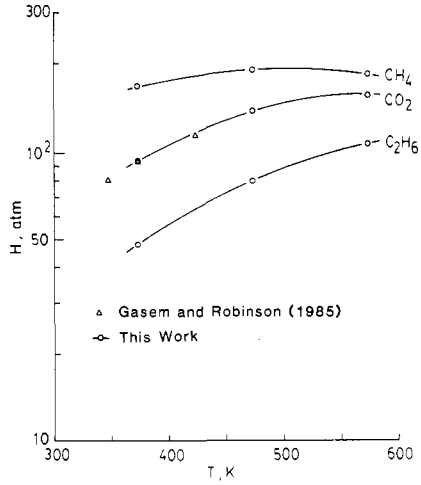

Figure 7. Henry's constant of carbon dioxide, methane, and ethane in *n*-octacosane.

ducible to within 1.5% in the mole fraction of the gas component. K values of gases reported in the tables were calculated from the averaged values of x and y according to the definition, $K \equiv y/x$. Figures 1-3 show the gas solubility as a function of pressure at different temperatures. Individual data points are shown in the figures where they can be distinguished. For carbon dioxide and ethane, solubility decreases with increasing temperature at the conditions of this work. The solubility of methane passes through a minimum at a temperature between 100 and 300 °C. Solubility of carbon dioxide in *n*-octacosane reported by Gasem and Robinson (*2*) is shown in Figure 1 for comparison with our data. The agreement is excellent.

Figures 4-6 show ln (f/x) of the solute as a function of pressure at a constant temperature. The solute fugacity f is calculated from the equilibrium gas by using the generalized correlation of fugacity coefficient by Lee and Kesler (*3*). Linear isotherms are obtained with an average absolute deviation of 0.8%. By the equation of Krichevsky and Kasarnovsky (*4*) the intercept at the vapor pressure of the solvent determines the Henry's constant, and the slope gives the partial molar volume at infinite dilution. The values thus obtained are reported in Table IV. Henry's constant is subject to an uncertainty of about 2%. Partial molar volume at infinite dilution is less accurate; their estimated standard deviations are listed in Table IV. Figure 7 shows the Henry's constant as a function of temperature. Our results are in agreement with those reported by Gasem and Robinson for CO_2 mixtures.

Registry No. CO_2, 124-38-9; CH_4, 74-82-8; C_2H_6, 74-84-0; *n*-octacosane, 630-02-4.

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Solubility of Carbon Dioxide, Methane, and Ethane in *n*-Eicosane

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Solubility of carbon dioxide, methane, and ethane in *n*-eicosane has been measured in a semiflow apparatus at temperatures up to 300 °C and pressures to 50 atm. Henry's constant of the dissolved gases in *n*-eicosane is determined from the data.

Introduction

This article reports data from an investigation of gas solubilities in model compounds of wax slurry of Fischer-Tropsch synthesis reactors. Solubility of carbon dioxide, methane, and ethane in *n*-eicosane at temperatures up to 300 °C and pressures to 50 atm has been determined, and Henry's constant is obtained from the data. The results are compared with literature values.

Experimental Section

A semiflow apparatus has been designed and constructed for the measurements of gas solubility in molten waxes. Detailed description of the equipment and sampling procedure has been reported (*1*). In the course of an experiment, molten wax was kept in a presaturator and in an equilibrium cell. A stream of gas passed through the cells in series. Upon saturation, samples from the equilibrium cell were withdrawn, reduced in pressure, and collected in a trap. The collected wax was weighed with an analytical balance, and the liberated gas from the trap was measured volumetrically in a buret. Temperature of the equilibrium cell was measured to an accuracy of ±0.1 °C by a type K chromel-alumel thermocouple inserted in the cell which is housed in a thermostated bath. The pressure was measured by a Heise gauge to ±0.05 atm.

The gases were purchased from Matheson Gas Products with a minimum purity of 99.0% for methane and ethane, and 99.8% for carbon dioxide. *n*-Eicosane was purchased from Aldrich Chemical Co., Inc., with a stated minimum purity of 99%. Possible thermal degradation of *n*-eicosane was examined by gas chromatographic (GC) analysis. No degradation was observed.

Results and Discussion

Table I presents vapor-liquid equilibrium (VLE) data for carbon dioxide + *n*-eicosane at four temperatures: 50.1, 100.3, 200.0, and 300.2 °C. Table II presents the VLE data of methane + *n*-eicosane at three temperatures: 100.2, 200.3, and 300.0 °C. Table III presents the VLE data of ethane + *n*-eicosane at three temperatures: 100.6, 200.5, and 299.7 °C. At each temperture, data are reported at five pressures 10, 20, 30, 40, and 50 atm for carbon dioxide and methane. Since the vapor pressure of ethane in the source cylinder was below 50 atm, the solubility of ethane was determined at only four pressures 10, 20, 30, and 40 atm.

