UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Pertama
Sidang Akademik 2005/2006

November 2005

EKC 483 – Kejuruteraan Pemprosesan Petroleum & Gas

Masa : 3 jam

Sila pastikan bahawa kertas peperiksaan ini mengandungi TUJUH muka surat yang bercetak dan TUJUH muka surat Lampiran sebelum anda memulakan peperiksaan ini.

Arahan: Jawab mana-mana **LIMA (5)** soalan.

Pelajar boleh menjawab semua soalan dalam Bahasa Malaysia. Jika pelajar ingin menjawab dalam Bahasa Inggeris, pelajar hendaklah menjawab sekurang-kurangnya SATU soalan dalam Bahasa Malaysia.

1. [a] [i] Senaraikan empat (4) negara pengeluar minyak terbanyak di dunia.

[4 markah]

[ii] Berikan tiga (3) sebab penubuhan OPEC sekitar tahun 1973.

[3 markah]

[iii] Berikan tiga (3) sebab bantahan negara lain terhadap penubuhan OPEC.

[3 markah]

[b] [i] Bincang secara ringkas operasi asas penapisan dalam kilang penapis petroleum lazim.

[5 markah]

[ii] Bincang lima (5) sifat fizik yang penting bagi minyak mentah.

[5 markah]

1. [a] [i] List four (4) major oil producing countries in the world.

[4 marks]

[ii] Give three (3) reasons for the formation of OPEC in 1973

[3 marks]

[iii] Give three (3) reasons for the objection of other countries on the formation of OPEC.

[3 marks]

[b] [i] Discuss briefly the basic refinery operations in a conventional petroleum refinery.

[5 marks]

[ii] Discuss five (5) important physical properties of a crude oil.

[5 marks]

...3/-

2. [a] [i] Terangkan secara ringkas unit penyulingan vakum dan kelebihan-kelebihannya.

[5 markah]

[ii] Senaraikan produk bagi unit penyulingan minyak mentah.

[5 markah]

[b] [i] Bincangkan secara ringkas proses pengkokan terlengah.

[5 markah]

[ii] Bincangkan secara ringkas proses rawatan hidro.

[5 markah]

2. [a] [i] Describe the crude vacuum distillation unit and its advantages.

[5 marks]

[ii] List the products of crude distillation unit.

[5 marks]

[b] [i] Discuss briefly the delayed coking process.

[5 marks]

[ii] Discuss briefly the hydrotreating process

[5 marks]

3. [a] Bina lengkuk peratus graviti-tengah bagi analisis minyak mentah seperti yang diberi dalam Lampiran 1.

[9 markah]

[b] Data ujian makmal ASTM berikut diperolehi untuk potongan minyak ringan. Tukarkan data ASTM berikut kepada data Takat Didih Sebenar (TBP).

Isipadu %	IBP	10	30	50	70	90	FBP
Suhu ASTM, °F	495	520	532	543	559	572	595

[5 markah]

[c] Nyatakan tujuan menggunakan yang berikut di dalam turus penyulingan atmosfera:

[i] Pam sekeliling

[ii] Longkang sisi berbilang dan pelucut

[iii] Stim perlucutan

[6 markah]

...4/-

3. *[a]* *Construct the gravity-mid percent curves for the crude oil analysis given in Appendix 1.*

[9 marks]

[b] *The following ASTM laboratory test data were obtained for light oil cut. Convert these ASTM data to True Boiling Point (TBP) data.*

Vol. %	*IBP*	*10*	*30*	*50*	*70*	*90*	*FBP*
ASTM Temperature, °F	*495*	*520*	*532*	*543*	*559*	*572*	*595*

[5 marks]

[c] *State the purpose of using the following in the atmospheric distillation tower:*

[i] Pump-around

[ii] Multiple side draws and stripers

[iii] Stripping steam

[6 marks]

4. [a] Suatu campuran mengandungi 10 mol % metana, 20 mol % etana dan 70 mol% propana pada 283 K (50°F).

[i] Apakah pecahan sistem tersebut dalam keadaan wap apabila tekanan pada 13.79 bar (200 psia)?

[ii] Apakah komposisi ketika fasa cecair dan wap berada dalam keseimbangan?

