RAUJ0980

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Gas phase isochores and vapor pressures of pure refrigerants: difluoromethane (R 32), pentafluoroethane (R 125), 1,1,1,2-tetrafluoroethane (R 134a), and 1,1,1,2,3,3,3-heptafluoropropane (R 227ea)

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Experimental pressure-temperature (P-T) data at several constant densities were obtained for gaseous non-chlorinated refrigerant fluids, difluoromethane (R 32), pentafluoroethane (R 125), 1,1,1,2-tetrafluoroethane (R 134a), and 1,1,1,2,3,3,3-heptafluoropropane (R 227ea), by using of a new constant-volume cell constructed to work at high pressures at temperatures from 273.15 K to 353.15 K. The vapor pressures were estimated graphically at the break point of the measured P-T curves. The vapor pressure values were correlated using Antoine and Wagner equations. These data, and the derived acentric factors and enthalpies of vaporization, agree within 2 to 5 % with literature values.

1. INTRODUCTION

The knowledge of precise vapor pressure data and the corresponding saturation curve of refrigerant fluids is important for the design of process equipment, especially heat exchangers and compressors. At present time, the non-chlorinated refrigerants difluoromethane (R 32), pentafluoroethane (R 125), 1,1,1,2-tetra fluoroethane (R 134a), and 1,1,1,2,3,3,3-hepta fluoropropane (R 227ea) and mixtures thereof, are predestinated to substitute the partially or totally chlorinated refrigerants (HCFC or CFC) having a high Ozone Depletion Potential (ODP) and Global Warming Potential (GWP), like trichlorofluoromethane (R 11), dichlorodifluoromethane (R 12), 1,2-dichlorotetrafluoro ethane (R 114), or the chlorodifluoromethane (R 22) + chloropentafluoroethane (R 115) azeotrope (R 502).

Experimental pressure-temperature (*P-T*) data and correlations are available in the literature for several of the fluids considered in this work. Data were reported by [BOUC1970; MCLM1900; SATT1941] for R 32, by [BOYS0950; DUAH0970; TSVO0950] for R 125 , and by [BLAW0950; TILR0940] for R 134a.

For R 227ea we have found saturated liquid density values [DEFD0970] and unpublished vapor pressure measurements [WEBL0980].

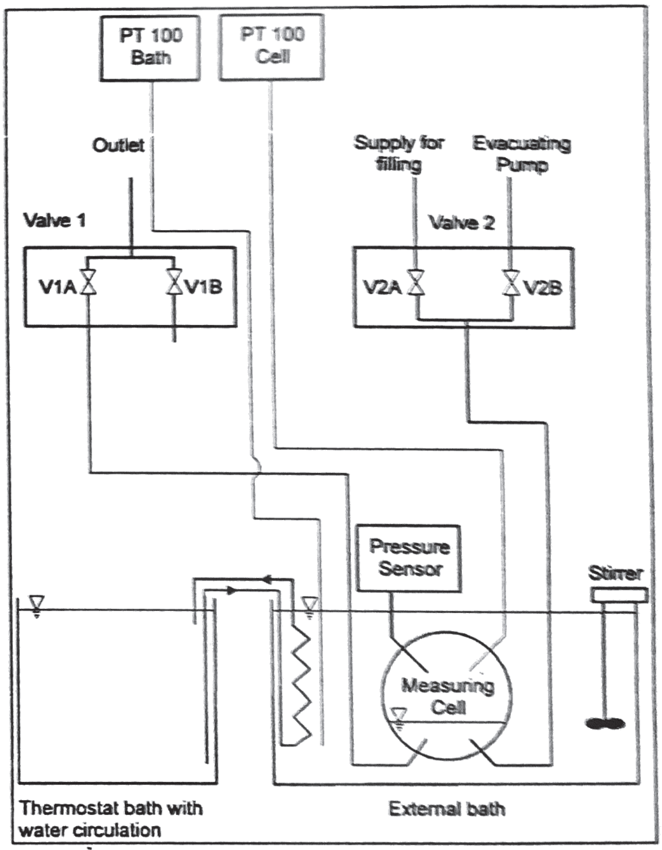

Figure 1. Schematic representation of the experimental equipment

The data from all references mentioned above were used for comparison with our experimental results obtained using a new high-pressure cell.

TABLE 1

Antoine coefficients, A, B, and C, Eq.(1), and Wagner coefficients, a_1, a_2, a_3, and a_4, Eq.(2), valid in the temperature range ΔT

Refrigerant	A	B	C	a_1	a_2	a_3	a_4	ΔT/K
R 32	15.0984	2105.3	-24.60	-7.929	3.494	-7.999	0.529	250-385
R 125	12.8429	1186.9	-86.76	-8.642	5.328	-9.521	0.477	250-360
R 134a	14.8115	2239.9	-30.18	-6.916	-1.431	3.516	1.322	250-390
R 227ea	14.5994	2338.4	-23.87	-7.840	0.471	2.392	1.192	255-380

2. EXPERIMENTAL SECTION

2.1. Apparatus and Procedure

A constant volume (ca. 0.98 dm^3) cell for P-T and vapor-liquid equilibrium (VLE) measurements was constructed to work at pressures up to 20 10^6Pa and temperatures up to 623.15 K. The cell, as well as all the parts of the suspension, were made of austenitic stainless-steel (Materials No. 1.4571 and 1.4301, respectively). The cell was immersed in a 300 x 400 x 300 mm external thermostat bath with water circulation. A schematic diagram of the apparatus is shown in Figure 1.

