$ |
| | 2. Tridecane, $C_{13}H_{28}$ |

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

Variables: V^E, molar excess volume

x_i, mole fraction of component i

Parameters: T, temperature

Constants: P, pressure

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

Author(s): Blanco, A. M.; Ortega, J. (Universidad de Las Palmas de Gran Canaria, Escuela Superior de Ingenieros Industriales, Cátedra de Termodinámica y Fisicoquímica, Las Palmas de Gran Canaria, Islas Canarias, Spain)

Edited by: Kehiaian, H. V. (Institut de Topologie et de Dynamique des Systèmes, Université Paris VII, CNRS, 1, Rue Guy de la Brosse, 75005 Paris, France)
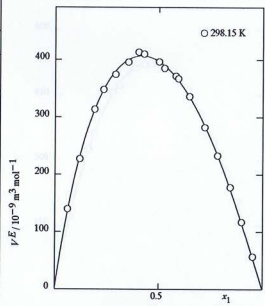
SOURCE OF DATA

Blanco, A. M.; Ortega, J. (University of Las Palmas de Gran Canaria, Canary Islands, Spain); FIRST PUBLISHED RESULTS

DIRECT EXPERIMENTAL VALUES

Notes: P, atm.

$T/K = 298.15$

x_1	$V^E/10^{-9}$ m^{3}mol^{-1}
0.0611	139.1
0.1205	226.6
0.1913	312.8
0.2339	346.8
0.2910	373.2
0.3532	394.6
0.4028	412.2
0.4290	408.9
0.5001	395.2
0.5272	384.0
0.5802	370.5
0.5925	366.3
0.6469	335.5
0.7204	281.6
0.7826	232.2
0.8431	177.0
0.8985	116.7
0.9534	56.3

○ 298.15 K

Points, direct experimental V^E values; curves, V^E_{calc} calculated from the smoothing equation.

SMOOTHING EQUATION

$$V^E_{calc} = x_1 x_2 \sum_{i=1}^{n} a_i (x_1 - x_2)^{i-1}$$

Coeffs. a_i in the smoothing eq., std. deviation σ_d, and max. deviation δ_m detd. by least-squares anal.

T/K	a_1	a_2	a_3	a_4	a_5	σ_d	δ_m
				10^{-9}m^{3}mol^{-1}			
298.15	1583.7 (5.9)	−456 (25)	258 (30)	−208 (65)		3.8	7.2

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

$\delta_m = \max |V^E_{calc} - V^E|$; $\sigma_d = [\Sigma(V^E_{calc} - V^E)^2/(N-n)]^{1/2}$

N, no. of direct exptl. values; n, no. of coeffs. a_i

All direct exptl. values equally weighted

AUXILIARY INFORMATION

Apparatus: Vibrating tube densimeter, (Anton Paar, Graz, Austria), Model DMA 602/60. Temp. was controlled to within 0.01 K using a Heto thermostat and was measured by means of a calibrated Pt resistance thermometer.

Procedure: Density, ρ, was calcd. from period of vibration, τ: $\rho = a + b\tau^2$. Consts. a and b were detd. by calibrating the app. (ref. 2) with doubly distd. and degassed H$_2$O, ρ(298.15 K)/kg m^{-3} = 997.043 (ref. 3) and nonane (Fluka AG, Buchs, Switzerland, 'purum', Lot No. 74252, of stated purity > 99 mole %), ρ(298.15 K)/kg m^{-3} = 713.855 (ref. 4). Mixts. were prepd. by weighing. V^E was calcd. from $V^E = V - (x_1 V_1^* + x_2 V_2^*)$, where $V = (x_1 M_1 + x_2 M_2)/\rho$ is the molar vol. of the mixt. and $V_i^* = V(x_i = 1)$ and M_i are, resp., the molar vol. and the molar mass of component i.