[8 markah]

[b] Apakah pendehidratan gas asli? Mengapa ianya perlu dan apakah kaedah utama pendehidratan yang digunakan dalam industri gas asli?

[6 markah]

[c] Gas asli digunakan dengan berbagai cara. Terangkan secara ringkas, kegunaan gas asli di dalam industri.

[6 markah]

4. *[a]* *A mixture of 10 mol % methane, 20 mol % ethane and 70 mol % propane is available at 283 K (50°F).*

[i] *What fraction of the system is vapour when the pressure is 13.79 bar (200 psia)?*

[ii] *What are the compositions of the equilibrium vapour and liquid phases?*

[8 marks]

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[b] *What is the dehydration of natural gas? Why is it necessary and what are the major methods of dehydration used in natural gas industry?*

[6 marks]

[c] *Natural gas is used in a variety of different ways. Briefly describe the industrial application of natural gas.*

[6 marks]

5. [a] Kirakan ketumpatan gas asli yang komposisinya diberi seperti di bawah pada suhu 297 K (75°F) dan tekanan kepada 110.32 bar (1600 psia).

Juzuk	Pecahan mol	Berat molekul
CH_4	0.899	16
C_2H_6	0.057	30
C_3H_8	0.040	44
i-C_4H_{10}	0.004	58

[8 markah]

[b] Gas asli boleh mengandungi H_2S dalam jumlah yang besar. Proses penyerapan merupakan kaedah yang efektif untuk menyingkirkan H_2S.

[i] Namakan dua pelarut yang sering digunakan di dalam proses ini.

[ii] Lakarkan gambarajah aliran proses dan berikan maklumat mengenai keadaan proses tersebut.

[6 markah]

[c] Proses pengembang kriogenik selalunya digunakan dalam industri gas asli. Secara ringkasnya, terangkan proses tersebut dan tujuannya.

[6 markah]

5. [a] *Calculate the density of natural gas of the compositions shown at a temperature of 297 K (75°F) and pressure to 110.32 bar (1600 psia).*

Constituent	*Mole fraction*	*Molecular weight*
CH_4	*0.899*	*16*
C_2H_6	*0.057*	*30*
C_3H_8	*0.040*	*44*
i-C_4H_{10}	*0.004*	*58*

[8 marks]

...6/-

[b] *Natural gas can contain large amounts of H_2S. Absorption process is an effective method for removal of H_2S.*

[i] *Name two solvents usually used in the process.*

[ii] *Draw the process flow diagram and give details of the process conditions.*

[6 marks]

[c] *Cryogenic expander process is usually used in natural gas industry. Briefly describe the process and its purpose.*

[6 marks]

6. [a] Terangkan secara ringkas, proses untuk pengangkutan gas asli secara aliran paip.

[4 markah]

[b] Takrifkan perkara-perkara berikut:

[i] Nilai haba pembakaran bagi gas asli

[ii] Cecair Gas Asli (NGLs)

[iii] Penjanaan semula bahan pengering

[6 markah]

[c] Bezakan di antara:

[i] Gas manis dan masam

[ii] Gas basah dan kering

[iii] Gas sekutu dan tidak sekutu

[6 markah]

[d] Apakah fenomena kondensasi songsang dan bagaimana untuk mengatasinya.

[4 markah]

6. *[a]* *Briefly describe the process of transportation of natural gas by pipeline.*

[4 marks]

Lampiran

CRUDE PETROLEUM ANALYSIS

Bureau of Mines Bartlesville Laboratory
Sample 54060

IDENTIFICATION

Bayou des Allemands field
Miocene

Louisiana
Lafourche Parish

GENERAL CHARACTERISTICS

Gravity, specific, 0.845 Gravity, ° API, 36.0 Pour point, ° F., 35
Sulfur, percent, 0.20 Color, brownish green
Viscosity, Saybolt Universal at 100°F., 49 sec. Nitrogen, percent, 0.040

DISTILLATION, BUREAU OF MINES ROUTINE METHOD

STAGE 1—Distillation at atmospheric pressure, 743 mm. Hg
First drop, 86 ° F.