The estimated uncertainty in the volume determination is 0.01 %. The temperature T in the measuring the cell and the temperature of the external bath were measured by means of Pt100 resistance thermometers (MWT 603/B, SAB, Goettingen, Germany), previously calibrated with a high precision thermometer unit (ASL, model F25, Bradville, UK) against ITS-90.

The pressure P inside the cell was measured with a digital pressure sensor, calibrated by the manufacturer (Type 892.23.520, WIKA Instruments, Klingenberg, Germany). However, that transducer was also calibrated against a high accuracy pressure controller/calibrator, Desgranges & Huot (Aubervillier, France), model PPC2, and the pertinent corrections were taken into consideration. After calibration, the estimated uncertainties in T and P were less than, respectively, 0.3 K and 0.02 10^6Pa (both in the working range).

In this work the P-T measurements were carried out by loading a known quantity of sample into the cell to obtain different isochoric lines. The mass of refrigerant was measured with an electronic balance COBOS, type C600SX (Barcelona, Spain) with an accuracy of 0.2 10^{-4}kg, corresponding to 0.3 kg m^{-3} overall accuracy in the densities ρ. The vapor pressure values were obtained by varying the cell temperature, in the range from ca. 353 K to 273 K, along 4 to 6 isochores, and measuring the pressure of the gaseous refrigerants from ca. max. 6 10^6Pa, until the dew points were reached (Figure 2). After the isochore determination the fluid was evacuated into a small tared vessel and reweighed.

2.2. Materials

CH_2F_2, Difluoromethane (R 32). DuPont (Wilmington, USA) material of stated purity 99.95 wt. % was used as received. Characteristic properties: Flammability, Yes; ODP (R 11, 1),0; GWP (CO_2, 100), 580; Substitutes, R 502.

C_2HF_5, Pentafluoroethane (R 125). DuPont (Wilmington, USA) material of stated purity 99.9 wt. % was used as received. Characteristic properties: Flammability, No; ODP (R 11, 1), 0; GWP (CO_2, 100), 3200; Substitutes, R 502.

$C_2H_2F_4$, 1,1,1,2-Tetrafluoroethane (R 134a). ICI (Barcelona, Spain) material of stated purity 99.99 wt. % was used as received. Characteristic properties: Flammability, No; ODP (R 11, 1), 0; GWP (CO_2, 100), 1300; Substitutes, R 12.

C_3HF_7, 1,1,1,2,3,3,3-Heptafluoropropane (R 227ea). Solvay (Hannover, Germany) material of stated purity 99.99 wt. % was used as received. Characteristic properties: Flammability, No; ODP (R 11, 1), 0; GWP (CO_2, 100), 3300; Substitutes, R 114.

3. RESULTS

The direct experimental P-T values at 4 to 6 constant densities ρ are all tabulated and graphed in the Appendix and saved on disk as Standard ELDATA Files **RAUJ0980.001** through **RAUJ0980.004**.

The vapor pressures, estimated graphically at the break point of the measured P-T curves, are all tabulated and graphed in the Appendix and saved on disk as Standard ELDATA Files **RAUJ0980.005** through **RAUJ0980.008**.