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Table I. Carbon Dioxide (CD) + *n*-Eicosane VLE Data

t, °C	p, atm	x_{CD}	y_{CD}	K_{CD}
50.1	9.79	0.114		8.79
	19.89	0.217		4.62
	30.21	0.305		3.28
	39.97	0.379		2.64
	49.48	0.446		2.24
100.3	10.04	0.0842		11.9
	19.83	0.157		6.38
	30.02	0.228		4.39
	39.63	0.286		3.50
	49.90	0.342		2.92
200.0	9.85	0.0593	0.9979	16.8
	19.71	0.114	0.9989	8.75
	30.24	0.170	0.9991	5.88
	40.12	0.216	0.9992	4.62
	49.50	0.259	0.9992	3.86
300.2	9.76	0.0528	0.9563	18.1
	19.93	0.104	0.9748	9.33
	29.64	0.151	0.9812	6.52
	40.64	0.201	0.9846	4.91
	49.97	0.237	0.9861	4.17

Table II. Methane (M) + *n*-Eicosane VLE Data

t, °C	p, atm	x_M	y_M	K_M
100.2	9.95	0.0472		21.2
	19.73	0.0903		11.1
	29.78	0.132		7.55
	39.84	0.172		5.82
	49.85	0.209		4.78
200.3	9.93	0.0427	0.9984	23.4
	19.69	0.0845	0.9990	11.8
	30.00	0.125	0.9992	7.97
	39.86	0.159	0.9993	6.27
	49.86	0.194	0.9993	5.16
300.0	9.96	0.0440	0.9595	21.8
	19.89	0.0869	0.9772	11.2
	29.84	0.127	0.9830	7.76
	39.96	0.165	0.9858	5.98
	49.74	0.203	0.9876	4.86

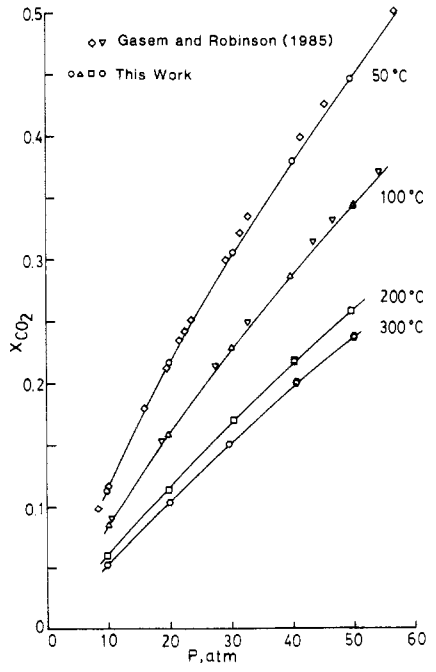

Figure 1. Solubility of carbon dioxide in *n*-eicosane.

The volatility of eicosane is very low at 100 °C and below. Eicosane was not found in the equilibrium vapor by the analytical method of this work. The equilibrium vapor is essentially pure light gas, though the compositions are not explicitly reported.

Table III. Ethane (E) + *n*-Eicosane VLE Data

t, °C	p, atm	x_E	y_E	K_E
100.6	6.69	0.159		6.29
	19.91	0.284		3.53
	29.90	0.387		2.59
	39.91	0.463		2.16
200.5	9.83	0.0960	0.9978	10.4
	19.86	0.175	0.9986	5.69
	29.99	0.251	0.9988	3.97
	40.18	0.314	0.9988	3.18
299.7	9.83	0.0731	0.9499	13.0
	19.64	0.139	0.9682	6.97
	29.90	0.206	0.9768	4.75
	39.85	0.262	0.9810	3.74

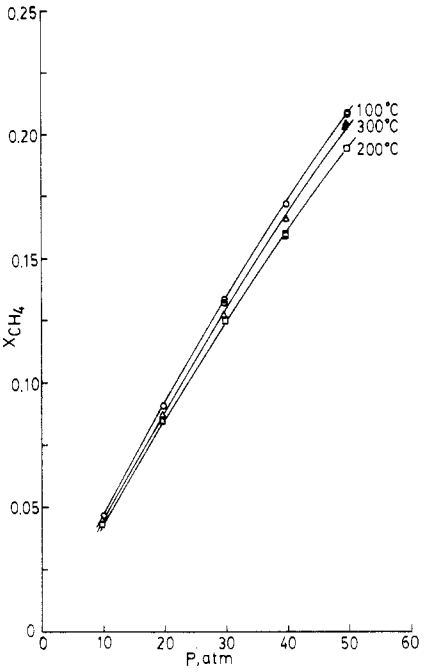

Figure 2. Solubility of methane in *n*-eicosane.

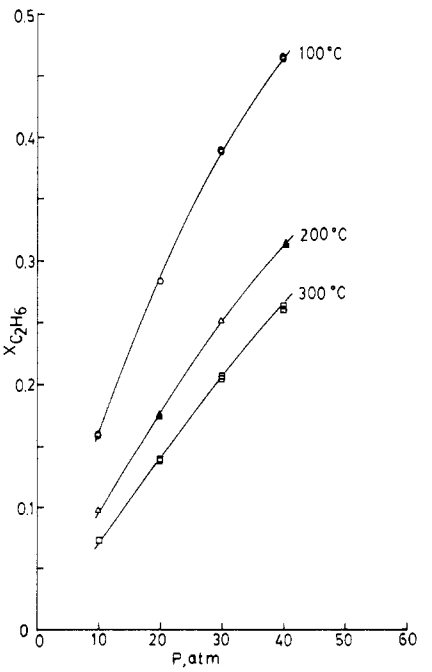

Figure 3. Solubility of ethane in *n*-eicosane.

