

COMPONENTS:

1. Methane; CH₄; [74-82-8]
2. Butane; C₄H₁₀; [106-97-8]

EVALUATOR:

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May 1982

EVALUATION:

This system has been extensively studied. The early data of Nederbragt (1) are rejected because of their limited nature and the low precision of the analytical techniques used in that work. The data of Frolich *et al.* are also rejected since the results were presented in the form of a small graph and the measurements have been superseded by more recent data.

The data of Wang and McKetta (3) and Roberts *et al.* (4) are classified as doubtful. These data show a fair degree of scatter in the reported solubilities. This probably arose because of the sampling and analyzing techniques employed.

The data of Wiese *et al.* (5) are not in good agreement with the data of Elliott *et al.* (6) at the overlapping temperature of 277.6 K. There is excellent agreement between the data of Wiese *et al.* (5) and Sage *et al.* (7) but in fact it appears that the two sets of data are derived from the same set of raw experimental measurements.

Although the data of Kahre (8) and Elliott *et al.* (6) agree more closely than do the data of Wiese *et al.* (5) and Elliott *et al.* (6), there are still significant discrepancies between the two sets of data. The precision, and probably the accuracy, of the data of Elliott *et al.* (6) is greater than that of the data of Kahre (8).

The data of Elliott *et al.* (6) are classified as tentative for the temperature range 144 K to 278 K and the data of Sage *et al.* (7) are classified as tentative for the range 294 K to 394 K although the accuracy of the later work is considerably less than the former.

In another paper Sage and coworkers (9) have made a detailed evaluation of phase behavior of this system.

References

1. Nederbragt, G. W. *Ing. Eng. Chem.*, 1938, *30*, 587.
2. Frolich, P. K.; Tauch, E. J.; Hogan, J. J.; Peer, A. A. *Ind. Eng. Chem.*, 1931, *23*, 548.
3. Wang, R. H.; McKetta, J. J. *J. Chem. Eng. Data*, 1964, *9*, 30.
4. Roberts, L. R.; Wang, R. H.; Azarnoosh, A.; McKetta, J. J. *J. Chem. Eng. Data*, 1962, *7*, 484.
5. Wiese, H. C.; Jacobs, J.; Sage, B. H. *J. Chem. Eng. Data*, 1970, *15*, 82.
6. Elliott, D. G.; Chen, R. J. J.; Chappellear, P. S.; Kobayashi, R. *J. Chem. Eng. Data*, 1974, *19*, 71.
7. Sage, B. H.; Hicks, B. L.; Lacey, W. N. *Ind. Eng. Chem.*, 1940, *32*, 1085.
8. Kahre, L. *J. Chem. Eng. Data*, 1974, *19*, 67.
9. Sage, B. H.; Budenholzer, R. A.; Lacey, W. N. *Ind. Eng. Chem.*, 1940, *32*, 1262.

COMPONENTS:		ORIGINAL MEASUREMENTS:	
1. Methane; CH ₄ ; [74-82-8] 2. Butane; C ₄ H ₁₀ ; [106-97-8]		Frolich, P.K.; Tauch, E.J.; Hogan, J.J.; Peer, A.A. <i>Ind. Eng. Chem.</i> <u>1931</u> , 23, 548-550.	
VARIABLES:		PREPARED BY:	
Pressure		C.L. Young	
EXPERIMENTAL VALUES:			
T/K	P/MPa	Solubility*, S	Mole fraction of methane in liquid, x _{CH₄}
298.15	1.0	18	0.0718
	2.0	35.5	0.132
	3.0	52	0.183
	4.0	70	0.231
	5.0	88	0.274
	6.0	106	0.313
	7.0	123	0.346
* Data taken from graph in original article.			
+ calculated by compiler.			
AUXILIARY INFORMATION			
METHOD/APPARATUS/PROCEDURE:		SOURCE AND PURITY OF MATERIALS:	
Static equilibrium cell. Liquid saturated with gas and after equilibrium established samples removed and analysed by volumetric method. Allowance was made for vapor pressure of liquid and the solubility of the gas at atmospheric pressure. Details in source.		Stated that the materials were the highest purity available (98 to 99 mole per cent.)	
		ESTIMATED ERROR:	
		$\delta T/K = \pm 0.1$; $\delta x_{CH_4} = \pm 5\%$	
		REFERENCES:	