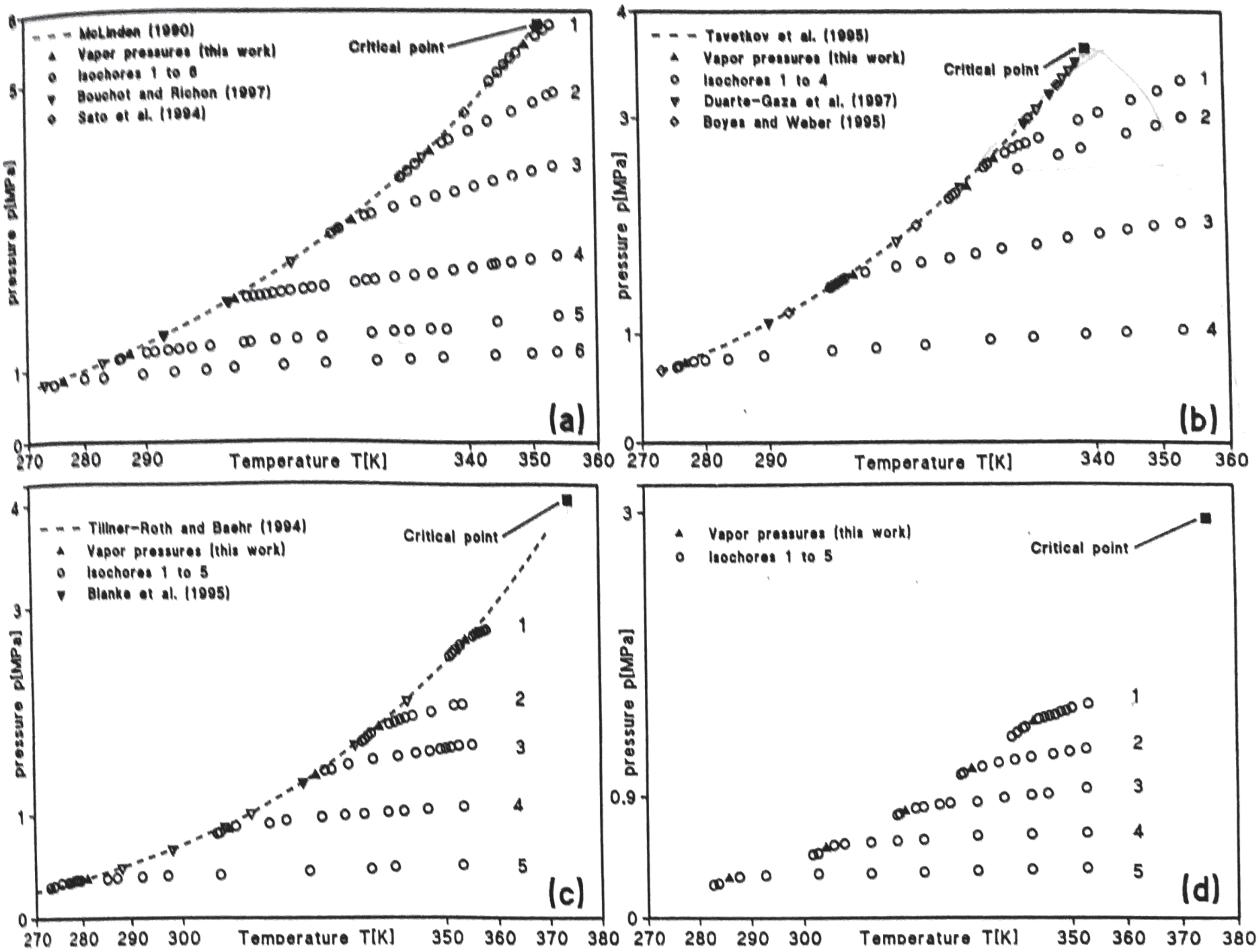

Figure 2. Pressure P – temperature T diagrams at various constant densities ρ/kg m 3 (given in parentheses) for gaseous refrigerants and derived vapor pressure curves. (a) R 32: 1 – (282.5), 2 – (184.5), 3 – (141.8), 4 – (107.6), 5 – (88.5), 6 – (82.6); (b) R 125: 1 – (222.2), 2 – (197.6), 3 – (123.3), 4 – (62.1); (c) R 134a: 1 – (161.8), 2 – (111.3), 3 – (87.70), 4 – (61.7), 5 – (42.0); (d) R 227ea: 1 – (167.8), 2 – (135.3), 3 – (111.5), 4 – (89.3), 5 – (80.0).

The vapor pressure data were fitted to two classical equations, the Antoine equation, Eq. (1):

$$\ln(P/10^3\mathrm{Pa}) = A - B/[(T/\mathrm{K}) + C] \quad (1)$$

and the Wagner equation [BLAW0950], Eq. (2):

$$\ln P_r = (a_1\tau + a_2\tau^{1.5} + a_3\tau^{2.5} + a_4\tau^5)/T_r \quad (2)$$

where $\tau = 1 - T_r$, $P_r = P/P_c$ is the reduced pressure, $T_r = T/T_c$ is the reduced temperature, P_c is the critical pressure, and T_c is the critical temperature.

The objective function Q was the sum of the squared relative deviations in pressure:

$$Q = \Sigma[(P_{\mathrm{calc}} - P_{\mathrm{exp}})/P_{\mathrm{exp}}]^2 \quad (3)$$

The coefficients are listed in Table 1.

4. DISCUSSION AND CONCLUSIONS

The vapor pressures calculated with the Antoine correlations obtained in this work agree fairly well with the experimental data from the literature. So for R 32 the mean deviations vary from 0.5 %, compared to [SATT1941], to 4 %, compared to [BOUC1970], for R 125 the deviations are less than 2 % in all cases, for R 134a the mean deviation, estimated in the working temperature range indicated in Table 1, is less than 3 %, and lastly for R 227ea the mean deviation from the values measured by [WEBL0980] is close to 3 %.

The correlated vapor pressure values were used to calculate two characteristic quantities for the present refrigerants [REIR0870]. The acentric factors ω were obtained from a linear regression of ln P_r vs. $1/T_r$. The values shown in Table 2 are similar to those calculated using the Lee-Kesler vapor-pressure relations.

The same relations were used to estimate the molar enthalpies of vaporization, ΔH_{vap}, as:

$$\Delta H_{vap} = \Theta R T_c \Delta Z_{vap} \quad (4)$$

where ΔZ_{vap} is the difference in compressibility factors of saturated vapor and saturated liquid, taken from generalized compressibility tables [HOU00590]. Θ was calculated from the slope of the straight line given by:

$$\Theta = - d\,(\ln P_r)/d(1/T_r) \quad (5)$$

The ΔH_{vap} values (Table 2) of R 32, R 125 and R 134a agree well with those obtained from saturation property tables. The largest discrepancy was found for R 32 whose value (Table 2) is 5 % higher than found in saturation tables [MCLM1900; TILR0940]. To our knowledge, no literature ΔH_{vap} value is available for R 227ea.

TABLE 2

Acentric factors ω and molar enthalpies of vaporization ΔH_{vap} at 298.15 K

Refrigerant	ω	$\Delta H_{vap}/10^3 J\ mol^{-1}$
R 32	0.313	14.9
R 125	0.312	13.4
R 134a	0.337	18.4
R 227ea	0.359	18.8

The present results prove the suitability of the new apparatus for precise measurements of the vapor pressures of pure liquids and liquid mixtures at high pressures.

Acknowledgment

The authors acknowledge gratefully Du Pont, ICI and Solvay for providing the samples used in this work. Support provided by the DGES, MEC (Spain), under the project PB95-0025 is also greatfully acknowledged.

REFERENCES

[BLAW0950] – Blanke, W.; Klingenberg, G.; Weiss, R. PVT measurements on tetrafluoroethane (R134a) along the vapor-liquid equilibrium boundary between 288 and 373 K and in the liquid state from the triple point to 265 K. *Int. J. Thermophys.* **1995,** *16,* 1143-1153.