Fraction No.	Cut temp. ° F.	Percent	Sum, percent	Sp. gr., 60/60° F.	° API, 60° F.	C. I.	Refractive index, n_D at 20° C.	Specific dispersion	S. U. visc., 100° F.	Cloud test, ° F.
1	122	0.5	0.5	0.670	79.7					
2	167	1.2	1.7	.675	78.1	11				
3	212	1.6	3.3	.722	64.5	23	1.39163	137.0		
4	257	2.7	6.0	.748	57.7	26	1.41725	141.7		
5	302	3.1	9.1	.765	53.5	26	1.42648	142.3		
6	347	3.9	13.0	.778	50.4	25	1.43374	140.7		
7	392	4.7	17.7	.789	47.8	24	1.43962	138.0		
8	437	5.7	23.4	.801	45.2	24	1.44529	137.6		
9	482	8.0	31.4	.814	42.3	25	1.45193	137.4		
10	527	10.7	42.1	.825	40.0	26	1.45884	142.9		
STAGE 2—Distillation continued at 40 mm. Hg										
11	392	5.0	47.1	0.845	36.0	31	1.46614	142.6	40	15
12	437	10.0	57.1	.854	32	32	1.46870	139.9	45	30
13	482	7.8	64.9	.863	32.5	33	1.47403	140.4	56	50
14	527	7.0	71.9	.874	30.4	35			81	65
15	572	6.5	78.4	.889	27.7	39			145	85
Residuum		20.8	99.2	.931	20.5					

Carbon residue, Conradson: Residuum, 3.7 percent; crude, 0.8 percent.

APPROXIMATE SUMMARY

	Percent	Sp. gr.	° API	Viscosity
Light gasoline	3.3	0.697	71.5	
Total gasoline and naphtha	17.7	0.759	54.9	
Kerosine distillate	24.4	.816	41.9	
Gas oil	14.2	.850	35.0	
Nonviscous lubricating distillate	14.1	.858-.878	33.4-29.7	50-100
Medium lubricating distillate	8.0	.878-.895	29.7-26.6	100-200
Viscous lubricating distillate	-	-	-	Above 200
Residuum	20.8	.931	20.5	
Distillation loss	.8			

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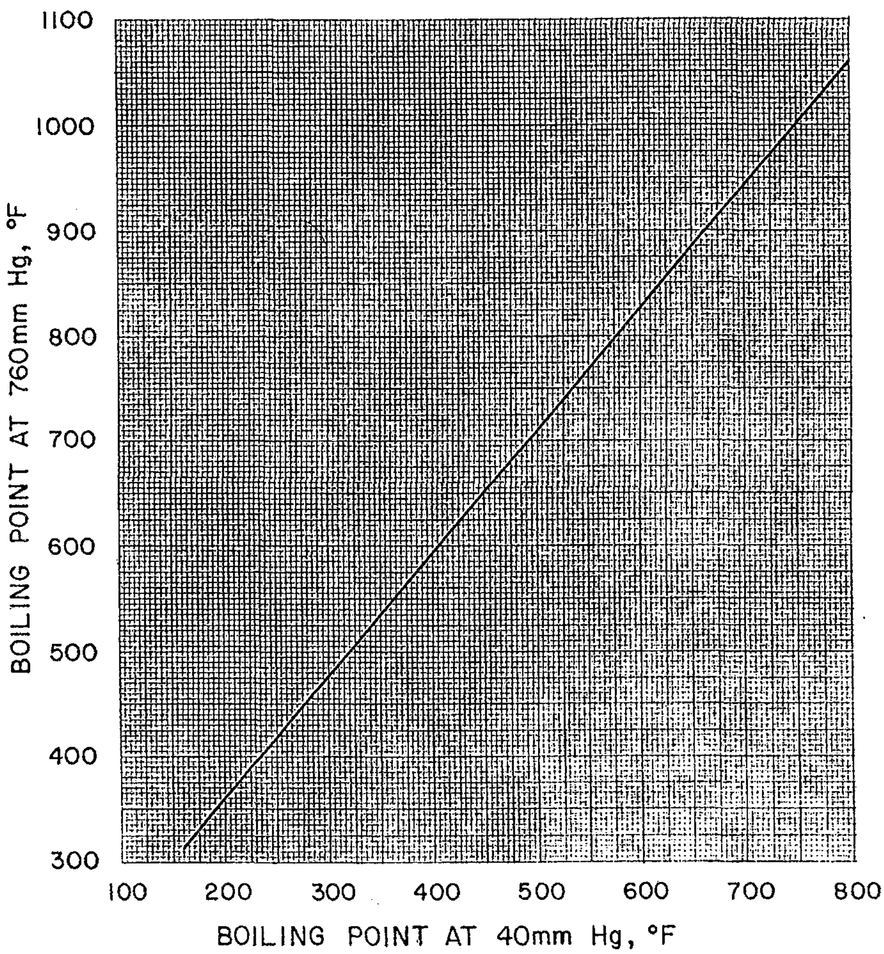
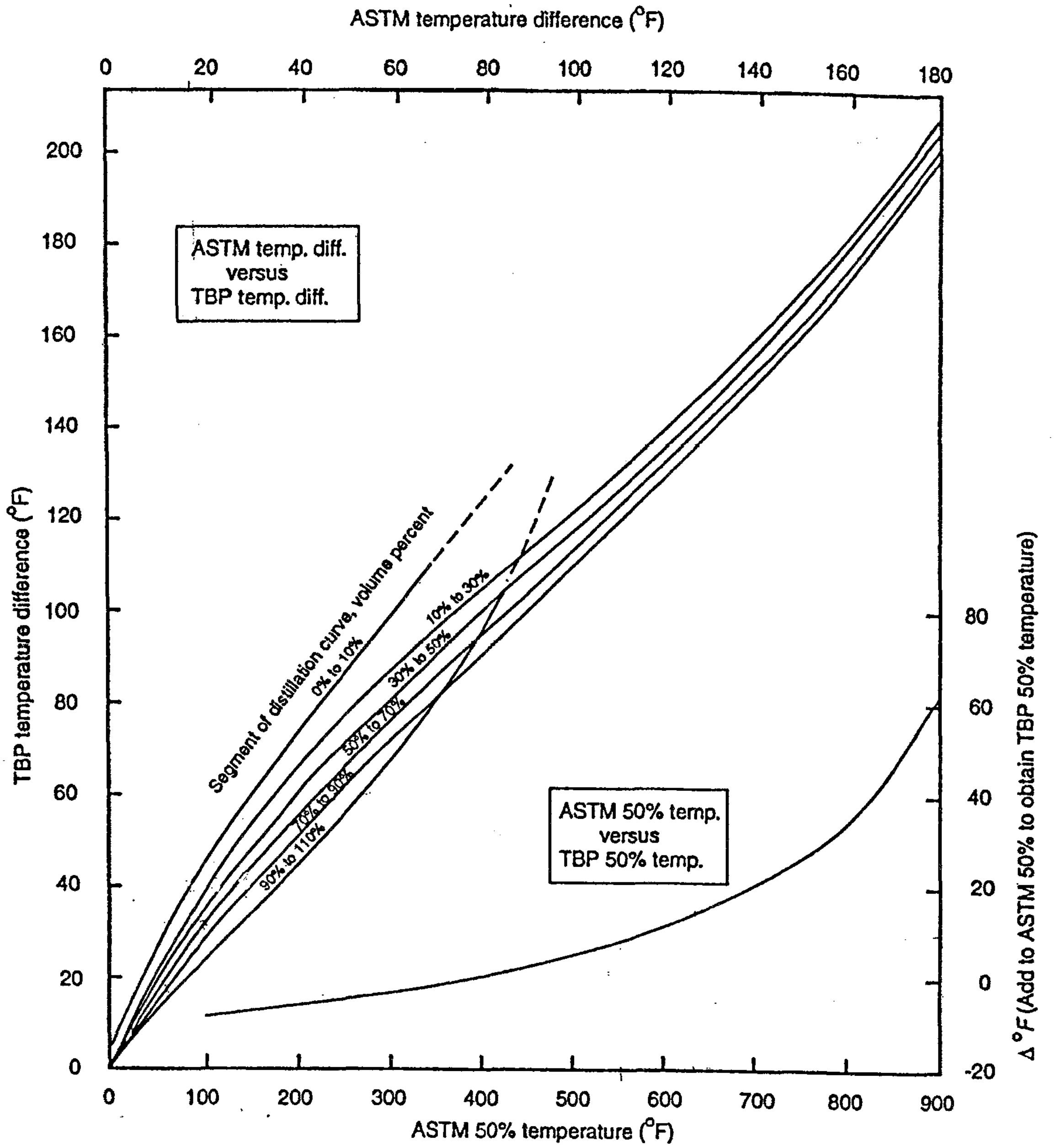
...2/-



Boiling point at 760 mm Hg vs boiling point at 40 mm Hg.

...3/-



From: Applied Hydrocarbon Thermodynamics Volume 2, by Wayne C. Edmister.

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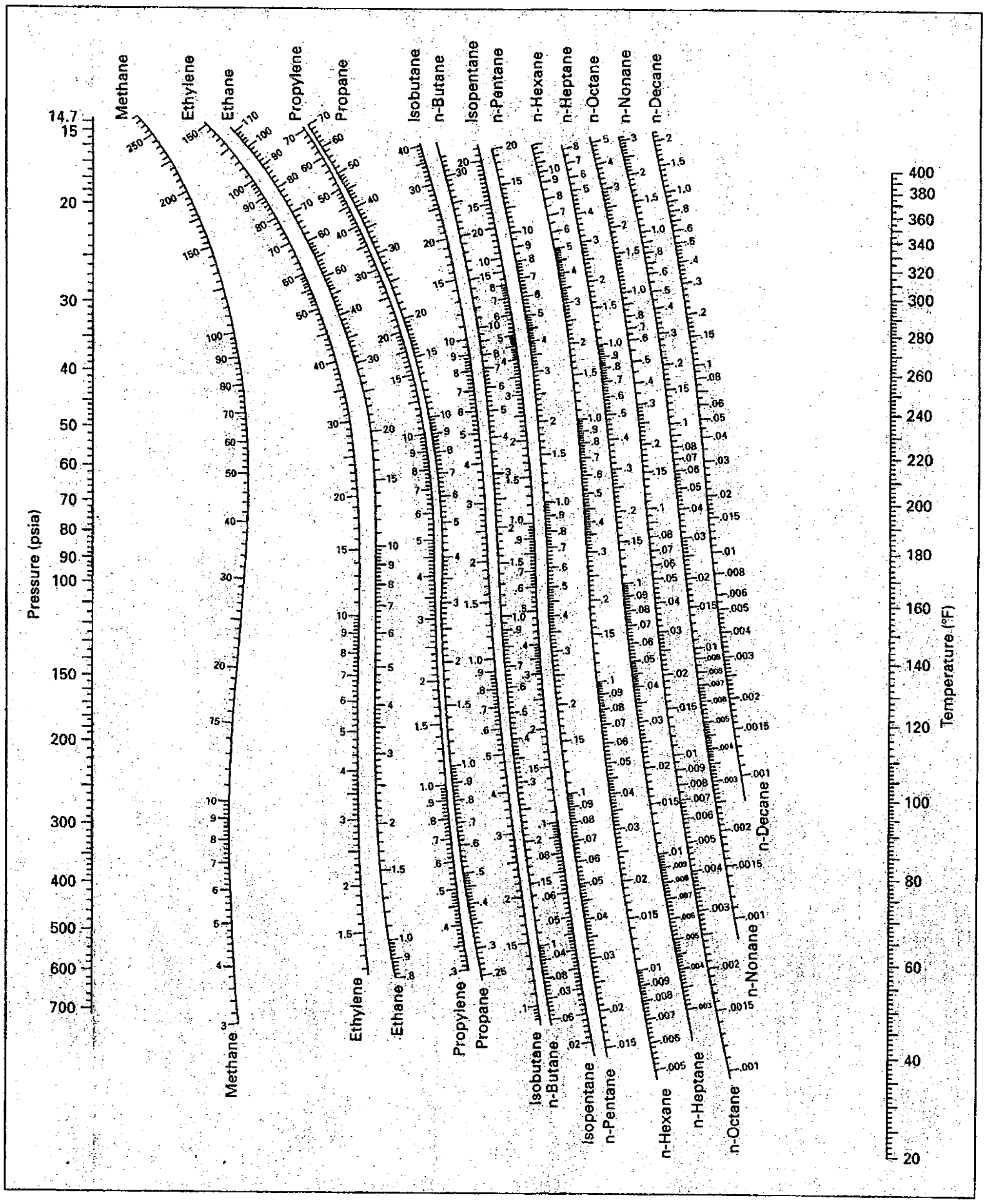

K-values for systems of light hydrocarbons. High-temperature range. (Reproduced by permission from C. L. DePriester, *Chem. Eng. Progr. Symp. Ser. No. 7*, vol. 49, p. 42, 1953.)

