FIGURE 24. *Temperature-entropy chart.*

17. References

[1] Michels, A., Levelt, J. M., and de Graaff, W., Compressibility isotherms of argon at temperatures between −25 and −155 degrees C and at densities up to 640 amagat (pressures up to 1050 atmospheres), Physica **24**, 659–671 (1958).

[2] Ziegler, W. T., Mullins, J. C., and Kirk, B. S., Calculation of the Vapor Pressure and Heats of Vaporization and Sublimation of Liquids and Solids, Especially Below One Atmosphere Pressure. II. Argon, Georgia Inst. Tech., Eng. Exp. Sta., Tech. Rept. No. 2 (June 1962).

[3] Bureau of the Census, U.S. Dept. of Commerce Current Industrial Reports 1928A(65)−13 supplement 2 issued Jan. 20, 1967 for 1965 production of Industrial gases.

[4] Hall, L. A., Hust, J. G., and Gosman, A. L., A Bibliography of Thermophysical Properties of Argon from 0 to 300 °K, NBS Tech. Note 217 (June 1964).

[5] Hirschfelder, J. O., Buehler, R. J., McGee, H. A., and Sutton, J. R., A generalized equation of state for both gases and liquids. I., Wisconsin, Univ. Naval Research Lab., Dept. of Chemistry, Tech. Rept., Wis−Oor−15 (Oct. 5, 1956) Ind. Eng. Chem. **50**, 375–385, 1958.

[6] Michels, A., Wijker, H., and Wijker, H. K., Isotherms of argon between 0 and 150 degrees C and pressures up to 2900 atmospheres, Physica **15**, No. 7, 627–633 (1949).

[7] Rogovaya, I. A., and Kaganer, M. G., Compressibility of argon at low temperatures up to 200 atmospheres, Russ. J. Phys. Chem. **35**, 1049–1050 (1961) (English translation), Zhur. Fiz. Khim. **35**, 2135–2136 (1961).

[8] van Itterbeek, A., and Verbeke, O., Density of liquid nitrogen and argon as a function of pressure and temperature, Physica **26**, No. 11, 931–938 (1960).

[9] van Itterbeek, A., Verbeke, O., and Staes, K., Measurements on the equation of state of liquid argon and methane up to 300 kg/sq cm at low temperatures, Physica **29**, 742–754 (1963).

[10] van Witzenburg, W., The Equation of State of Liquid and Solid Argon, Toronto Univ., Canada, Ph. D. Thesis (1963).

[11] Walker, P. A., The Equation of State and the Specific Heat of Liquid Argon, University of London, Ph. D. Thesis (1956).

[12] Private communication from O. Verbeke, Laboratorium voor Lage temperaturen, Leuven, Belgium (1965).

[13] Private communication from P. A. Walker, Research Laboratories, General Electric Co., Ltd., Wembley, Middlesex, England (1961).

[14] Clark, A. M., Din, F., Robb, J., Michels, A., Wassenaar, T., and Zwietering, Th., The vapour pressure of argon, Physica **17**, No. 10, 876–884 (1951). 116th publication of the van der Waals Fund, Amsterdam, Nederland.

[15] Flubacher, P., Leadbetter, A. J., and Morrison, J. A., Thermodynamic Properties of Argon, Proceedings of the International Conference on Low Temperature Physics, 7th, Toronto, Canada, 1960, pp. 695–697 (1961).

[16] van Itterbeek, A., de Boelpaep, J., Verbeke, O., Theeuwes, F., and Staes, K., Vapour pressure of liquid argon, Physics **30**, No. 12, 2119–2122 (Dec. 1964).

[17] Mathias, E., Onnes, H. K., and Crommelin, C. A., On the rectilinear diameter for argon, Communs. Phys. