

FOR ETHANE-NITROGEN MIXTURES

Composition: 29.96% C₂H₆ — 70.04% N₂

Composition: 50.26% C₂H₆ — 49.74% N₂

Temperature		Pressure		Density	Compressibility Factor
°K	°F	Psia	atm	gm moles / 1000 cc	z = P/RTp
1st Isometric					
305.38	90.00	4243.4	288.452	12.6655	0.90882
294.27	70.00	3826.9	260.404	12.6774	0.85063
283.17	50.08	3406.2	231.777	12.6908	0.78596
266.54	20.09	2785.4	189.535	12.7127	0.68164
249.83	-10.00	2176.2	148.081	12.7373	0.56708
238.72	-30.00	1808.8	124.081*	—	—
227.60	-50.00	1686.0	114.725*	—	—
216.49	-70.00	1573.7	107.084*	—	—
2nd Isometric					
305.38	90.00	3254.0	221.421	10.9429	0.80745
294.27	70.00	2939.5	200.204	10.9547	0.75682
283.17	50.08	2623.2	178.498	10.9674	0.70041
266.54	20.09	2158.1	146.849	10.9875	0.61105
255.35	0.00	1855.8	126.279	11.0020	0.54776
249.83	-10.00	1716.5	116.800*	—	—
238.72	-30.00	1591.0	108.261*	—	—
227.60	-50.00	1471.9	100.157*	—	—
3rd Isometric					
305.38	90.00	2546.7	173.292	9.1780	0.75346
294.27	70.00	2314.1	157.465	9.1884	0.70969
283.17	50.08	2079.9	141.528	9.1995	0.66206
266.54	20.09	1754.7	118.039	9.2171	0.58551
260.94	10.00	1621.2	110.316	9.2232	0.55858
255.38	0.00	1534.6	104.423*	—	—
249.83	-10.00	1477.3	100.524*	—	—
238.72	-30.00	1364.0	92.814*	—	—
4th Isometric					
305.38	90.00	2012.9	136.969	7.4084	0.73778
294.27	70.00	1844.3	125.497	7.4174	0.70065
283.17	50.08	1673.6	113.881	7.4268	0.65989
266.54	20.09	1418.1	96.496	7.4412	0.59289
260.94	10.00	1349.3	91.814*	—	—
249.83	-10.00	1237.3	84.193*	—	—
238.72	-30.00	1132.5	77.062*	—	—
5th Isometric					
305.38	90.00	1571.3	106.920	5.6627	0.75347
294.27	70.00	1454.1	98.945	5.6697	0.72270
283.17	50.08	1335.5	90.875	5.6767	0.68892
266.54	20.09	1155.8	78.647	5.6874	0.63223
260.94	10.00	1098.6	74.755*	—	—
249.83	-10.00	994.5	67.671*	—	—
238.72	-30.00	902.8	61.432*	—	—
6th Isometric					
305.38	90.00	1143.0	77.776	3.8892	0.79802
294.27	70.00	1071.6	72.918	3.8937	0.77552
283.17	50.08	999.1	67.984	3.8982	0.75052
266.54	20.09	891.2	60.424	3.9048	0.70748
260.94	10.00	838.6	57.063*	—	—
249.83	-10.00	746.4	50.789*	—	—
238.72	-30.00	667.4	45.414*	—	—
7th Isometric					
305.38	90.00	691.0	47.020	2.1530	0.87150
294.27	70.00	655.4	44.597	2.1553	0.85688
283.17	50.08	620.0	42.188	2.1574	0.84155
266.54	20.09	566.4	38.541	2.1607	0.81552
255.35	0.00	529.6	36.037	2.1629	0.79514