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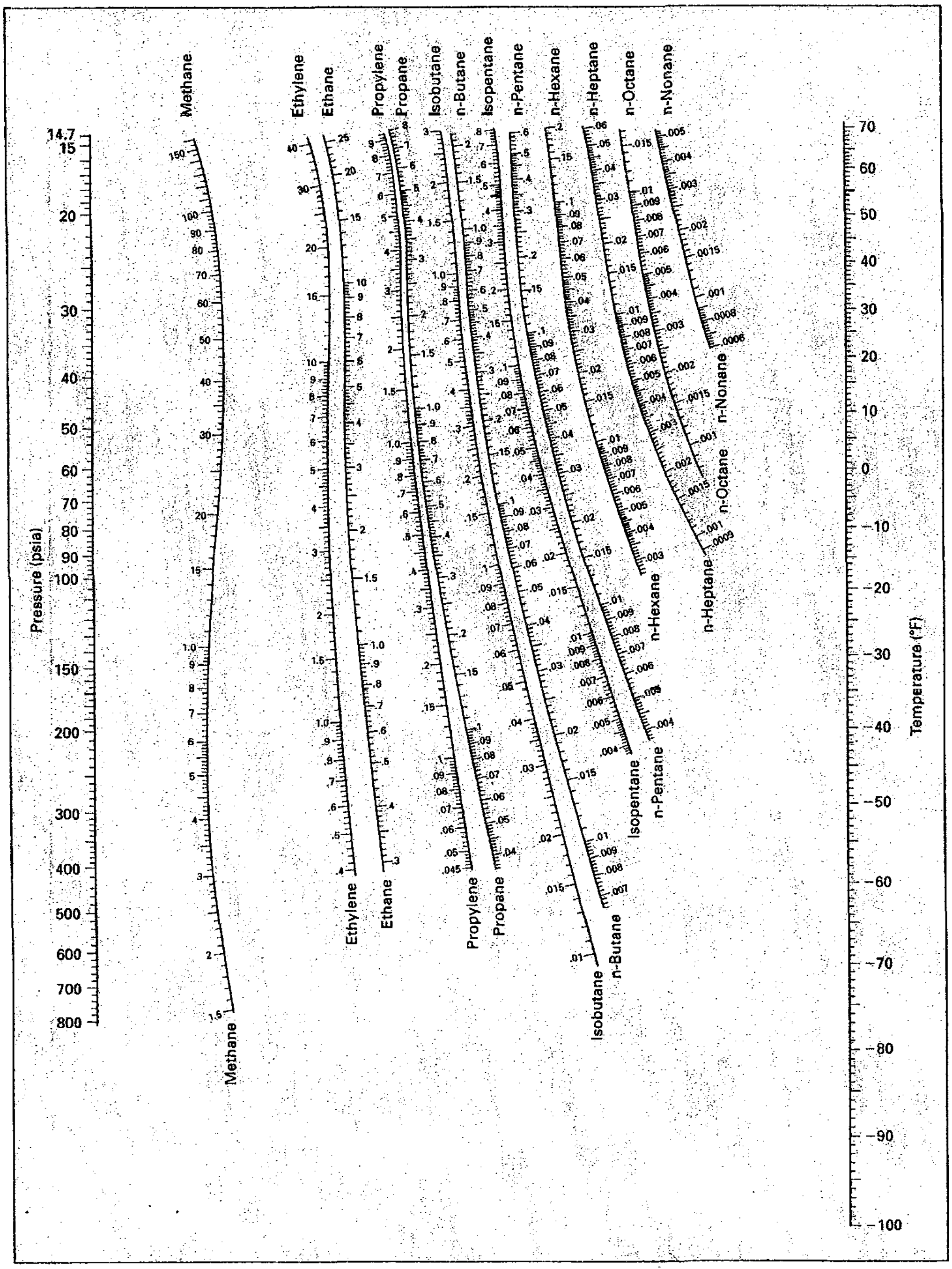

K-values for systems of light hydrocarbons. Low-temperature range. (Reproduced by permission from C. L. DePriester, *Chem. Eng. Progr. Symp. Ser. No. 7*, vol. 49, p. 41, 1953.)