Materials: 1. Aldrich Chem. Co., Inc. (Milwaukee, WI, USA) material, of stated purity ~ 99 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; ρ_1(298.15 K)/kg m^{-3} = 1064.65; n(D, 298.15 K) = 1.4555; $M_1/10^{-3}$kg mol^{-1} = 155.06668.
2. Fluka AG (Buchs, St. Gallen, Switzerland) 'puriss' grade material of stated GLC purity > 99.5 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; ρ_2(298.15 K) m^{-3} = 752.79; n(D, 298.15 K) = 1.4238; $M_2/10^{-3}$kg mol^{-1} = 184.36532. Materials were degassed ultrasonically before use.

Errors: δT(reproducibility)/K < 0.01; δT(IPTS-68)/K = 0.01; $\Delta x_1 = 0.0001$; $\delta V^E/10^{-9}$m^{3}mol^{-1} < 5.

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1. Int. DATA Ser., Ser. A, Guideline 2c, 1979.
2. Ortega, J.; Matos, J. S.; Paz Andrade, M. I.; Jiménez, E. J. J. Chem. Thermodyn. 1985, 17, 1127.
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4. Anton Paar Information Bull. No. 6, March 1982.

*Ser. A. Thermodynamic Properties of Non-reacting Binary Systems of Organic Substances

Components:	1. 1,6-Dichlorohexane, $C_6H_{12}Cl_2$
	2. Pentadecane, $C_{15}H_{32}$
State:	Binary system, single-phase liquid; pure components, both liquid
Variables:	V^E, molar excess volume
	x_i, mole fraction of component i
Parameters:	T, temperature
Constants:	P, pressure
Method:	Calculation of V^E from density measurements at constant T and P and variable x_i; ref. 1

Author(s): Blanco, A. M.; Ortega, J. (Universidad de Las Palmas de Gran Canaria, Escuela Superior de Ingenieros Industriales, Cátedra de Termodinámica y Fisicoquímica, Las Palmas de Gran Canaria, Islas Canarias, Spain)

Edited by: Kehiaian, H. V. (Institut de Topologie et de Dynamique des Systèmes, Université Paris VII, CNRS, 1, Rue Guy de la Brosse, 75005 Paris, France)
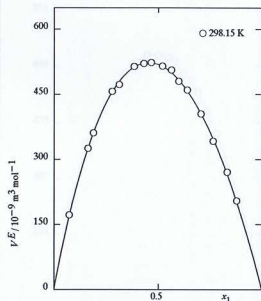
SOURCE OF DATA
Blanco, A. M.; Ortega, J. (University of Las Palmas de Gran Canaria, Canary Islands, Spain); FIRST PUBLISHED RESULTS

DIRECT EXPERIMENTAL VALUES

Notes: P, atm.

T/K = 298.15

x_1	$V^E/10^{-9}$ $m^3 mol^{-1}$
0.0723	172.1
0.1625	325.6
0.1892	361.6
0.2785	457.6
0.3133	472.8
0.3859	514.4
0.4316	521.3
0.4668	523.7
0.5207	515.7
0.5646	506.6
0.5991	480.3
0.6413	460.1
0.7068	405.6
0.7653	341.9
0.8332	270.4
0.8795	204.5

Points, direct experimental V^E values; curves, V^E_{calc} calculated from the smoothing equation.

SMOOTHING EQUATION

$$V^E_{calc} = x_1 x_2 \sum_{i=1}^{n} a_i(x_1 - x_2)^{i-1}$$

Coeffs. a_i in the smoothing eq., std. deviation σ_d and max. deviation δ_m detd. by least-squares anal.

