

COMPONENTS:

1. Methane; CH₄; [74-82-8]
2. Heptane; C₇H₁₆; [142-82-5]

EVALUATOR:

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March 1984

EVALUATION:

The solubility of methane in heptane has been studied at high pressures over the temperature range 183 K to 511 K.

The data of Boomer *et al.* (1) are classified as doubtful since these workers used methane which contained over 5 mole per cent of nitrogen. The data of Koonce and Kobayashi (2) were over a very limited range of experimental variables and are not considered further.

The data of Reamer *et al.* (3) cover the temperature range 277.6 K to 510.9 K and overlap with the data of Kohn (4) at 277.6 K. The two sets of data agree well at the common temperature. Both sets of data are classified as tentative. There is also fair agreement between the data of Kohn (4) and Chang *et al.* (5) for temperature in the range 200 K to 255 K, the later data giving a slightly greater mole solubility of methane. The data of Chang *et al.* (5) are also classified as tentative.

References

1. Boomer, E. H.; Johnson, C. A.; Piercey, A. G. A. *Can. J. Res.*, 1938, B16, 396.
2. Koonce, K. T.; Kobayashi, R. *J. Chem. Eng. Data*, 1964, 9, 494.
3. Reamer, H. H.; Sage, B. H.; Lacey, W. N. *J. Chem. Eng. Data*, 1956, 1, 29.
4. Kohn, J. P. *Am. Inst. Chem. Engrs. J.*, 1961, 7, 514.
5. Chang, H. L.; Hunt, L. J.; Kobayashi, R. *Am. Inst. Chem. Engrs. J.*, 1966, 12, 1212.