COMPONENTS:		ORIGINAL MEASUREMENTS:			
1. Methane; CH ₄ ; [74-82-8]		Sage, B. H.; Hicks, B. L.; Lacey, W. N. <i>Ind. Eng. Chem.</i> <u>1940</u> , 32, 1085-1092.			
2. Butane; C ₄ H ₁₀ ; [106-97-8]					
VARIABLES:		PREPARED BY:			
Temperature, pressure		C. L. Young			
EXPERIMENTAL VALUES:					
T/K	P/kPa	Wt. fraction of methane in liquid,	in gas,	Mole fraction of methane in liquid, x_{CH_4}	in gas, y_{CH_4}
294.25	0.276	0.0010	0.06845	0.0036	0.2103
	0.414	0.0031	0.1899	0.0111	0.4593
	0.552	0.0052	0.2795	0.0186	0.5843
	0.689	0.0074	0.3489	0.0263	0.6601
	1.034	0.0129	0.4651	0.0452	0.7591
	1.379	0.0185	0.5387	0.0639	0.8089
	2.068	0.0301	0.6265	0.1011	0.8587
	2.758	0.0423	0.6758	0.1380	0.8831
	3.447	0.0551	0.7081	0.1745	0.8979
	4.137	0.0686	0.7300	0.2107	0.9074
	5.516	0.0971	0.7540	0.2804	0.9174
	6.895	0.1289	0.7610	0.3491	0.9203
	8.274	0.1644	0.7550	0.4162	0.9178
	8.618	0.1726	0.7510	0.4305	0.9162
	9.653	0.2014	0.7331	0.4775	0.9087
	10.34	0.2232	0.7190	0.5101	0.9027
	11.03	0.2485	0.7000	0.5451	0.8942
	11.72	0.2812	0.6750	0.5864	0.8827
	12.07	0.3020	0.6590	0.6106	0.8751
	12.41	0.3268	0.6392	0.6376	0.8652
	12.76	0.3591	0.6120	0.6700	0.8511
	13.10	0.4094	0.5659	0.7153	0.8253
	13.26	0.482	0.482	0.7713 (cont.)	0.7713
AUXILIARY INFORMATION					
METHOD/APPARATUS/PROCEDURE:			SOURCE AND PURITY OF MATERIALS:		
PVT cell charged with mixture of known composition. Pressure measured with pressure balance. Temperature measured with resistance thermometer. Bubble point and dew point determined for various compositions from discontinuity in PV isotherm. Coexisting liquid and gas phase properties determined by graphical means.			1. Crude sample treated for removal of higher alkanes, carbon dioxide and water vapor. Final purity 99.9 mole per cent.		
			2. Phillips petroleum sample, distilled, final purity better than 99.96 mole per cent.		
			ESTIMATED ERROR: $\delta T/K = \pm 0.1$; $\delta P/kPa = \pm 0.007$; $\delta x_{CH_4} = \pm 0.0005$; $\delta y_{CH_4} = \pm 0.003$ (estimated by compiler).		
			REFERENCES: 1. Sage, B. H.; Lacey, W. N. <i>Trans. Am. Inst. Mining Met. Engrs.</i> <u>1940</u> , 136, 136.		

COMPONENTS:		ORIGINAL MEASUREMENTS:			
1. Methane; CH ₄ ; [74-82-8]		Sage, B. H.; Hicks, B. L.; Lacey, W. N.			
2. Butane; C ₄ H ₁₀ ; [106-97-8]		Ind. Eng. Chem. 1940, 32, 1085-1092.			
EXPERIMENTAL VALUES:					
T/K	P/kPa	Wt. fraction of methane in liquid,	in gas,	Mole fraction of methane in liquid, x_{CH_4}	in gas, y_{CH_4}
310.93	0.414	0.0008	0.0408	0.0029	0.1336
	0.552	0.0029	0.1230	0.0104	0.3370
	0.689	0.0049	0.1901	0.0175	0.4596
	1.034	0.0100	0.3128	0.0353	0.6226
	1.379	0.0152	0.3948	0.0530	0.7027
	2.068	0.0257	0.4985	0.0873	0.7827
	2.758	0.0368	0.5636	0.1216	0.8240
	3.447	0.0484	0.6050	0.1556	0.8473
	4.137	0.0604	0.6335	0.1889	0.8623
	5.516	0.0859	0.6640	0.2540	0.8775
	6.895	0.1136	0.6712	0.3172	0.8809
	8.274	0.1452	0.6690	0.3810	0.8799
	8.618	0.1540	0.6664	0.3975	0.8786
	9.653	0.1821	0.6550	0.4467	0.8731
	10.34	0.2030	0.6418	0.4800	0.8665
	11.03	0.2279	0.6232	0.5168	0.8570
	11.72	0.2589	0.5990	0.5587	0.8441
	12.07	0.2790	0.5825	0.5837	0.8349
	12.41	0.3024	0.5616	0.6110	0.8228
	12.76	0.3325	0.5330	0.6435	0.8053
13.10	0.3954	0.4815	0.7033	0.7709	
13.18	0.4195	0.4195	0.7237	0.7237	
327.59	0.689	0.0018	0.05675	0.0065	0.1790
	1.034	0.0066	0.1724	0.0235	0.4302
	1.379	0.0115	0.2546	0.0405	0.5531
	2.068	0.0214	0.3672	0.0734	0.6777
	2.758	0.0317	0.4387	0.1061	0.7391
	3.447	0.0424	0.4867	0.1383	0.7746
	4.137	0.0534	0.5194	0.1697	0.7966
	5.516	0.0769	0.5559	0.2319	0.8194
	6.895	0.1028	0.5688	0.2934	0.8270
	8.274	0.1322	0.5711	0.3557	0.8283
	8.618	0.1403	0.5697	0.3716	0.8275
	9.653	0.1662	0.5600	0.4194	0.8218
	10.34	0.1855	0.5481	0.4522	0.8147
	11.03	0.2088	0.5313	0.4889	0.8042
	11.72	0.2362	0.5040	0.5285	0.7864
	12.07	0.2560	0.4858	0.5550	0.7740
12.41	0.2756	0.4617	0.5796	0.7566	
12.76	0.3131	0.4266	0.6229	0.7295	
12.93	0.3610	0.3610	0.6719	0.6719	
344.26	1.034	0.0025	0.0543	0.0090	0.1722
	1.379	0.0068	0.1303	0.0242	0.3519
	2.068	0.0165	0.2387	0.0573	0.5319
	2.758	0.0261	0.3135	0.0885	0.6233
	3.447	0.0363	0.3661	0.1201	0.6767
	4.137	0.0469	0.4030	0.1513	0.7098
	5.516	0.0691	0.4465	0.2120	0.7451
	6.895	0.0943	0.4628	0.2740	0.7574
	8.274	0.1210	0.4655	0.3328	0.7594
	8.618	0.1285	0.4648	0.3483	0.7589
	9.653	0.1542	0.4567	0.3978	0.7529
	10.34	0.1740	0.4450	0.4329	0.7440
	11.03	0.1964	0.4255	0.4697	0.7286
	11.72	0.2234	0.3959	0.5104	0.7037
	12.07	0.2466	0.3730	0.5426	0.6831
	12.41	0.2665	0.3330	0.5684	0.6440
12.48	0.3073	0.3073	0.6165	0.6165	