T/K	a_1	a_2	a_3	a_4	a_5	σ_d	δ_m
			$10^{-9} m^3 mol^{-1}$				
298.15	2076.7 (6.2)	-349 (14)	176 (32)			3.9	7.3

The std. deviations σa_i of the coeffs. a_i are given in parentheses

$\delta_m = max |V^E_{calc} - V^E|$; $\sigma_d = [\Sigma(V^E_{calc} - V^E)^2/(N-n)]^{1/2}$

N, no. of direct exptl. values; n, no. of coeffs. a_i
All direct exptl. values equally weighted

AUXILIARY INFORMATION

Apparatus: Vibrating tube densimeter, (Anton Paar, Graz, Austria), Model DMA 602/60. Temp. was controlled to within 0.01 K using a Heto thermostat and was measured by means of a calibrated Pt resistance thermometer.

Procedure: Density, ρ, was calcd. from period of vibration, τ: $\rho = a + b\tau^2$. Consts. a and b were detd. by calibrating the app. (ref. 2) with doubly distd. and degassed H_2O, ρ(298.15 K)/kg m^{-3} = 997.043 (ref. 3) and nonane (Fluka AG, Buchs, Switzerland, 'purum', Lot No. 74252, of stated purity > 99 mole %), ρ(298.15 K)/kg m^{-3} = 713.855 (ref. 4). Mixts. were prepd. by weighing. V^E was calcd. from $V^E = V - (x_1V^*_1 + x_2V^*_2)$, where $V = (x_1M_1 + x_2M_2)/\rho$ is the molar vol. of the mixt. and $V^*_i = V_i$ ($x_i = 1$) and M_i are, resp., the molar vol. and the molar mass of component i.

Materials: 1. Aldrich Chem. Co., Inc. (Milwaukee, WI, USA) material, of stated purity > 99 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; ρ_1(298.15 K)/kg m^{-3} = 1064.65; n(D, 298.15 K) = 1.4555; $M_1/10^{-3}$ kg mol^{-1} = 155.06668.
2. Fluka AG (Buchs, St. Gallen, Switzerland) 'purum' grade material of stated GLC purity > 98 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; ρ_2(298.15 K)/kg m^{-3} = 764.80; n(D, 298.15 K) = 1.4298; $M_2/10^{-3}$ kg mol^{-1} = 212.41908.
Materials were degassed ultrasonically before use.

Errors: δT(reproducibility)/K < 0.01; δT(IPTS-68)/K = 0.01; $\delta x_1 = 0.0001$; $\delta V^E/10^{-9} m^3 mol^{-1} < 5$.

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2. Ortega, J.; Matos, J. S.; Paz Andrade, M. I.; Jiménez, E. J. J. Chem. Thermodyn. 1985, 17, 1127.
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Int. DATA Ser., Sel. Data Mixtures, Ser. A 1993, 21(3), 195-231
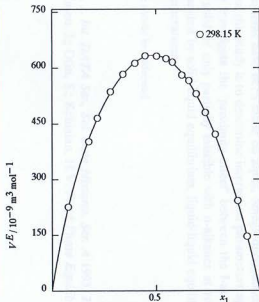
0147-1503/93/093-23152.20

Author(s): Blanco, A. M.; Ortega, J. (Universidad de Las Palmas de Gran Canaria, Escuela Superior de Ingenieros Industriales, Cátedra de Termodinámica y Fisicoquímica, Las Palmas de Gran Canaria, Islas Canarias, Spain)

Edited by: Kehiaian, H. V. (Institut de Topologie et de Dynamique des Systèmes, Université Paris VII, CNRS, 1, Rue Guy de la Brosse, 75005 Paris, France)

Components:	1. 1,6-Dichlorohexane, $C_6H_{12}Cl_2$
	2. Heptadecane, $C_{17}H_{36}$
State:	Binary system, single-phase liquid; pure components, both liquid
Variables:	V^E, molar excess volume
	x_i, mole fraction of component i
Parameters:	T, temperature
Constants:	P, pressure
Method:	Calculation of V^E from density measurements at constant T and P and variable x_i; ref 1

SOURCE OF DATA

Blanco, A. M.; Ortega, J. (University of Las Palmas de Gran Canaria, Canary Islands, Spain); FIRST PUBLISHED RESULTS

DIRECT EXPERIMENTAL VALUES

Notes: P, atm.