COMPONENTS:		ORIGINAL MEASUREMENTS:			
1. Methane; CH ₄ ; [74-82-8] 2. Heptane; C ₇ H ₁₆ ; [142-82-5]		Reamer, H.H.; Sage, B.H.; Lacey, W.N. <i>J. Chem. Engng. Data</i> , <u>1956</u> ,1,29-42			
VARIABLES:		PREPARED BY:			
Temperature, pressure		C.L. Young			
EXPERIMENTAL VALUES:					
T/°F	T/K	p/psi	P/MPa	Mole fraction of methane in liquid, x_{CH_4}	in vapor, y_{CH_4}
40	277.6	200	1.38	0.0753	0.9964
		400	2.76	0.1445	0.9974
		600	4.14	0.2084	0.9971
		800	5.52	0.2670	0.9970
		1000	6.89	0.3215	0.9966
		1250	8.62	0.3840	0.9957
		1500	10.34	0.4410	0.9940
		1750	12.07	0.4930	0.9920
		2000	13.79	0.5425	0.9890
		2250	15.51	0.5900	0.9850
		2500	17.24	0.6373	0.9780
		2750	18.96	0.6870	0.9690
		3000	20.68	0.7400	0.9530
		3328	22.95	0.894	0.894
100	310.9	200	1.38	0.0640	0.9866
		400	2.76	0.1240	0.9905
		600	4.14	0.1810	0.9911
		800	5.52	0.2340	0.9911
		1000	6.89	0.2842	0.9910
		1250	8.62	0.3425	0.9900
		1500	10.34	0.3963	0.9881
		1750	12.07	0.4470	0.9850
		2000	13.79	0.4950	0.9801
		2250	15.51	0.5435	0.9748
		2500	17.24	0.5905	0.9690
AUXILIARY INFORMATION					
METHOD/APPARATUS/PROCEDURE:			SOURCE AND PURITY OF MATERIALS:		
PVT cell charged with mixture of known composition. Bubble and dew points determined for various compositions. Temperature measured with platinum resistance thermometer, pressure measured with pressure balance. Coexisting liquid and gas compositions determined by graphical means. Details in source and ref (1).			1. Crude sample treated for removal of higher alkanes, CO ₂ and H ₂ O. Final purity 99.9 mole per cent, less than 0.02 mole per cent of other hydrocarbons.		
			2. Purity better than 99.95 mole per cent.		
			ESTIMATED ERROR:		
			$\delta T/K = \pm 0.02$; $\delta P/\text{psi} = \pm 0.1$; $\delta x_{CH_4} = \pm 0.0005$; $\delta y_{CH_4} = \pm 0.0003$		
			REFERENCES:		
			1. Sage, G.B.; 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]				Reamer, H.H.; Sage, B.G.; Lacey, W.N.	
2. Heptane; C ₇ H ₁₆ ; [142-82-5]					
				<i>J. Chem. Engng. Data.</i> <u>1956</u> , 1, 29-42.	
EXPERIMENTAL VALUES:				Mole fraction of methane	
T/°F	T/K	p/psi	P/MPa	in liquid, x_{CH_4}	in vapor, y_{CH_4}
100	310.9	2750	18.96	0.6400	0.9620
		3000	20.68	0.6910	0.9530
		3500	24.13	0.8030	0.9050
160	344.3	3609	24.88	0.8550	0.8550
		200	1.38	0.0565	0.9597
		400	2.76	0.1110	0.9733
		600	4.14	0.1623	0.9780
		800	5.52	0.2107	0.9798
		1000	6.89	0.2567	0.9804
		1250	8.62	0.3108	0.9795
		1500	10.34	0.3620	0.9770
		1750	12.07	0.4125	0.9742
		2000	13.79	0.4620	0.9705
		2250	15.51	0.5090	0.9656
		2500	17.24	0.5580	0.9590
		2750	18.96	0.6070	0.9490
220	377.6	3000	20.68	0.6610	0.9360
		3500	24.13	0.7870	0.8595
		3549	24.47	0.817	0.817
		200	1.38	0.0494	0.8942
		400	2.76	0.1003	0.9305
		600	4.14	0.1492	0.9449
		800	5.52	0.1960	0.9517
		1000	6.89	0.2410	0.9558
		1250	8.62	0.2940	0.9566
		1500	10.34	0.3450	0.9564
		1750	12.07	0.3957	0.9532
		2000	13.79	0.4457	0.9474
		2250	15.51	0.4944	0.9392
2500	17.24	0.5450	0.9280		
2750	18.96	0.5995	0.9120		
280	410.9	3000	20.68	0.6615	0.8864
		3298	22.74	0.778	0.778
		200	1.38	0.0405	0.7481
		400	2.76	0.0918	0.8628
		600	4.14	0.1390	0.8894
		800	5.52	0.1850	0.9037
		1000	6.89	0.2290	0.9100
		1250	8.62	0.2810	0.9120
		1500	10.34	0.3308	0.9170
		1750	12.07	0.3810	0.9073
		2000	13.79	0.4329	0.9000
		2250	15.51	0.4880	0.8900
		2500	17.24	0.5446	0.8660
2750	18.96	0.6150	0.8280		
340	477.6	2927	20.18	0.732	0.732
		200	1.38	0.0305	0.5100
		400	2.76	0.0840	0.7220
		600	4.14	0.1317	0.7750
		800	5.52	0.1786	0.8060
		1000	6.89	0.2240	0.8260
		1250	8.62	0.2780	0.8369
		1500	10.34	0.3316	0.8360
		1750	12.07	0.3850	0.8250
		2000	13.79	0.4431	0.8040
		2250	15.51	0.5165	0.7730
		2469	17.02	0.672	0.672
		400	477.6	200	1.38
400	2.76			0.0670	0.5223
600	4.14			0.1200	0.6210
800	5.52			0.1740	0.6700

COMPONENTS:				ORIGINAL MEASUREMENTS	
1. Methane; CH ₄ ; [74-82-8]				Reamer, H.H.; Sage, B.H.; Lacey, W.N. <i>J. Chem. Engng. Data.</i> <u>1956</u> , 1, 29-42.	
2. Heptane; C ₇ H ₁₆ ; [142-82-5]					
EXPERIMENTAL VALUES:				Mole fraction of methane	
T/°F	T/K	p/psi	P/MPA	in liquid x_{CH_4}	in vapor y_{CH_4}
400	477.6	1000	6.89	0.2290	0.6930
		1250	8.62	0.2980	0.6990
		1500	10.34	0.3725	0.6940
		1750	12.07	0.4620	0.6690
		1906	13.14	0.585	0.585
460	510.9	400	2.76	0.0485	0.2640
		600	4.14	0.1205	0.4199
		800	5.52	0.1918	0.4670
		1000	6.89	0.2730	0.4750
		1206	8.32	0.441	0.441