[BOUC1970] – Bouchot, C.; Richon, D. Gas, liquid, and saturated vapor-liquid densities and vapor pressures of difluoromethane (R-32) and octafluoropropane (R-218) at temperatures from 253 K to 333 K and pressure up to 14.5 MPa. *ELDATA Int. Electron. J. Phys.-Chem. Data* **1997,** *3,* 1-16.

[BOYS0950] – Boyes, S. J.; Weber, L. A. Vapor pressures and gas-phase (p,.rho.n,T) values for CF3CHF2 (R125). *J. Chem. Thermodyn.* **1995,** *27,* 163-174.

[DEFD0970] – Defibaugh, D. R.; Moldover, M. R. Compressed and saturated liquid densities for 18 halogenated organic compounds. *J. Chem. Eng. Data* **1997,** *42,* 160-168.

[DUAH0970] – Duarte-Garza, H. A.; Stouffer, C. E.; Hall, K. R.; Holste, J. C.; Marsh, K. N.; Gammon, B. E. Experimental critical constants, vapor pressures, and vapor and liquid densities for pentafluoroethane (R-125). *J. Chem. Eng. Data* **1997,** *42,* 745-753.

[HOU00590] – Hougen, O. A.; Watson, K. M.; Ragatz, R. A. *Chemical Process Principles, Part II, Thermodynamics, 2nd Ed. J. Wiley, New York, NY, USA* **1959.**

[MCLM1900] – McLinden, M. O. Thermodynamic properties of CFC alternatives: a survey of the available data. *Rev. Int. Froid* **1990,** *13,* 149-161.

[REIR0870] – Reid, R. C.; Prausnitz, J. M.; Poling, B. E. *The Properties of Gases and Liquids.* 4th Ed., McGraw-Hill Book Company, New York, USA (ISBN 0-07-051799-1) **1987,** 1-742.

[SATT1941] – Sato, T.; Sato, H.; Watanabe, K. PVT property measurements for difluoromethane. *J. Chem. Eng. Data* **1994,** *39,* 851-854.

[TILR0940] – Tillner-Roth, R.; Baehr, H. D. An international standard formulation for the thermodynamic properties of 1,1,2,2-tetrafluoroethane for temperatures from 170 K to 455 K and pressures up to 70 MPa. *J. Phys. Chem. Ref. Data* **1994,** *23,* 657-730.

[TSV00950] – Tsvetkov, O. B.; Kletski, A. V.; Laptev, Yu. A.; Asambaev, A. J.; Zausaev, I. A. Thermal conductivity and PVT measurements of pentafluoroethane (refrigerant HFC-125). *Int. J. Thermophys.* **1995,** *16,* 1185-1192.

[WEBL0980] – Weber, L. A. *Private Communication* **1998.**

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Property Code: [VPTG1020] VOLUMETRIC PROPERTIES OF PURE GASES AND MIXTURES **RAUJ0980.001**
State: Single-component gaseous system
Parameters: [P1] ρ/kg m^{-3}, Mass density
Variables: [X1] *T*/K, Temperature
[Y1] *P*/Pa, Pressure
Method: Direct measurement of *P* at variable *T* and constant ρ

Components: 1. CH_2F_2, Difluoromethane

[P1] = .826000E+02		[P1] = .885000E+02	
[X1]	[Y1]	[X1]	[Y1]
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.283300E+03	.900000E+06	.288600E+03	.123000E+07
.289700E+03	.940000E+06	.290400E+03	.124000E+07
.299700E+03	.990000E+06	.291700E+03	.125000E+07
.304100E+03	.102000E+07	.293800E+03	.127000E+07
.311800E+03	.105000E+07	.295500E+03	.128000E+07
.318200E+03	.108000E+07	.297500E+03	.130000E+07
.326000E+03	.112000E+07	.300400E+03	.132000E+07
.331100E+03	.115000E+07	.305700E+03	.136000E+07
.336100E+03	.118000E+07	.306700E+03	.137000E+07
.344200E+03	.121000E+07	.310600E+03	.140000E+07
.349900E+03	.123000E+07	.313900E+03	.142000E+07
.353800E+03	.125000E+07	.317700E+03	.144000E+07
		.325300E+03	.150000E+07
		.328700E+03	.153000E+07
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		.334300E+03	.157000E+07
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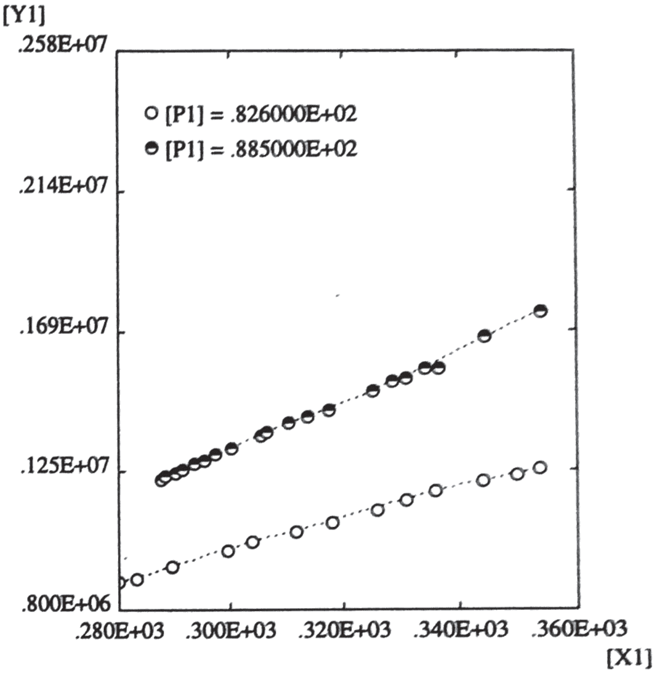