Properties of Pure Species

	Molar mass	ω	T_c/K	P_c/bar	Z_c	V_c cm^3 mol^{-1}	T_n/K
Methane	16.043	0.012	190.6	45.99	0.286	98.6	111.4
Ethane	30.070	0.100	305.3	48.72	0.279	145.5	184.6
Propane	44.097	0.152	369.8	42.48	0.276	200.0	231.1
n-Butane	58.123	0.200	425.1	37.96	0.274	255.	272.7
n-Pentane	72.150	0.252	469.7	33.70	0.270	313.	309.2
n-Hexane	86.177	0.301	507.6	30.25	0.266	371.	341.9
n-Heptane	100.204	0.350	540.2	27.40	0.261	428.	371.6
n-Octane	114.231	0.400	568.7	24.90	0.256	486.	398.8
n-Nonane	128.258	0.444	594.6	22.90	0.252	544.	424.0
n-Decane	142.285	0.492	617.7	21.10	0.247	600.	447.3
Isobutane	58.123	0.181	408.1	36.48	0.282	262.7	261.4
Isooctane	114.231	0.302	544.0	25.68	0.266	468.	372.4
Cyclopentane	70.134	0.196	511.8	45.02	0.273	258.	322.4
Cyclohexane	84.161	0.210	553.6	40.73	0.273	308.	353.9
Methylcyclopentane	84.161	0.230	532.8	37.85	0.272	319.	345.0
Methylcyclohexane	98.188	0.235	572.2	34.71	0.269	368.	374.1
Ethylene	28.054	0.087	282.3	50.40	0.281	131.	169.4
Propylene	42.081	0.140	365.6	46.65	0.289	188.4	225.5
1-Butene	56.108	0.191	420.0	40.43	0.277	239.3	266.9
cis-2-Butene	56.108	0.205	435.6	42.43	0.273	233.8	276.9
trans-2-Butene	56.108	0.218	428.6	41.00	0.275	237.7	274.0
1-Hexene	84.161	0.280	504.0	31.40	0.265	354.	336.3
Isobutylene	56.108	0.194	417.9	40.00	0.275	238.9	266.3
1,3-Butadiene	54.092	0.190	425.2	42.77	0.267	220.4	268.7
Cyclohexene	82.145	0.212	560.4	43.50	0.272	291.	356.1
Acetylene	26.038	0.187	308.3	61.39	0.271	113.	189.4
Benzene	78.114	0.210	562.2	48.98	0.271	259.	353.2
Toluene	92.141	0.262	591.8	41.06	0.264	316.	383.8
Ethylbenzene	106.167	0.303	617.2	36.06	0.263	374.	409.4
Cumene	120.194	0.326	631.1	32.09	0.261	427.	425.6
o-Xylene	106.167	0.310	630.3	37.34	0.263	369.	417.6
m-Xylene	106.167	0.326	617.1	35.36	0.259	376.	412.3
p-Xylene	106.167	0.322	616.2	35.11	0.260	379.	411.5
Styrene	104.152	0.297	636.0	38.40	0.256	352.	418.3
Naphthalene	128.174	0.302	748.4	40.51	0.269	413.	
Biphenyl	154.211	0.365	789.3	38.50	0.295	502.	528.2
Formaldehyde	30.026	0.282	408.0	65.90	0.223	115.	254.1
Acetaldehyde	44.053	0.291	466.0	55.50	0.221	154.	294.0
Methyl acetate	74.079	0.331	506.6	47.50	0.257	228.	330.1
Ethyl acetate	88.106	0.366	523.3	38.80	0.255	286.	350.2
Acetone	58.080	0.307	508.2	47.01	0.233	209.	329.4
Methyl ethyl ketone	72.107	0.323	535.5	41.50	0.249	267.	352.8
Diethyl ether	74.123	0.281	466.7	36.40	0.263	280.	307.6
Methyl *t*-butyl ether	88.150	0.266	497.1	34.30	0.273	329.	328.4