EXPERIMENTAL VALUES:			EXPERIMENTAL VALUES:		
T/K	P/10 ⁵ Pa	Mole fraction of methane in liquid, x_{CH_4}	T/K	P/10 ⁵ Pa	Mole fraction of methane in liquid, x_{CH_4}
277.59	6.89	0.036	266.48	68.95	0.342
	13.79	0.072		75.84	0.370
	20.68	0.108		82.74	0.394
	27.58	0.141		89.63	0.416
	34.47	0.174		96.53	0.438
	41.37	0.204		103.42	0.462
	48.26	0.235	255.37	6.89	0.044
	55.16	0.264		13.79	0.089
	62.05	0.291		20.68	0.131
	68.95	0.318		27.58	0.171
	75.84	0.346		34.47	0.209
	82.74	0.372		41.37	0.244
	89.63	0.395		48.26	0.278
	96.53	0.416		55.16	0.312
	103.42	0.440		62.05	0.340
266.48	6.89	0.040		68.95	0.369
	13.79	0.081		75.84	0.398
	20.68	0.119		82.74	0.422
	27.58	0.156		89.63	0.444
	34.47	0.192		96.53	0.466
	41.37	0.223		103.42	0.489
	48.26	0.257	244.26	6.89	0.049
	55.16	0.288		13.79	0.098
	62.05	0.315			

(cont.)

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Pyrex glass cell. Temperature measured with platinum resistance thermometer and pressure with Bourdon gauge. Bubble points of mixtures of known composition determined. Experimental data quoted obtained by smoothing.

SOURCE AND PURITY OF MATERIALS:

1. Pure grade material, purity better than 99 mole per cent. Dried and pressed over activated charcoal; final purity 99.5 mole per cent or better.
2. Pure grade material, degassed.

ESTIMATED ERROR:

$\delta T/K = \pm 0.02$; $\delta P/MPa = \pm 0.1\%$ or ± 0.007 (whichever is greater);
 $\delta x_{CH_4} = \pm 1\%$ (compiler).

REFERENCES:

1. Methane; CH₄; [74-82-8] Kohn, J. P.
 2. Heptane; C₇H₁₆; [142-82-5] *Am. Inst. Chem. Engrs. J.*
1961, 7, 514-8.

EXPERIMENTAL VALUES:

T/K	P/10 ⁵ Pa	Mole fraction of methane in liquid, x_{CH_4}	T/K	P/10 ⁵ Pa	Mole fraction of methane in liquid, x_{CH_4}
244.26	20.68	0.144	222.04	89.63	0.585
	27.58	0.187		96.53	0.610
	34.47	0.228		103.42	0.640
	41.37	0.266	210.93	6.89	0.072
	48.26	0.302		13.79	0.140
	55.16	0.336		20.68	0.203
	62.05	0.370		27.58	0.262
	68.95	0.402		34.47	0.323
	75.84	0.431		41.37	0.375
	82.74	0.457		48.26	0.433
	89.63	0.480		55.16	0.476
	96.53	0.504		62.05	0.515
	103.42	0.527		68.95	0.552
233.15	6.89	0.055		75.84	0.584
	13.79	0.110	199.82	6.89	0.084
	20.68	0.159		13.79	0.163
	27.58	0.207		20.68	0.240
	34.47	0.249		27.58	0.310
	41.37	0.294		34.47	0.387
	48.26	0.330		41.37	0.460
	55.16	0.366		48.26	0.530
	62.05	0.406		55.16	0.565
	68.95	0.443	194.26	6.89	0.091
	75.84	0.473		13.79	0.181
	82.74	0.502		20.68	0.267
	89.63	0.527		27.58	0.351
	96.53	0.554		34.47	0.435
	103.42	0.578		41.37	0.520
222.04	6.89	0.063	188.71	6.89	0.100
	13.79	0.124		13.79	0.206
	20.68	0.179		20.68	0.306
	27.58	0.232		27.58	0.403
	34.47	0.279		34.47	0.498
	41.37	0.329		41.37	0.582
	48.26	0.370	183.15	6.89	0.132
	55.16	0.410		13.79	0.250
	62.05	0.450		20.68	0.350
	68.95	0.492		27.58	0.459
	75.84	0.524		34.47	0.578
	82.74	0.556			