(cont.)

COMPONENTS:		ORIGINAL MEASUREMENTS:			
1. Methane; CH ₄ ;	[74-82-8]	Sage, B. H.; Hicks, B. L.; Lacey, W. N.			
2. Butane; C ₄ H ₁₀ ;	[106-97-8]	<i>Ind. Eng. Chem.</i> <u>1940</u> , 32, 1085-1092.			
EXPERIMENTAL VALUES:					
T/K	P/kPa	Wt. fraction of methane in liquid,	in gas,	Mole fraction of methane in liquid, x_{CH_4}	in gas, y_{CH_4}
360.93	1.379	0.0022	0.0333	0.0079	0.1110
	2.068	0.0110	0.1357	0.0387	0.3627
	2.758	0.0202	0.2062	0.0695	0.4849
	3.447	0.0299	0.2584	0.1005	0.5581
	4.137	0.0399	0.2960	0.1309	0.6038
	5.516	0.0614	0.3417	0.1916	0.6529
	6.895	0.0851	0.3610	0.2521	0.6719
	8.274	0.1128	0.3638	0.3155	0.6745
	8.618	0.1206	0.3627	0.3320	0.6735
	9.653	0.1479	0.3534	0.3861	0.6645
	10.34	0.1702	0.3406	0.4264	0.6518
	11.03	0.1957	0.3165	0.4685	0.6266
	11.38	0.2108	0.2975	0.4919	0.6055
	11.71	0.2525	0.2525	0.5504	0.5504
383.15	2.068	0.0049	0.0499	0.0175	0.1599
	2.758	0.0136	0.1169	0.0476	0.3242
	3.447	0.0229	0.1666	0.0783	0.4201
	4.137	0.0328	0.2030	0.1094	0.4800
	5.516	0.0543	0.2468	0.1722	0.5429
	6.895	0.0784	0.2623	0.2356	0.5630
	8.274	0.1063	0.2610	0.3012	0.5614
	8.618	0.1145	0.2586	0.3191	0.5583
	8.963	0.1227	0.2545	0.3364	0.5530
	9.653	0.1457	0.2425	0.3820	0.5371
	10.00	0.1575	0.2322	0.4039	0.5229
	10.34	0.1768	0.2154	0.4377	0.4987
	10.48	0.1980	0.1980	0.4722	0.4722
394.26	2.758	0.0061	0.0436	0.0218	0.1418
	3.447	0.0152	0.0905	0.0530	0.2650
	4.137	0.0250	0.1250	0.0850	0.3411
	5.516	0.0471	0.1636	0.1519	0.4148
	6.895	0.0719	0.1739	0.2192	0.4328
	7.584	0.0900	0.1720	0.2639	0.4295
	8.274	0.1067	0.1610	0.3021	0.4102
	8.618	0.1243	0.1474	0.3397	0.3852
	8.715	0.1345	0.1345	0.3603	0.3603

COMPONENTS:			ORIGINAL MEASUREMENTS:	
1. Methane; CH ₄ ; [74-82-8] 2. Butane; C ₄ H ₁₀ ; [106-97-8]			Sage, B. H.; Budenholzer, R. A.; Lacey, W. N. <i>Ind. Eng. Chem.</i> <u>1940</u> , 32, 1262-1277.	
VARIABLES:			PREPARED BY:	
Temperature, pressure			C. L. Young	
EXPERIMENTAL VALUES:				
T/K (T/°F)	p/psi	P/MPa	Wt. fraction of methane	Mole fraction of methane, x_{CH_4}
294.3 (70)	257.0 460.5 645.4 819 976 1122 1393 1604 1745 1893 1924 1867 1600	1.772 3.175 4.450 5.647 6.729 7.736 9.604 11.06 12.03 13.05 13.27 12.87 11.03	0.025 0.050 0.075 0.100 0.125 0.150 0.200 0.250 0.300 0.400 0.500 0.600 0.700	0.0849 0.160 0.227 0.287 0.341 0.390 0.475 0.547 0.608 0.707 0.784 0.844 0.894
310.9 (100)	275.0 514.2 716.1 903.3 1074 1228 1485 1672 1796 1906	1.896 3.545 4.937 6.228 7.405 8.467 10.24 11.53 12.38 13.14	0.025 0.050 0.075 0.100 0.125 0.150 0.200 0.250 0.300 0.400	0.0849 0.160 0.227 0.287 0.341 0.390 0.475 0.547 0.608 0.707 (cont.)
AUXILIARY INFORMATION				
METHOD/APPARATUS/PROCEDURE:			SOURCE AND PURITY OF MATERIALS:	
PVT cell charged with mixture of known composition. Pressure measured with pressure balance. Temperature measured with resistance thermometer. Bubble point and dew point determined from discontinuity in PV isotherm. Coexisting liquid and gas phase properties determined by graphical means. Details of apparatus in ref. (1).			1. Crude sample, treated for removal of higher alkanes, carbon dioxide and water vapor. Final purity 99.9 mole per cent. 2. Phillips Petroleum sample, distilled, final purity better than 99.96 mole per cent.	
NOTE: Source contains extensive PVT data.			ESTIMATED ERROR: $\delta T/K = \pm 0.1$; $\delta P/MPa = \pm 0.007$; $\delta x_{CH_4} = \pm 0.002$ (estimated by compiler).	
			REFERENCES: 1. Sage, B. H.; Lacey, W. N. <i>Trans. Am. Inst. Mining Met. Engrs.</i> <u>1940</u> , 136, 136.	