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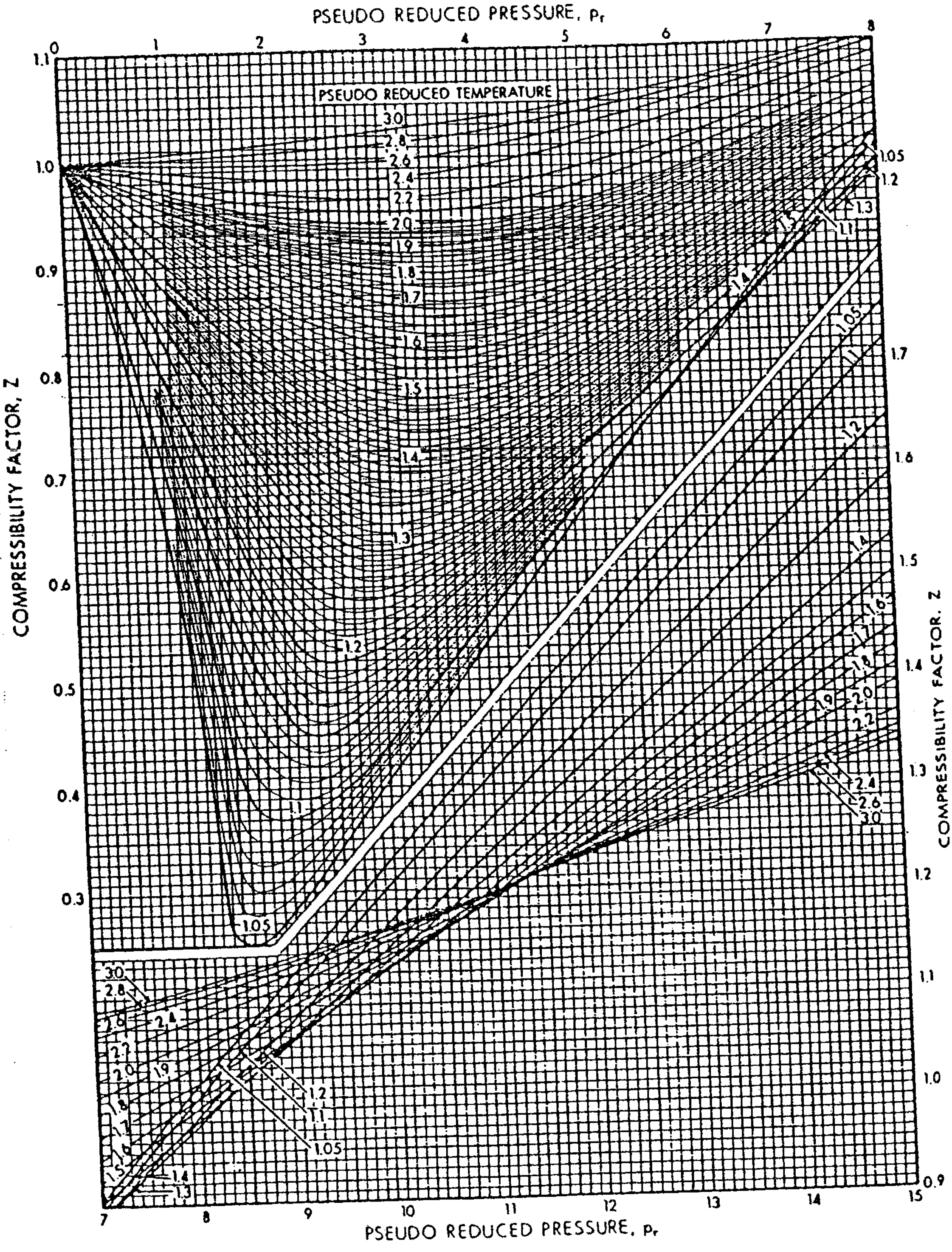

Compressibility factors for natural gas [Standing & Katz, 4-72, courtesy SPE-AIME].