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State: Single-component gaseous system
Parameters: [P1] ρ/kg m^{-3}, Mass density
Variables: [X1] *T*/K, Temperature
[Y1] *P*/Pa, Pressure
Method: Direct measurement of *P* at variable *T* and constant ρ

Components: 1. CH_2F_2, Difluoromethane

[P1] = .107600E+03		[P1] = .141800E+03		[P1] = .184500E+03		[P1] = .282500E+03	
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.306300E+03	.199000E+07	.324500E+03	.312000E+07	.336500E+03	.415000E+07	.351200E+03	.565000E+07
.307300E+03	.200000E+07	.325500E+03	.315000E+07	.337500E+03	.419000E+07	.352400E+03	.574000E+07
.308300E+03	.201000E+07	.328900E+03	.325000E+07	.340500E+03	.431000E+07	.353400E+03	.581000E+07
.309300E+03	.202000E+07	.332300E+03	.333000E+07	.343500E+03	.444000E+07		
.310300E+03	.204000E+07	.335300E+03	.341000E+07	.347300E+03	.458000E+07		
.311600E+03	.206000E+07	.338300E+03	.347000E+07	.350600E+03	.471000E+07		
.313000E+03	.208000E+07	.341300E+03	.354000E+07	.352800E+03	.481000E+07		
.315000E+03	.210000E+07	.344300E+03	.361000E+07	.353800E+03	.485000E+07		
.316300E+03	.212000E+07	.347300E+03	.368000E+07				
.318200E+03	.214000E+07	.350300E+03	.375000E+07				
.322900E+03	.220000E+07	.353500E+03	.382000E+07				
.324600E+03	.223000E+07						
.325900E+03	.224000E+07						
.328900E+03	.228000E+07						
.331900E+03	.231000E+07						
.334700E+03	.234000E+07						
.337900E+03	.239000E+07						
.340900E+03	.242000E+07						
.343900E+03	.246000E+07						
.344500E+03	.247000E+07						
.346900E+03	.249000E+07						
.349900E+03	.253000E+07						
.354000E+03	.258000E+07						

Property Code: [VPTG1020] VOLUMETRIC PROPERTIES OF PURE GASES AND MIXTURES **RAUJ0980.002**
State: Single-component gaseous system
Parameters: [P1] ρ/kg m^{-3}, Mass density
Variables: [X1] T/K, Temperature
[Y1] P/Pa, Pressure
Method: Direct measurement of P at variable T and constant ρ

Components: **1. C_2HF_5 , Pentafluoroethane**

[P1] = .621000E+02		[P1] = .123300E+03	
[X1]	[Y1]	[X1]	[Y1]
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.278200E+03	.750000E+06	.305100E+03	.157000E+07
.280000E+03	.760000E+06	.309900E+03	.162000E+07
.283600E+03	.770000E+06	.313800E+03	.166000E+07
.289200E+03	.800000E+06	.318200E+03	.170000E+07
.295200E+03	.820000E+06	.322200E+03	.174000E+07
.299800E+03	.850000E+06	.326200E+03	.179000E+07
.306600E+03	.870000E+06	.331500E+03	.183000E+07
.314200E+03	.900000E+06	.336200E+03	.189000E+07
.324200E+03	.950000E+06	.341000E+03	.193000E+07
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.344700E+03	.102000E+07	.353200E+03	.204000E+07
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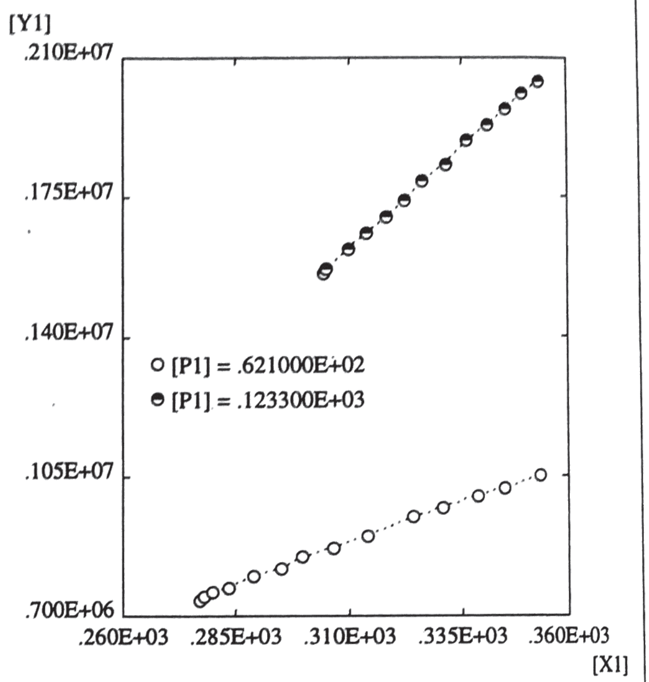

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State: Single-component gaseous system
Parameters: [P1] ρ/kg m^{-3}, Mass density
Variables: [X1] T/K, Temperature
[Y1] P/Pa, Pressure
Method: Direct measurement of P at variable T and constant ρ