COMPONENTS:			ORIGINAL MEASUREMENTS:	
1. Methane; CH ₄ ; [74-82-8]			Sage, B. H.; Budenholzer, R. A.; Lacey, W. N.	
2. Butane; C ₄ H ₁₀ ; [106-97-8]			<i>Ind. Eng. Chem.</i> <u>1940</u> , 32, 1262-1277.	
EXPERIMENTAL VALUES:				
T/K (T/°F)	p/psi	P/MPa	Wt. fraction of methane	Mole fraction of methane, x_{CH_4}
310.9 (100)	1888	13.02	0.500	0.784
	1696	11.69	0.600	0.844
327.6 (130)	335.0	2.310	0.025	0.0849
	569.6	3.927	0.050	0.160
	784.0	5.403	0.075	0.227
	979.5	6.753	0.100	0.287
	1153	7.950	0.125	0.341
	1308	9.018	0.150	0.390
	1565	10.79	0.200	0.475
	1736	11.97	0.250	0.547
	1833	12.64	0.300	0.608
	1870	12.89	0.400	0.707
	1712	11.80	0.500	0.784
344.3 (160)	378.2	2.608	0.025	0.0849
	628.3	3.142	0.050	0.160
	848.5	5.850	0.075	0.227
	1049	7.233	0.100	0.287
	1228	8.467	0.125	0.341
	1377	9.494	0.150	0.390
	1611	11.11	0.200	0.475
	1757	12.11	0.250	0.547
	1810	12.48	0.300	0.608
	1689	11.64	0.400	0.707
360.0 (190)	449.8	3.101	0.025	0.0849
	696.5	4.802	0.050	0.160
	848.6	5.851	0.075	0.227
	1111	7.660	0.100	0.287
	1276	8.798	0.125	0.341
	1409	9.715	0.150	0.390
	1602	11.05	0.200	0.475
	1698	11.71	0.250	0.547
1645	11.34	0.300	0.608	
377.6 (220)	521.8	3.598	0.025	0.0849
	762.0	5.254	0.050	0.160
	973.1	6.709	0.075	0.227
	1167	8.046	0.100	0.287
	1307	9.011	0.125	0.341
	1422	9.804	0.150	0.390
	1517	10.46	0.200	0.475
	1349	9.301	0.250	0.547
394.3 (250)	660	4.551	0.025	0.0840
	824.8	5.687	0.050	0.160
	1024	7.060	0.075	0.227
	1173	8.088	0.100	0.287
	1255	8.653	0.125	0.341
	1242	8.563	0.150	0.390

EXPERIMENTAL VALUES:			Mole fraction of methane in liquid, in vapor,	
T/K (T/°F)	P/psi	P/MPa	x_{CH_4}	y_{CH_4}
410.9 (280)	535	3.69	0.038	0.113
	669	5.68	0.087	0.202
	824	5.68	0.158	0.227
	831	5.73	0.158	-
	798	5.50	0.143	-
	787	5.43	0.127	0.231
	747	5.15	0.117	0.242
377.6 (220)	735	5.07	0.115	0.234
	1348	9.29	-	0.452
	1342	9.25	-	0.478
	1339	9.23	0.389	0.496
	1336	9.21	0.382	0.506
	1125	7.76	0.287	0.552
277.6 (40)	878	6.05	0.201	0.533
	53	0.36	0.0330	0.6213
	74	0.51	0.0317	0.7053
	102	0.70	0.0547	0.7969
	152	1.05	0.0768	0.8633
	192	1.32	0.0887	0.8867
	253	1.74	0.0914	0.9039
	298	2.05	0.1157	0.9140
	341	2.35	0.1484	0.9200
	447	3.08	0.1806	0.9420

(cont.)