T/K = 298.15

x_1	$V^E/10^{-9}$ m^{3}mol^{-1}
0.0766	226.0
0.1769	402.5
0.2177	466.0
0.2804	537.6
0.3410	584.1
0.3996	613.9
0.4485	633.9
0.5039	633.2
0.5504	625.9
0.5813	616.3
0.6269	581.8
0.6605	566.9
0.6966	531.0
0.7389	481.1
0.7863	421.5
0.8952	242.2
0.9382	146.2

○ 298.15 K

Points, direct experimental V^E values; curves, V^E_{calc} calculated from the smoothing equation.

SMOOTHING EQUATION

$$V^E_{calc} = x_1 x_2 \sum_{i=1}^{n} a_i (x_1 - x_2)^{i-1}$$

Coeffs. a_i in the smoothing eq., std. deviation σ_d and max. deviation δ_m detd. by least-squares anal.

T/K	a_1	a_2	a_3	a_4	a_5	σ_d	δ_m
			10^{-9}m^{3}mol^{-1}				
298.15	2539.9 (7.6)	−102 (26)	84 (84)	−317 (74)	500 (150)	4.0	7.1

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

$$\delta_m = \max |V^E_{calc} - V^E|\; ; \; \sigma_d = [\Sigma (V^E_{calc} - V^E)^2/(N-n)]^{1/2}$$

N, no. of direct exptl. values; n, no. of coeffs.
All direct exptl. values equally weighted

AUXILIARY INFORMATION

Apparatus: Vibrating tube densimeter, (Anton Paar, Graz, Austria), Model DMA 602/60. Temp. was controlled to within 0.01 K using a Heto thermostat and was measured by means of a calibrated Pt resistance thermometer.

Procedure: Density, ρ, was calcd. from period of vibration, τ: $\rho = a + b\tau^2$. Consts. a and b were detd. by calibrating the app. (ref. 2) with doubly distd. and degassed H_2O, ρ(298.15 K)/kg m^{-3} = 997.043 (ref. 3) and nonane (Fluka AG, Buchs, Switzerland, 'purum', Lot No. 74252, of stated purity > 99 mole %), ρ(298.15 K)/kg m^{-3} = 713.855 (ref. 4). Mixts. were prepd. by weighing. V^E was calcd. from $V^E = V - (x_1 V^*_1 + x_2 V^*_2)$, where $V = (x_1 M_1 + x_2 M_2)/\rho$ is the molar vol. of the mixt. and $V^*_i = V_i (x_i = 1)$ are, resp., the molar vol. and the molar mass of component i.

Materials: 1. Aldrich Chem. Co., Inc. (Milwaukee, WI, USA) material, of stated purity ~ 99 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; ρ_1(298.15 K)/kg m^{-3} = 1064.65; n(D, 298.15 K) = 1.4555; $M_1/10^{-3}$kg mol^{-1} = 155.06668.
2. Fluka AG (Buchs, St. Gallen, Switzerland) 'purum' grade material of stated GLC purity ~ 99 mole %, dried over mol. sieve Type 3A (from Fluka) and used without further purification; ρ_2(298.15 K)/kg m^{-3} = 774.33; n(D, 298.15 K) = 1.4347; $M_2/10^{-3}$kg mol^{-1} = 240.47284.
Materials were degassed ultrasonically before use.

Errors: δT(reproducibility)/K < 0.01; δT(IPTS-68)/K = 0.01; $\delta x_1 = 0.0001$; $\delta V^E/10^{-9}$m^{3}mol^{-1} < 5.

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3. Riddick, J. A.; Bunger, W. B. Organic Solvents, II, in Techniques of Chemistry, Weissberger, A., Editor, Wiley-Interscience, New York, 1970.
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*Ser. A. Thermodynamic Properties of Non-reacting Binary Systems of Organic Substances