COMPONENTS:			ORIGINAL MEASUREMENTS:		
1. Methane; CH ₄ ; [74-82-8] 2. Heptane; C ₇ H ₁₆ ; [142-82-5]			Koonce, K. T.; Kobayashi, R. <i>J. Chem. Engng. Data</i> 1964, 9, 494-501.		
VARIABLES:			PREPARED BY:		
Temperature, Pressure			C. L. Young		
EXPERIMENTAL VALUES:					
			Mole fractions		
T/K (T/°F)	P/psi	P/MPa	x _{CH₄}	x _{C₇H₁₆}	y _{CH₄}
233.15 (40)	100	0.689	0.0667	0.9333	1.0
	200	1.38	0.120	0.880	1.0
	396	2.73	0.216	0.784	1.0
	605	4.17	0.311	0.689	1.0
	805	5.55	0.389	0.611	1.0
244.26 (-20)	1008	6.95	0.455	0.545	1.0
	96.0	0.662	0.0568	0.9432	1.0
	212	1.46	0.114	0.886	1.0
	400	2.76	0.196	0.804	1.0
	608	4.19	0.280	0.720	1.0
	807	5.56	0.353	0.647	1.0
	990	6.83	0.412	0.588	1.0
AUXILIARY INFORMATION					
METHOD/APPARATUS/PROCEDURE:			SOURCE AND PURITY OF MATERIALS:		
The solubilities were determined by measurement of retention volumes using gas chromatography. The method uses methane as a carrier gas, radioactively tagged methane as a sample and heptane as the stationary liquid. The technique is described in the source and in ref. (1).			1. Sample dried, purity 99.7 mole per cent; 0.2 mole per cent nitrogen and 0.1 mole per cent ethane.		
			2. Phillips Petroleum research grade sample, purity 99.90 mole per cent.		
			ESTIMATED ERROR: δT/K = ±0.1; δP/MPa = ±2%; δx, δy = ±6% (estimated by compiler).		
			REFERENCES:		
			1. Koonce, K. T. <i>Ph.D. thesis, Rice University, Houston, 1963.</i>		

EXPERIMENTAL VALUES:				EXPERIMENTAL VALUES:			
T/K	P/MPa	Mole fraction of methane in liquid, x_{CH_4}	Mole fraction of methane in gas, y_{CH_4}	T/K	P/MPa	Mole fraction of methane in liquid, x_{CH_4}	Mole fraction of methane in gas, y_{CH_4}
255.4	0.690	0.04450	0.99857	244.3	15.51	0.72190	0.99304
	1.379	0.09012	0.99877		17.24	0.78127	0.98833
	2.758	0.17441	0.99896		18.96	0.86340	0.97560
	4.137	0.24904	0.99873	233.2	0.690	0.05555	0.99970
	5.516	0.31600	0.99860		1.379	0.11632	0.99974
	6.895	0.37720	0.99838		2.758	0.20810	0.99968
	8.618	0.44521	0.99778		4.137	0.29901	0.99958
	10.34	0.49657	0.99639		5.516	0.37280	0.99948
	12.07	0.55700	0.99584		6.895	0.44809	0.99933
	13.79	0.61693	0.99427		8.618	0.51596	0.99907
	15.51	0.66590	0.99265		10.34	0.57895	0.99869
	17.24	0.71831	0.98535		12.07	0.65488	0.99818
	18.96	0.77888	0.97340		13.79	0.73746	0.99746
	20.68	0.85850	0.93999		15.51	0.81499	0.99600
244.3	0.690	0.04903	0.99936		17.24	0.88799	0.99200
	1.379	0.10330	0.99945	222.0	0.690	0.06280	0.99985
	2.758	0.18830	0.99934		1.379	0.12350	0.99987
	4.137	0.26685	0.99924		2.758	0.23220	0.99985
	5.516	0.34125	0.99909		4.137	0.32550	0.99980
	6.895	0.40781	0.99893		5.516	0.41170	0.99973
	8.618	0.47841	0.99849		6.895	0.49210	0.99964
	10.34	0.53885	0.99789		8.618	0.57200	0.99951
	12.07	0.60585	0.99707		10.34	0.65420	0.99929
	13.79	0.66583	0.99596				(cont.)