AUXILIARY INFORMATION	
<p>METHOD/APPARATUS/PROCEDURE:</p> <p>Windowed stainless steel equilibrium cell. Vapor recirculated with magnetic pump. Temperature measured with thermocouple and pressure measured with Bourdon type gauge. Details of apparatus in source. Samples of liquid and gas analyzed by gas chromatography.</p>	<p>SOURCE AND PURITY OF MATERIALS:</p> <ol style="list-style-type: none"> Phillips Petroleum Co., research grade sample, purity better than 99.5 mole per cent, major impurity nitrogen. Phillips Petroleum Co., research grade sample, purity better than 99.9 mole per cent.
	<p>ESTIMATED ERROR:</p> <p>$\delta T/K = \pm 0.1$; $\delta P/\text{psi} = \pm 2$;</p> <p>$\delta x_{\text{CH}_4}, \delta y_{\text{CH}_4} = \pm 0.002$.</p>
	<p>REFERENCES:</p>

COMPONENTS:			ORIGINAL MEASUREMENTS:	
1. Methane; CH ₄ ; [74-82-8]			Roberts, L. R.; Wang, R. H.;	
2. Butane; C ₄ H ₁₀ ; [106-97-8]			Azarnoosh, A.; McKetta, J. J.	
			<i>J. Chem. Eng. Data</i>	
			<u>1962</u> , 7, 484-5.	
EXPERIMENTAL VALUES:				
T/K (T/°F)	P/psi	P/MPa	Mole fraction of methane in liquid, x_{CH_4}	Mole fraction of methane in vapor, y_{CH_4}
277.6 (40)	449	3.10	0.2061	0.9282
	515	3.56	0.1979	0.9312
	584	4.03	0.2232	0.9424
	640	4.41	0.2424	0.9432
	735	5.07	0.2887	0.9510
	835	5.76	0.3139	0.9464
	840	5.79	0.3139	0.9463
	930	6.41	0.3453	0.9479
	1060	7.31	0.3674	0.9456
	1155	7.96	0.4245	0.9437
	1285	8.86	0.4795	0.9381
	1370	9.45	0.4842	0.9351
	1480	10.20	0.5227	0.9321
	1615	11.14	0.5641	0.9177
	1685	11.62	0.5888	0.8937
	1750	12.07	0.6369	0.9015
	1770	12.20	0.6275	0.8862
	1835	12.65	0.6898	0.8545
	1905	13.13	0.7749	0.8171
	1915	13.20	0.7953	0.7953
244.3 (-20)	26	0.18	0.015	0.457
	49	0.34	0.023	0.785
	78	0.54	0.043	0.875
	120	0.83	0.064	0.925
	149	1.03	0.077	0.930
	177	1.22	0.095	0.941
	251	1.73	0.116	0.971
	348	2.40	0.174	0.973
	429	2.96	0.205	0.978
	506	3.49	0.246	0.980
	613	4.23	0.306	0.978
	720	4.96	0.334	0.975
	845	5.83	0.403	0.977
	910	6.27	0.412	0.982
	930	6.41	0.422	0.977
	1075	7.41	0.504	0.973
	1225	8.44	0.552	0.970
	1235	8.52	0.563	0.968
	1290	8.89	0.578	0.967
	1295	8.93	0.580	0.970
1380	9.51	0.608	0.957	
1590	10.96	0.719	0.938	
1645	11.34	0.793	0.903	
1724	11.89	0.863	0.863	
210.9 (-80)	27	0.19	0.0350	0.8782
	57	0.39	0.0728	0.9437
	110	0.76	0.1058	0.9758
	169	1.17	0.1759	0.9839
	207	1.43	0.1796	0.9940
	263	1.81	0.2376	0.9918
	359	2.48	0.3165	0.9883
	518	3.57	0.4133	0.9917
	725	5.00	0.5986	0.9918
	785	5.41	0.6554	0.9948
	890	6.14	0.7412	0.9840
	975	6.72	0.8112	0.9670
	1041	7.18	0.9214	0.9214

COMPONENTS:			ORIGINAL MEASUREMENTS:	
1. Methane; CH ₄ ; [74-82-8] 2. Butane; C ₄ H ₁₀ ; [106-97-8]			Wang, R. H.; McKetta, J. J. <i>J. Chem. Engng. Data</i> <u>1964</u> , 9, 30-35.	
VARIABLES:			PREPARED BY:	
Pressure			C. L. Young	
EXPERIMENTAL VALUES:				
T/K (T/°F)	P/MPa	P/psi	Mole fraction of methane in liquid, in vapor, x_{CH_4} y_{CH_4}	
177.6 (-140)	0.503 0.841 1.18 1.50 1.77 2.28 2.66 2.93 3.12	73 122 171 217 256 330 386 425 453	0.1579 0.2652 0.3582 0.4601 0.4913 0.7037 0.8241 0.9086 1.000	0.9732 0.9924 0.9945 0.9868 0.9925 0.9942 0.9901 0.9942 1.000
AUXILIARY INFORMATION				
METHOD/APPARATUS/PROCEDURE:			SOURCE AND PURITY OF MATERIALS:	
Stainless steel windowed equilibrium cell with magnetic pump for re-circulating vapor. Samples analysed by gas chromatography and mass spectrometry. Some details given in source and ref. (1).			1 and 2. Phillips Petroleum Co. research grade samples, purity at least 99.9 mole per cent.	
			ESTIMATED ERROR: $\delta T/K = \pm 0.3$; $\delta P/MPa = \pm 0.2\%$; $\delta x_{CH_4}, \delta y_{CH_4} = \pm 0.001$.	
			REFERENCES: 1. Wang, R. H. <i>Ph.D. thesis, University of Texas, Austin, 1963.</i>	