Components: **1. C_2HF_5 , Pentafluoroethane**

[P1] = .191600E+03		[P1] = .222200E+03	
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.328900E+03	.253000E+07	.327000E+03	.268000E+07
.335100E+03	.266000E+07	.328200E+03	.272000E+07
.338500E+03	.272000E+07	.329200E+03	.275000E+07
.345400E+03	.286000E+07	.330200E+03	.277000E+07
.349900E+03	.294000E+07	.332200E+03	.282000E+07
.353700E+03	.302000E+07	.338200E+03	.298000E+07
		.341200E+03	.305000E+07
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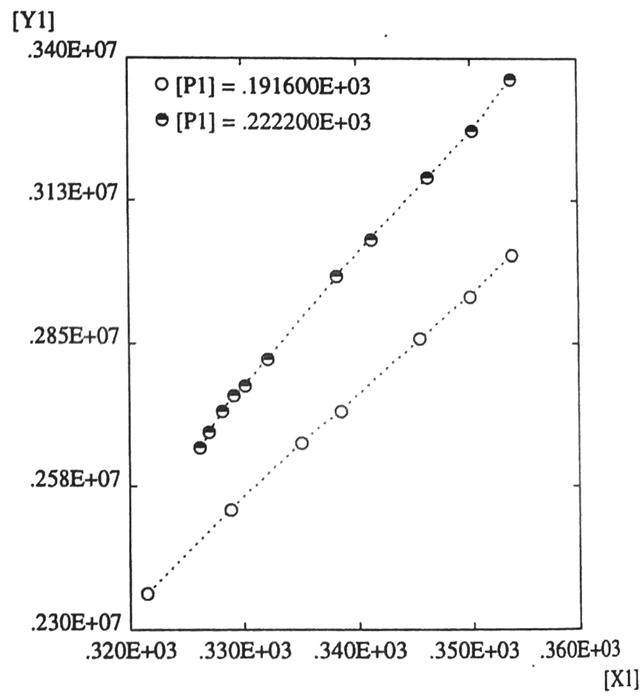

Property Code: [VPTG1020] VOLUMETRIC PROPERTIES OF PURE GASES AND MIXTURES **RAUJ0980.003**
State: Single-component gaseous system
Parameters: [P1] ρ/kg m^{-3}, Mass density
Variables: [X1] T/K, Temperature
[Y1] P/Pa, Pressure
Method: Direct measurement of P at variable T and constant ρ

Components: 1. $C_2H_2F_4$, 1,1,1,2-Tetrafluoroethane

[P1] = .420000E+02		[P1] = .617000E+02	
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.285200E+03	.380000E+06	.316600E+03	.920000E+06
.287200E+03	.400000E+06	.319800E+03	.950000E+06
.292200E+03	.400000E+06	.326600E+03	.980000E+06
.297200E+03	.410000E+06	.331000E+03	.100000E+07
.307200E+03	.420000E+06	.334700E+03	.101000E+07
.324100E+03	.460000E+06	.339200E+03	.103000E+07
.335900E+03	.480000E+06	.342200E+03	.104000E+07
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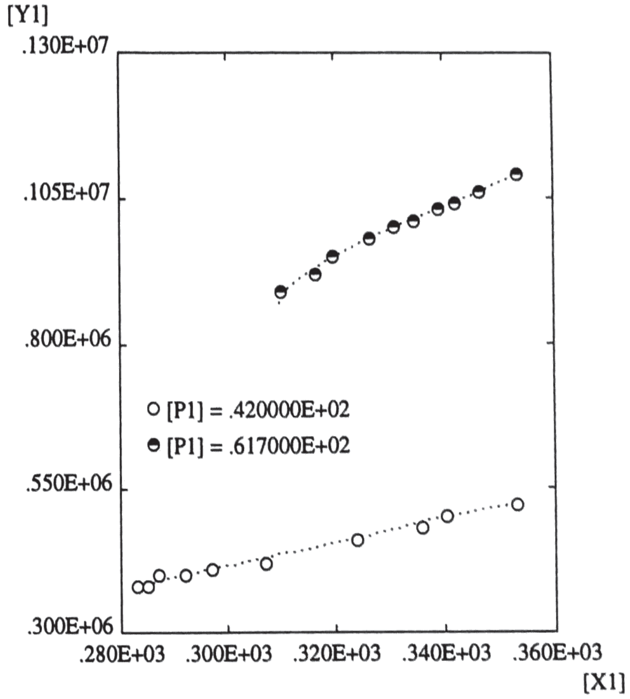

Property Code: [VPTG1020] VOLUMETRIC PROPERTIES OF PURE GASES AND MIXTURES **RAUJ0980.003**
State: Single-component gaseous system
Parameters: [P1] ρ/kg m^{-3}, Mass density
Variables: [X1] T/K, Temperature
[Y1] P/Pa, Pressure
Method: Direct measurement of P at variable T and constant ρ