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Recirculating vapor flow apparatus with magnetic pump. Pressure measured with Bourdon gauge and temperature measured with thermopile. Samples of both phases analysed using gas chromatography with flame ionisation detector. Details in source and ref. (1).

SOURCE AND PURITY OF MATERIALS:

- High purity sample from Associated Oil and Gas Company.
- Phillips Petroleum Co. research grade sample.

ESTIMATED ERROR:

$\delta T/K = \pm 0.01$; $\delta P/MPa = \pm 0.015$;
 $\delta x_{CH_4}, \delta y_{CH_4} = \pm 0.00001$ (claimed by authors).

REFERENCES:

- Price, A. R.; Kobayashi, R.
J. Chem. Eng. Data
1958, 4, 40.

COMPONENTS:				ORIGINAL MEASUREMENTS:			
1. Methane; CH ₄ ; [74-82-8]				Chang, H. L.; Hunt, L. J.			
2. Heptane; C ₇ H ₁₆ ; [142-82-5]				Kobayashi, R.			
				<i>Am. Inst. Chem. Engr. J.</i>			
				<u>1966</u> , 11, 1212-1216.			
EXPERIMENTAL VALUES:							
T/K	P/MPa	Mole fraction of methane		T/K	P/MPa	Mole fraction of methane	
		in liquid, x_{CH}	in gas, y_{CH}			in liquid, x_{CH}	in gas, y_{CH}
222.0	12.07	0.72800	0.99905	210.9	12.07	0.80300	0.999220
	13.79	0.79490	0.99854		13.79	0.89110	0.998590
	15.51	0.88190	0.99659	199.8	0.690	0.08470	0.999964
210.9	0.690	0.07260	0.999930		1.379	0.16350	0.999964
	1.379	0.14090	0.999932		2.758	0.31100	0.999955
	2.758	0.26300	0.999932		4.137	0.46120	0.999940
	4.137	0.37800	0.999900		5.516	0.56520	0.999910
	5.516	0.47650	0.999854		6.895	0.62400	0.999860
	6.895	0.55490	0.999794		8.618	0.71500	0.999800
	8.618	0.65800	0.999720		10.34	0.80560	0.999700
	10.34	0.72100	0.999590		12.07	0.90000	0.999300