EXPERIMENTAL VALUES:				Mole fraction of methane in liquid, in vapor,	
T/K	T/°F	P/MPa	P/psia	x_{CH_4}	y_{CH_4}
277.6	40	1.38	200	0.0808	0.8888
		3.45	500	0.1913	0.9369
		6.89	1000	0.3651	0.9461
		8.62	1250	0.4513	0.9407
		10.34	1500	0.5390	0.9262
310.9	100	11.72	1700	0.6194	0.9044
		1.38	200	0.0530	0.7027
		3.45	500	0.1556	0.8473
		6.89	1000	0.3171	0.8809
		8.62	1250	0.3974	0.8786
344.3	160	10.34	1500	0.4799	0.8665
		11.72	1700	0.5586	0.8440
		1.38	200	0.0091	0.1171
		3.45	500	0.1201	0.6796
		6.89	1000	0.2717	0.7567
377.6	220	8.62	1250	0.3482	0.7588
		10.34	1500	0.4329	0.7439
		11.72	1700	0.5103	0.7036
		3.45	500	0.0783	0.4200
		6.89	1000	0.2361	0.5630
8.62	1250	0.3200	0.5338		

AUXILIARY INFORMATION	
<p>METHOD/APPARATUS/PROCEDURE:</p> <p>PVT cell charged with mixture of known composition. Pressure measured with pressure balance and temperature measured using a platinum resistance thermometer. Details in ref. (1). Samples of coexisting phases analysed by GC.</p>	<p>SOURCE AND PURITY OF MATERIALS:</p> <ol style="list-style-type: none"> 1. Texaco sample, passed over calcium chloride, activated charcoal, Ascarite and anhydrous calcium sulfate at pressures in excess of 3 MPa, purity 99.99 mole per cent. 2. Phillips Petroleum Co. samples, degassed, purity 99.95 mole per cent.
	<p>ESTIMATED ERROR:</p> <p>$\delta T/K = \pm 0.01$; $\delta P/MPa = \pm 0.1\%$</p> <p>$\delta x_{\text{CH}_4}, \delta y_{\text{CH}_4} = 0.005$ or better.</p>
	<p>REFERENCES:</p> <ol style="list-style-type: none"> 1. Sage, B. H.; Lacey, W. N. <i>Trans. Am. Inst. Mining Met.</i> <u>1940</u>, 136, 136.

COMPONENTS:			ORIGINAL MEASUREMENTS:	
1. Methane; CH ₄ ; [74-82-8]			Elliott, D. G.; Chen, R. J. J.;	
2. Butane; C ₄ H ₁₀ ; [106-97-8]			Chappelear, P. S.; Kobayashi, R.	
			<i>J. Chem. Eng. Data</i>	
			<u>1974</u> , 19, 71-7.	
VARIABLES:			PREPARED BY:	
Temperature, pressure			C. L. Young	
EXPERIMENTAL VALUES:				
T/K	P/psi	P/MPa	Mole fraction of methane in liquid, x_{CH_4}	in gas, y_{CH_4}
277.59	17.66	0.1218	0.0000	0.0000
	100.00	0.692	0.04258	0.796
	200.00	1.382	0.08986	0.890
	300.4	2.071	0.1339	0.9176
	400	2.758	0.1759	0.9313
	500	3.447	0.2152	0.9385
	600	4.137	0.2536	0.9425
	800	5.516	0.3262	0.9469
	1000	6.895	0.3976	0.9459
	1200	8.274	0.4651	0.9390
	1400	9.653	0.5331	0.9294
	1600	11.03	0.6078	0.9100
	1700	11.72	0.6558 ^a	0.8967
	1800	12.41	0.7278 ^a	0.8460
	1822 ^b	12.56	0.7828 ^a	0.7828
255.38	7.25	0.050	0.0000	0.0000
	50.3	0.347	0.02570	0.837
	100.0	0.692	0.05591	0.9161
	200.3	1.381	0.1124	0.9516
	300.4	2.071	0.1643	0.9639
	400	2.758	0.2135	0.9689
	500	3.447	0.2580	0.9716
	700	4.826	0.3455	0.9729
	800	5.516	0.3905	0.9728
(cont.)				
AUXILIARY INFORMATION				
METHOD/APPARATUS/PROCEDURE:			SOURCE AND PURITY OF MATERIALS:	
Recirculating vapor flow apparatus with windowed equilibrium cell. Temperature measured with platinum resistance thermometer, pressure measured with Bourdon gauge. Butane added to cell, air removed, methane added and recirculated for at least 0.5 hour. Sample analysed by G.C. Details in source and ref. (1).			1. Ultra high purity Matheson sample, purity 99.97 mole per cent.	
			2. Matheson research grade sample, purity 99.93 mole per cent.	
			ESTIMATED ERROR: $\delta T/K = \pm 0.02$; $\delta P/MPa = \pm 0.013$; $\delta x_{CH_4} < \pm 2\%$, $\delta(1-y_{CH_4}) = \pm 2\%$ or 0.00001 whichever is larger.	
			REFERENCES: 1. Wichterle, I.; Kobayashi, R. <i>J. Chem. Eng. Data</i> <u>1972</u> , 17, 4.	

1. Methane; CH₄; [74-82-8] Elliott, D. G.; Chen, R. J. J.;
Chappellear, P. S.; Kobayashi, R.
2. Butane; C₄H₁₀; [106-97-8] *J. Chem. Eng. Data*
1974, 19, 71-7.