* Two-phase region

Temperature		Pressure		Density	Compressibility Factor
°K	°F	Psia	atm	gm moles / 1000 cc	z = P/RTp
1st Isometric					
305.38	90.00	4168.7	283.662	11.3394	0.99804
294.27	70.00	3863.4	262.888	11.3503	0.95915
283.17	50.08	3553.6	241.807	11.3611	0.91595
266.54	20.09	3092.0	210.397	11.3803	0.84526
249.83	-10.00	2626.8	178.743	11.3996	0.76483
238.72	-30.00	2320.0	157.866	11.4127	0.70612
227.60	-50.00	2018.5	137.350	11.4258	0.64363
222.05	-60.00	1872.0	127.382*	—	—
216.49	-70.00	1799.6	122.455*	—	—
210.94	-80.00	1726.0	117.447*	—	—
197.05	-105.00	1538.6	104.695*	—	—
2nd Isometric					
305.38	90.00	3295.5	224.245	9.5980	0.93224
294.27	70.00	3063.6	208.465	9.6072	0.89858
283.17	50.08	2829.1	192.508	9.6175	0.86141
266.54	20.09	2479.1	168.692	9.6335	0.80060
249.83	-10.00	2125.8	144.652	9.6496	0.73121
238.72	-30.00	1891.3	128.695	9.6605	0.68005
233.16	-40.00	1774.6	120.754*	—	—
227.60	-50.00	1692.6	115.174*	—	—
216.49	-70.00	1565.5	106.526*	—	—
199.83	-100.00	1367.5	93.0525*	—	—
3rd Isometric					
305.38	90.00	2593.8	176.497	7.8530	0.89686
294.27	70.00	2422.6	164.848	7.8611	0.86841
283.17	50.08	2249.4	153.062	7.8696	0.83702
266.54	20.09	1989.3	135.363	7.8822	0.78516
249.83	-10.00	1726.3	117.467	7.8957	0.72569
244.27	-20.00	1638.6	111.500	7.9004	0.70391
238.72	-30.00	1550.3	105.491	7.9048	0.68125
227.60	-50.00	1429.9	97.299*	—	—
216.49	-70.00	1316.5	89.582*	—	—
4th Isometric					
305.38	90.00	1991.1	135.486	6.1149	0.88415
294.27	70.00	1870.6	127.286	6.1216	0.86107
283.17	50.08	1748.4	118.971	6.1281	0.83548
266.54	20.09	1564.8	106.478	6.1381	0.79311
249.83	-10.00	1377.0	93.699	6.1483	0.74337
244.27	-20.00	1313.8	89.398	6.1535	0.72477
238.72	-30.00	1258.1	85.608	6.1585	0.70961
5th Isometric					
305.38	90.00	1440.6	98.027	4.3807	0.89295
294.27	70.00	1362.5	92.712	4.3853	0.87551
283.17	50.08	1283.3	87.323	4.3900	0.85602
266.54	20.09	1164.2	79.219	4.3969	0.82374
249.83	-10.00	1042.7	70.951	4.4038	0.78588
6th Isometric					
305.38	90.00	893.6	60.806	2.6315	0.92207
294.27	70.00	851.5	57.941	2.6340	0.91095
283.17	50.08	808.9	55.042	2.6365	0.89844
266.54	20.09	745.0	50.694	2.6404	0.87779
249.83	-10.00	679.9	46.264	2.6442	0.85344
7th Isometric					
305.38	90.00	512.0	34.839	1.4614	0.95131
294.27	70.00	490.3	33.363	1.4628	0.94451
283.17	50.08	468.5	31.879	1.4641	0.93704
266.54	20.09	435.9	29.661	1.4661	0.92497
249.83	-10.00	402.8	27.409	1.4685	0.91042
238.72	-30.00	380.7	25.905	1.4695	0.89989
227.60	-50.00	358.5	24.394	1.4708	0.88802
216.49	-70.00	321.2	21.856	1.4725	0.83551