COMPONENTS:			ORIGINAL MEASUREMENTS:					
1. Methane; CH ₄ ; [74-82-8] 2. Nitrogen; N ₂ ; [7727-37-9] 3. Heptane; C ₇ H ₁₆ ; [142-82-5]			Boomer, E. H.; Johnson, C. A.; Piercey, A. G. A. <i>Can. J. Res. B</i> <u>1938</u> , 16, 396-410.					
VARIABLES:			PREPARED BY:					
Temperature, pressure			C. L. Young					
EXPERIMENTAL VALUES:								
T/K	P/atm	P/MPa	in liquid			in vapor		
			x _{CH₄}	x _{N₂}	x _{C₇H₁₆}	y _{CH₄}	y _{N₂}	y _{C₇H₁₆}
298.15	1	0.1	-	-	-	0.945	-	0.045
	36.2	3.67	0.163	0.002	0.835	0.9285	0.054	0.0175
			0.159	0.003	0.838	-	-	-
	68.4	6.93	0.276	0.008	0.716	0.932	0.0579	0.0101
			-	-	-	0.928	0.0591	0.0129
	101.7	10.30	0.376	0.009	0.615	0.925	0.0641	0.0109
			0.387	0.005	0.608	0.936	0.0531	0.0109
	135	13.7	0.470	0.012	0.518	0.908	0.0787	0.0133
			-	-	-	0.910	0.0781	0.0119
	167.9	17.01	0.539	0.026	0.435	0.910	0.068	0.0220
			0.540	0.022	0.438	0.910	0.0685	0.0215
	202.2	20.49	0.622	0.024	0.354	0.894	0.069	0.037
			0.619	0.027	0.354	0.899	0.066	0.035
	236.0	23.91	0.705	0.035	0.260	-	-	-
236.8	23.99	0.705	0.040	0.255	0.871	0.065	0.064	
243.6	24.68	0.731	0.043	0.226	0.858	0.079	0.083	
250.0	25.33	0.761	0.047	0.192	0.849	0.055	0.096	
328.15	1	0.1	-	-	-	0.769	-	0.231
	34.8	3.53	-	-	-	0.904	0.064	0.032
			0.141	0.004	0.855	-	-	-
	100.9	10.22	0.352	0.009	0.639	0.928	0.051	0.021
(cont.)								
AUXILIARY INFORMATION								
METHOD/APPARATUS/PROCEDURE:				SOURCE AND PURITY OF MATERIALS:				
Rocking autoclave stirred by steel piston falling under gravity. Samples of vapor and liquid trapped in two auxiliary high pressure cells. Equilibrium samples analysed in complicated volumetric and combustion apparatus. Details in ref. (1).				1 and 2. Natural gas sample containing 94.4 mole per cent of methane and 5.6 mole per cent of nitrogen. Impurities may have been present amounting to 0.1 mole per cent. 3. Jeffrey Pine Oil sample, fractionated.				
NOTE: The source reference also contains data on impure heptane samples.				ESTIMATED ERROR: δT/K = ±0.1; δP/MPa = ±0.02; δx, δy = ±1% (estimated by compiler).				
				REFERENCES: 1. Boomer, E. H.; Johnson, C. A.; Argue, G. H. <i>Can. J. Res. B</i> <u>1937</u> , 15, 367.				

COMPONENTS:			ORIGINAL MEASUREMENTS:					
1. Methane; CH ₄ ; [74-82-8]			Boomer, E. H.; Johnson, C. A.;					
2. Nitrogen; N ₂ ; [7727-3709]			Piercey, A. G. A.					
3. Heptane; C ₇ H ₁₆ ; [142-82-5]			Can. J. Res. B					
			1938, 16, 396-410.					
EXPERIMENTAL VALUES:								
T/K	P/atm	P/MPa	in liquid			in vapor		
			x _{CH₄}	x _{N₂}	x _{C₇H₁₆}	y _{CH₄}	y _{N₂}	y _{C₇H₁₆}
328.15	167.2	16.94	0.513	0.019	0.468	0.906	0.062	0.032
	236	23.9	0.685	0.031	0.284	0.860	0.061	0.079
			0.683	0.033	0.284	0.864	0.058	0.078
	249.3	25.3	0.747	0.037	0.216	0.822	0.055	0.123
			0.743	0.041	0.216	0.818	0.065	0.117
	252.8	25.61	0.759	0.043	0.198	-	-	-
			-	-	-	0.768	0.044	0.188
			-	-	-	-	-	-
			-	-	-	0.323	-	0.677
			-	-	-	0.918	0.042	0.040
358.15	1	0.1	-	-	-	0.911	0.058	0.031
	34.8	3.53	0.130	0.005	0.865	0.887	0.061	0.052
	100.9	10.22	0.339	0.010	0.651	0.819	0.054	0.127
	167.2	16.94	0.494	0.020	0.486	0.821	0.049	0.130
	236	23.9	-	-	-	0.752	0.041	0.207
			0.695	0.041	0.264	0.762	0.039	0.199
	242.5	24.57	0.735	0.037	0.228	-	-	-
	249.3	25.26	0.763	0.036	0.201	-	-	-