EXPERIMENTAL VALUES:

T/K	P/psi	P/MPa	Mole fraction of methane		
			in liquid, x_{CH_4}	in gas, y_{CH_4}	
255.38	1000	6.896	0.4651	0.9696	
	1200	8.274	0.5466	0.9625	
	1400	9.653	0.6326	0.9499	
	1600 _b	11.03	0.7498	0.9175	
	1652 ^b	11.39	0.8543 ^a	0.8543	
244.28	4.326	0.0298	0.0000	0.0000	
	100.2	0.691	0.06304	0.9488	
	200.3	1.381	0.1237	0.9703	
	400	2.758	0.2335	0.9801	
	600	4.137	0.3325	0.9818	
	800	5.516	0.4223	0.9809	
	1000	6.895	0.5101	0.9772	
	1200	8.274	0.6062	0.9688	
	1400	9.653	0.7189	0.9498	
	1500 _b	10.34	0.8059 ^a	0.9159	
	1515 ^b	10.45	0.8605 ^a	0.8605	
233.18	2.439	0.0168	0.0000	0.0000	
	100.0	0.692	0.07208	0.9703	
	200.3	1.381	0.1400	0.9827	
	400	2.758	0.2655	0.9878	
	600	4.137	0.3739	0.9882	
	800	5.516	0.4804	0.9868	
	1000	6.895	0.5875	0.9822	
	1200	8.274	0.6948	0.9705	
	1300	8.963	0.7886	0.9608	
	1350 _b	9.308	0.8549 ^a	0.9318	
	1355 ^b	9.342	0.9097 ^a	0.9097	
	222.07	1.285	0.00886	0.0000	0.0000
		100.2	0.691	0.08202	0.9840
200.3		1.381	0.1586	0.99034	
400		2.758	0.2981	0.99298	
600		4.137	0.4284	0.99262	
800		5.516	0.5564	0.99046	
1000		6.895	0.7056	0.9843	
1100		7.584	0.8001	0.9774	
1150 _b		7.929	0.8637 ^a	0.9648	
1169 ^b		8.060	0.9326 ^a	0.9326	
210.94		0.625	0.00431	0.0000	0.0000
	200.0	1.379	0.1880	0.99506	
	400	2.758	0.3523	0.99608	
	600	4.137	0.5104	0.99546	
	800	5.516	0.6954	0.99271	
	900	6.205	0.8232	0.9896	
	950 _b	6.550	0.9036	0.9862	
	973 ^b	6.709	0.9591 ^a	0.9591	
	199.88	0.276	0.00190	0.0000	0.0000
		200.1	1.380	0.2267	0.99757
300.3		2.070	0.3261	0.99794	
400		2.758	0.4267	0.99795	
500		3.447	0.5322	0.99770	
600		4.137	0.6591	0.99715	
700		4.826	0.8296	0.99584	
750 _b		5.171	0.9257	0.99445	
792 ^b		5.461	0.9829 ^a	0.9829	
190.58		0.12506	0.00086	0.0000	0.0000
		100.1	0.670	0.1466	0.99814
	199.7	1.377	0.2773	0.99880	
	299.7	2.066	0.3988	0.99895	

(cont.)

1. Methane; CH₄; [74-82-8] Elliott, D. G.; Chen, R. J. J.;
Chappelear, P. S.; Kobayashi, R.
2. Butane; C₄H₁₀; [106-97-8] *J. Chem. Eng. Data*
1974, 19, 71-7.

EXPERIMENTAL VALUES:

T/K	P/psi	P/MPa	Mole fraction of methane	
			in liquid, x_{CH_4}	in gas, y_{CH_4}
190.58	400	2.758	0.5314	0.99889
	500	3.447	0.7031	0.99866
	600	4.137	0.9469	0.99823
	671	4.626	1.000	1.000
189.06	0.109	0.00075	0.0000	0.0000
	101.1	0.697	0.1526	0.99835
	201.0	1.386	0.2860	0.99896
	300.3	2.070	0.4150	0.999083
	400	2.758	0.5521	0.999049
	501	3.454	0.7511	0.99875
	550	3.792	0.9009	0.99861
	600	4.137	0.9808	0.99873
	636	4.385	1.000	1.000
	0.0360	0.000248	0.0000	0.0000
177.62	50.0	0.345	0.09796	0.999001
	100.1	0.690	0.1879	0.999391
	149.8	1.033	0.2804	0.999531
	199.9	1.378	0.3716	0.999597
	299.9	2.068	0.5812	0.999651
	350	2.413	0.7288	0.999651
	400	2.758	0.9370	0.999671
	420	2.896	0.9793	0.999767
	420	2.896	0.9841	0.999767
	440	3.034	1.000	1.000
	0.0106	0.000073	0.0000	0.0000
166.50	50.0	0.345	0.1370	0.999656
	100.0	0.689	0.2640	0.999801
	150.0	1.034	0.3930	0.999831
	200.0	1.379	0.5451	0.999866
	250.0	1.724	0.7910	0.999911
	296	2.041	1.000	1.000
	0.00264	0.000018	0.0000	0.0000
	20.1	0.139	0.08016	0.999828
155.38	50.1	0.345	0.1925	0.999901
	100.1	0.690	0.3860	0.999940
	150.1	1.035	0.6678	0.999948
	187	1.289	1.000	1.000
	0.0005	0.000003	0.0000	0.0000
144.26	25.2	0.174	0.1492	0.999960
	49.9	0.344	0.3006	0.999971
	99.9	0.689	0.8173	0.999983
	115	0.793	1.0000	1.0000

^a Bubble point analysis by gas chromatography.