Four replicate samples were taken at each experimental condition. Reproducibility of the replicates was within 1.5%. Figures 1–3 show the individual data points where they can be

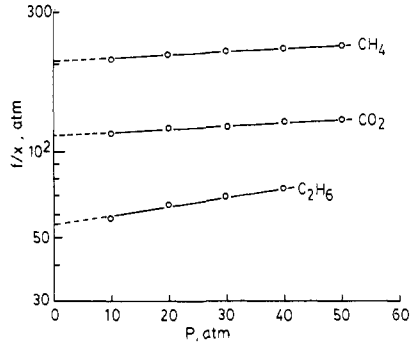

Figure 4. Plot of (f/x) vs p at 100 °C.

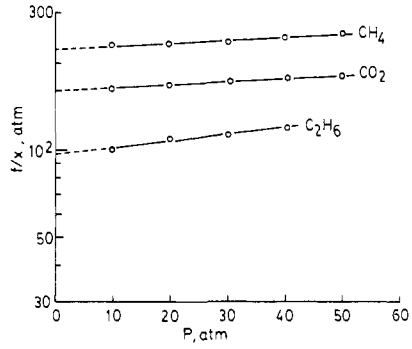

Figure 5. Plot of (f/x) vs p at 200 °C.

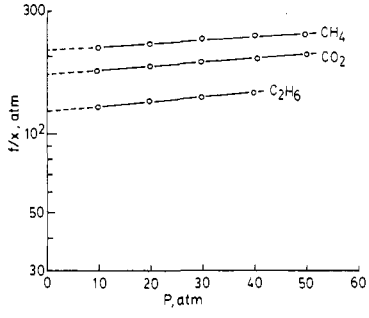

Figure 6. Plot of (f/x) vs p at 300 °C.

distinguished. K values of gases reported in Tables I–III were calculated from the averaged values of x and y according to the definition $K \equiv y/x$.

Gasem and Robinson (*2*) reported solubility of carbon dioxide in *n*-eicosane at 50 and 100 °C. Their data are included in Figure 1 for comparison. Our data coincide with theirs at low pressures but are about 2% lower at the higher pressures.

Gas solubility increases with pressure at conditions of this work. The solubilities of carbon dioxide and ethane decrease with increasing temperature, but methane data show a minimum value at a temperature between 100 and 300 °C.

Figures 4–6 show solute ln (f/x) as a function of pressure at 100, 200, and 300 °C, respectively. The solute fugacity f was calculated for the equilibrium gas by using the generalized correlation of fugacity coefficients by Lee and Kesler (*3*). Henry's constant is determined from the intercept at vapor pressure of *n*-eicosane from the plots of Figures 4–6. The values are reported in Table IV. Henry's constant determined in this work is subject to 3% uncertainty. Figure 7 shows the Henry's constant of this work in comparison with that of Gasem and Robinson on carbon dioxide, and with that of Chappelow and Prausnitz (*4*) on methane and ethane. Excellent agreement is obtained for carbon dioxide. Our methane and ethane results are about 5% different from those of Chappelow and Prausnitz.

Table IV. Henry's Constant of Carbon Dioxide, Methane, and Ethane in *n*-Eicosane

solute	temp, °C	Henry's const, atm
CO_2	100.3	114
	200.0	160
	300.2	171
CH_4	100.2	205
	200.3	223
	300.0	212
C_2H_6	100.6	55.1
	200.5	96.3
	299.7	123

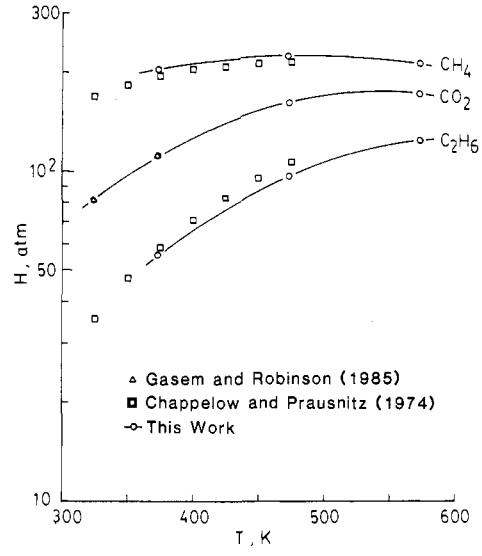

Figure 7. Henry's constants in *n*-eicosane.

Registry No. CO_2, 124-38-9; CH_4, 74-82-8; C_2H_6, 74-84-0; *n*-eicosane, 112-95-8.

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