* Two-phase region

REFERENCES CITED

- 1 Bean, H. S., *J. Research* 4, 645-61 (1930).
- 2 Beattie, J. A. and Bridgeman, O. C., *Proc. Am. Acad. Arts and Sci.* 63, 229-307 (1930).
- 3 Beattie, J. A. and Ikehara, S., *Proc. Am. Acad. Arts and Sci.* 64, 127-76 (1930).
- 4 Benedict, M., Webb, G. B. and Rubin, L. C., *J. Chem. Phys.* 8, 334-45 (1940); *op. cit.* 10, 747 (1942).
- 5 Benedict, M., Webb, G. B., Rubin, L. C. and Friend, L., *Chem. Eng. Progress* 47, 571 (1951).
- 6 Bloomer, O. T. and Rao, K. N., Institute of Gas Technology Research Bulletin No. 17. Chicago: 1952.
- 7 Bloomer, O. T. and Rao, K. N., Institute of Gas Technology Research Bulletin No. 18. Chicago: 1952.
- 8 Bloomer, O. T., Eakin, B. E., Ellington, R. T. and Gami, D. C., Institute of Gas Technology Research Bulletin No. 21. Chicago: 1955.
- 9 Bloomer, O. T., Gami, D. C. and Parent, J. D., Institute of Gas Technology Research Bulletin No. 22. Chicago: 1953.
- 10 Bond, D. C. and Russell, N. B., *Trans. Am. Inst. Mining Engrs.* (Pub. No. 2450) 79, 192-98 (1949).
- 11 Davis, P. C., Gore, T. L. and Kurata, F., *Ind. Eng. Chem.* 43, 1826-27 (1951).
- 12 Donnelly, H. S. and Katz, D. L., *Ind. Eng. Chem.* 46, 511-17 (1954).
- 13 Gibbs, T. W., "Collected Works," Longman Trans. Vol. I, 55-150, 1874-78. Connecticut Acad.: 1928.
- 14 Katz, D. L. and Kurata, F., *Ind. Eng. Chem.* 32, 817-27 (1940).
- 15 Katz, D. L., Schalz, R. H. and Williams, B., *Oil Gas J.* 52, 118-23 (1953) Sept. 28; 52, 108 (1953) Nov. 26.
- 16 Kobayashi, R. and Katz, D. L., *Petroleum Trans. Am. Inst. Mining Engrs.* (TP-2579) 1, 66-70 (1949).
- 17 Mullins, P. V. and Wilson, R. W., "Prospective Methods and Estimated Costs for Removing Excess Nitrogen from Gas." Natural Gas Production and Transmission Research Report, AGA (1952).
- 18 Reamer, H. H., Selleck, F. J., Sage, B. H. and Lacey, W. N., *Ind. Eng. Chem.* 44, 198-201 (1952).
- 19 Ricci, J. E., "The Phase Rule and Heterogeneous Equilibrium." New York: D. van Nostrand Co., 1951.
- 20 Sage, B. H. and Lacey, W. N., "Volumetric and Phase Behavior of Hydrocarbons," 118. Stanford University: Stanford University Press, 1939.
- 21 Sage, B. H. and Lacey, W. N., "Thermodynamic Properties of the Lighter Paraffin Hydrocarbons and Nitrogen." New York: American Petroleum Institute, 1950.
- 22 Tsiklis, D. S., *Doklady Akad. Nauk SSSR* 86, 993-95 (1952).
- 23 Waals, van der, J. D., *Arch. néerland sci.* (Ser II) 15, 126 (1910).
- 24 Walters, J. E. and Loomis, A. G., *J. Am. Chem. Soc.* 47, 2302-06 (1925).
- 25 Wetmore, F. E. W. and Leroy, D. J., "Principles of Phase Equilibria." New York: McGraw-Hill Book Co., 1951.

INSTITUTE OF GAS TECHNOLOGY RESEARCH BULLETIN SERIES

- No. 1 STORAGE OF NATURAL GAS AS HYDRATE, by J. D. Parent, 1948 (January). \$2.50
- No. 2 EQUILIBRIUM COMPOSITIONS AND ENTHALPY CHANGES FOR THE REACTIONS OF CARBON, OXYGEN AND STEAM, by J. D. Parent and S. Katz, 1948 (January). \$10.00
- No. 3 SUPPLYING HOUSEHOLD HEATING SERVICES BY HIGH TEMPERATURE CIRCULATING LIQUIDS AND VAPORS, by E. F. Davis, J. J. First and R. E. Peck, 1948 (January). \$2.50
- No. 4 CRACKING CATALYST ACTIVITY IN THE PRESENCE OF HYDROGEN SULFIDE, by H. A. Dirksen, H. R. Linden and E. S. Pettyjohn, 1953 (February). \$3.50
- No. 5 IDENTIFICATION AND DETERMINATION OF ORGANIC SULFUR IN UTILITY GASES. *In preparation.*
- No. 6 PILOT PLANT CATALYTIC GASIFICATION OF HYDROCARBONS, by C. H. Riesz, P. C. Lurie, C. L. Tsaros and E. S. Pettyjohn, 1953 (July). \$5.00
- No. 7 GASIFICATION OF COAL IN SUSPENSION AT ATMOSPHERIC PRESSURE. *In preparation.*
- No. 8 *Withdrawn.*
- No. 9 SELECTION OF OILS FOR CARBURETED WATER GAS, by E. S. Pettyjohn and H. R. Linden, 1952 (March). \$4.00
- No. 9 *Supplement.* Nomographs from Bulletin No. 9 reproduced in large scale, 22" × 31", \$1.50
- No. 10 SULFUR POISONING OF NICKEL CATALYSTS, by C. H. Riesz, H. A. Dirksen and W. J. Kirkpatrick, 1951 (September). \$2.50
- No. 11 EXPANSION BEHAVIOR OF COAL DURING CARBONIZATION, by O. P. Brysch and W. E. Ball, 1951 (October). \$5.00
- No. 12 SELECTION OF OILS FOR HIGH-BTU OIL GAS, by H. R. Linden and E. S. Pettyjohn, 1952 (April). \$5.00
- No. 12 *Supplement.* Nomographs from Bulletin No. 12 reproduced in large scale, 22" × 31", \$1.50