^b Critical point of mixture.

EXPERIMENTAL VALUES:			Mole fraction of methane	
T/K	P/psi	P/MPa	in liquid, x_{CH_4}	in vapor, y_{CH_4}
283.15	21.6	0.1489	0.00	0.00
	51	0.352	0.013	0.566
	100	0.689	0.035	0.775
	201	1.386	0.076	0.875
	400	2.758	0.152	0.925
	600	4.137	0.232	0.939
	800	5.516	0.304	0.941
	1000	6.895	0.377	0.941
	1200	8.274	0.442	0.933
	1400	9.653	0.514	0.924
255.35	7.26	0.0501	0.00	0.00
	20	0.138	0.063 ^b	0.623
	50	0.345	0.0212 ^b	0.846
	100	0.689	0.0461 ^b	0.9174
	400	2.758	0.195	0.9704
	599	4.130	0.2925	0.9746
	998	6.881	0.470	0.9710
	1397	9.632	0.651	0.9531
	1597	11.011	0.758	0.9317
	227.55	1.77	0.0122	0.00
50		0.345	0.034 ^b	0.962
100		0.689	0.069	0.980
200		1.379	0.139 ^b	0.988

(cont.)

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Apparatus for isotherm at 283.15 described in ref. (1). Other isotherm determined with a re-circulating vapor flow apparatus described in ref. (2).
Liquid sample added to windowed equilibrium cell, air removed.
Methane added to cell and re-circulated for at least 1/2 hour.
Samples analysed by G.C.

SOURCE AND PURITY OF MATERIALS:

- Phillips Petroleum Co. research grade methane.
- Phillips Petroleum Co. research grade butane.

ESTIMATED ERROR:

$$\delta T/K = \pm 0.05; \quad \delta P/MPa = \pm 0.015;$$

$$\delta x_{CH_4} = \pm 2\%; \quad \delta(1-y_{CH_4}) = 2\%.$$

REFERENCES:

- Kahre, L.
J. Chem. Eng. Data 1973, *18*, 267.
- Wichterle, I.; Kobayashi, R. J.
J. Chem. Eng. Data 1972, *17*, 4.

1. Methane; CH₄; [74-82-8]

Kahre, L. C.

2. Butane; C₄H₁₀; [106-97-8]*J. Chem. Eng. Data*1974, 19, 67.

EXPERIMENTAL VALUES:

T/K	P/psi	P/MPa	Mole fraction of methane in liquid, x_{CH_4}	in vapor, y_{CH_4}
227.55	299	2.062	0.209	0.9907
	499	3.440	0.350	0.9918
	798	5.502	0.534	0.990
	998	6.881	0.656	0.985
	1197	8.253	0.805	0.972
210.95	0.62	0.0043	0.00	0.00
	20	0.138	0.019 ^b	0.969
	40	0.276	0.038 ^b	0.984
	80	0.552	0.077 ^b	0.9913
	120	0.827	0.111 ^b	0.9936
	160	1.103	0.148 ^b	0.9948
	200	1.379	0.184	0.9955
	399	2.751	0.351	0.9965
	599	4.130	0.532	0.9959
	798	5.502	0.721	0.9934
	936	6.453	...	0.9867
	973	6.709	0.933	0.9802
194.10	0.17	0.0012	0.00	0.00
	20	0.138	0.025 ^b	0.9917
	40	0.276	0.051 ^b	0.9955
	81	0.558	0.103	0.9975
	100	0.689	0.130	0.9979
	200	1.379	0.248	0.9986
	399	2.751	0.500	0.9988
	595	4.102	0.830	0.9980
	627	4.323	0.896	0.9977
	649	4.475	0.930	0.9975
	677	4.668	0.968	0.9972
185.95	0.084	0.00058	0.00	0.00
	20	0.138	0.028 ^b	0.9956
	50	0.345	0.069	0.9981
	100	0.689	0.144	0.9989
	200	1.379	0.290	0.99927
	299	2.062	0.444	0.99934
	399	2.751	0.608	0.99926
	449	3.096	0.728	0.99920
	499	3.440	0.871	0.99914
	549	3.785	0.972	0.99931
	578	3.985	1.00	1.00
177.55	0.035	0.00024	0.00	0.00
	20	0.138	0.036 ^b	0.9981
	50	0.345	0.091	0.99918
	100	0.689	0.180	0.99950
	200	1.379	0.360	0.99963
	299	2.062	0.573	0.99967
	354	2.441	0.732	0.99966
	386	2.661	0.875	0.99967
	404	2.785	0.934	0.99970
	441	3.041	1.00	1.00
166.45	0.010	0.000069	0.00	0.00
	20	0.138	0.047 ^b	0.99940
	49	0.338	0.116	0.99972
	100	0.689	0.251	0.99984
	148	1.020	0.379	0.99987
	199	1.372	0.545	0.99989
	249	1.717	0.753	0.999902
	272	1.875	0.897	0.999920
	283	1.951	0.950	0.999943
	298	2.055	1.00	1.00