Components: 1. $C_2H_2F_4$, 1,1,1,2-Tetrafluoroethane

[P1] = .877000E+02		[P1] = .111300E+03		[P1] = .161800E+03	
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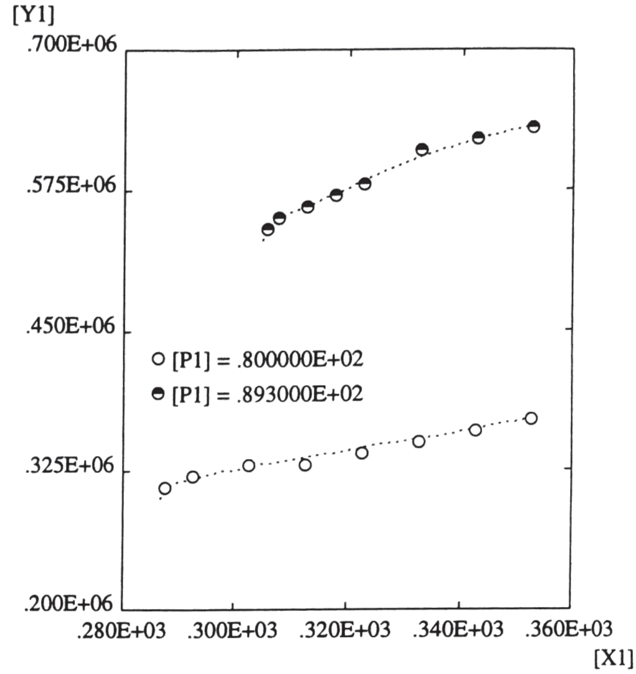
.327300E+03	.143000E+07	.339700E+03	.188000E+07	.355200E+03	.273000E+07
.328600E+03	.144000E+07	.340700E+03	.190000E+07	.355700E+03	.274000E+07
.331800E+03	.149000E+07	.341700E+03	.192000E+07	.356200E+03	.276000E+07
.336500E+03	.154000E+07	.342700E+03	.194000E+07	.356700E+03	.277000E+07
.341200E+03	.157000E+07	.344100E+03	.196000E+07	.357200E+03	.278000E+07
.344600E+03	.160000E+07	.347600E+03	.200000E+07	.357700E+03	.279000E+07
.347200E+03	.162000E+07	.351900E+03	.207000E+07	.358200E+03	.280000E+07
.349200E+03	.164000E+07	.353500E+03	.208000E+07		
.350200E+03	.165000E+07				
.351200E+03	.166000E+07				
.352700E+03	.168000E+07				
.355200E+03	.169000E+07				

Property Code: [VPTG1020] VOLUMETRIC PROPERTIES OF PURE GASES AND MIXTURES **RAUJ0980.004**
State: Single-component gaseous system
Parameters: [P1] ρ/kg m^{-3}, Mass density
Variables: [X1] T/K, Temperature
[Y1] P/Pa, Pressure
Method: Direct measurement of P at variable T and constant ρ

Components: **1. C_3HF_7 , 1,1,1,2,3,3,3-Heptafluoropropane**

[P1] = .800000E+02		[P1] = .893000E+02	
[X1]	[Y1]	[X1]	[Y1]
.287700E+03	.310000E+06	.305700E+03	.540000E+06
.292700E+03	.320000E+06	.307700E+03	.550000E+06
.302700E+03	.330000E+06	.312700E+03	.560000E+06
.312700E+03	.330000E+06	.317700E+03	.570000E+06
.322700E+03	.340000E+06	.322700E+03	.580000E+06
.332700E+03	.350000E+06	.332700E+03	.610000E+06
.342700E+03	.360000E+06	.342700E+03	.620000E+06
.352700E+03	.370000E+06	.352700E+03	.630000E+06



Property Code: [VPTG1010] VOLUMETRIC PROPERTIES OF PURE GASES AND MIXTURES **RAUJ0980.004**
State: Single-component gaseous system
Parameters: [P1] T/K, Temperature
Variables: [X1] P/Pa, Pressure
[Y1] ρ/kg m^{-3}, Mass density
Method: Direct measurement of ρ at variable P and constant T

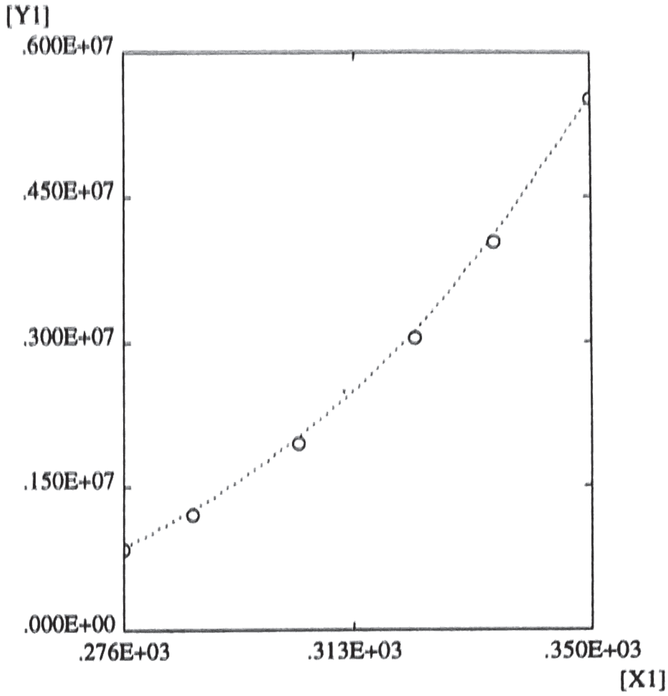
Components: **1. C_3HF_7 , 1,1,1,2,3,3,3-Heptafluoropropane**

[P1] = .111500E+03		[P1] = .135300E+03		[P1] = .167800E+03	
[X1]	[Y1]	[X1]	[Y1]	[X1]	[Y1]
.319700E+03	.800000E+06	.332700E+03	.111000E+07	.343700E+03	.146000E+07
.321200E+03	.810000E+06	.333700E+03	.112000E+07	.344200E+03	.147000E+07
.322700E+03	.820000E+06	.336700E+03	.115000E+07	.345200E+03	.148000E+07
.325700E+03	.840000E+06	.339700E+03	.117000E+07	.346200E+03	.149000E+07
.327700E+03	.850000E+06	.342700E+03	.119000E+07	.347200E+03	.150000E+07
.332700E+03	.860000E+06	.346700E+03	.121000E+07	.348200E+03	.152000E+07
.337700E+03	.890000E+06	.349700E+03	.123000E+07	.349200E+03	.153000E+07
.342700E+03	.910000E+06	.352700E+03	.125000E+07	.350200E+03	.155000E+07
.345700E+03	.920000E+06			.353200E+03	.158000E+07
.352700E+03	.960000E+06				

Property Code: [EPTL1120] VAPOR PRESSURE AND BOILING TEMPERATURE OF PURE LIQUIDS **RAUJ0980.005**
State: Single-component vapor-liquid system
Variables: [X1] *T*/K, Temperature
[Y1] *P*/Pa, Pressure
Method: Graphical estimation of *P* at the break point of measured isochoric temperature-pressure curves, at variable density

Components: **1. CH_2F_2, Difluoromethane**

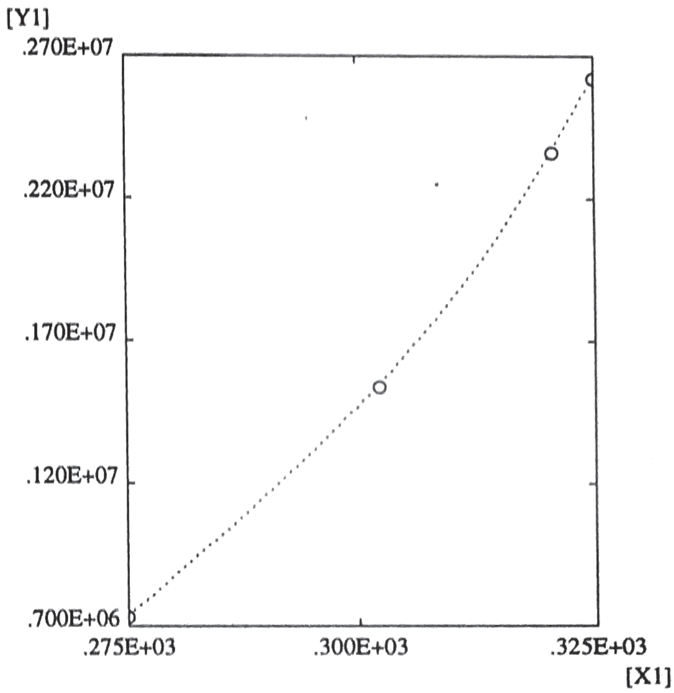
[X1]	[Y1]
.276500E+03	.850000E+06
.287600E+03	.121000E+07
.304300E+03	.195000E+07
.322500E+03	.305000E+07
.334500E+03	.403000E+07
.349400E+03	.552000E+07



Property Code: [EPTL1120] VAPOR PRESSURE AND BOILING TEMPERATURE OF PURE LIQUIDS **RAUJ0980.006**
State: Single-component vapor-liquid system
Variables: [X1] *T*/K, Temperature
[Y1] *P*/Pa, Pressure
Method: Graphical estimation of *P* at the break point of measured isochoric temperature-pressure curves, at variable density

Components: **1. C_2HF_5 , Pentafluoroethane**

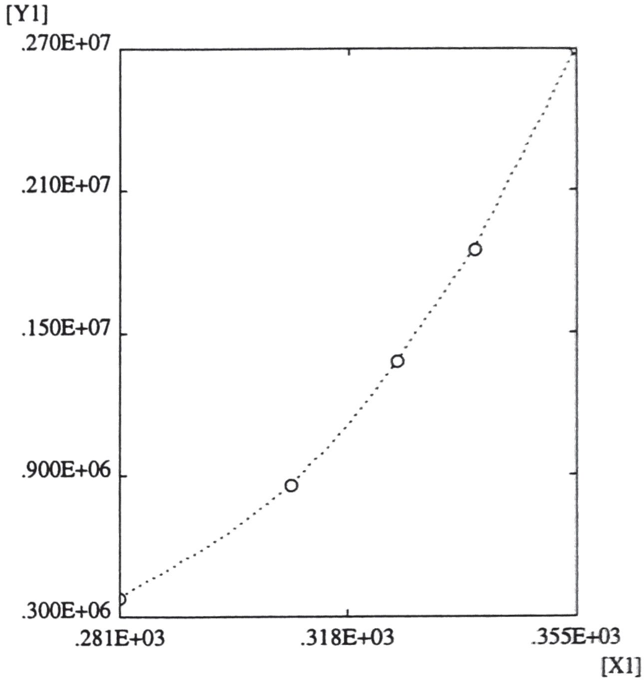
[X1]	[Y1]
.276800E+03	.730000E+06
.303200E+03	.154000E+07
.321000E+03	.236000E+07
.325200E+03	.262000E+07



Property Code: [EPTL1120] VAPOR PRESSURE AND BOILING TEMPERATURE OF PURE LIQUIDS **RAUJ0980.007**
State: Single-component vapor-liquid system
Variables: [X1] *T*/K, Temperature
[Y1] *P*/Pa, Pressure
Method: Graphical estimation of *P* at the break point of measured isochoric temperature-pressure curves, at variable density

Components: **1. $C_2H_2F_4$, 1,1,1,2-Tetrafluoroethane**

[X1]	[Y1]		
.281100E+03	.380000E+06		
.308800E+03	.860000E+06		
.325500E+03	.138000E+07		
.337700E+03	.185000E+07		
.354200E+03	.270000E+07		



Property Code: [EPTL1120] VAPOR PRESSURE AND BOILING TEMPERATURE OF PURE LIQUIDS **RAUJ0980.008**
State: Single-component vapor-liquid system
Variables: [X1] *T*/K, Temperature
[Y1] *P*/Pa, Pressure
Method: Graphical estimation of *P* at the break point of measured isochoric temperature-pressure curves, at variable density

Components: **1. C_3HF_7 , 1,1,1,2,3,3,3-Heptafluoropropane**

[X1]	[Y1]		
.285700E+03	.300000E+06		
.304200E+03	.520000E+06		
.319200E+03	.790000E+06		
.331700E+03	.110000E+07		
.343200E+03	.145000E+07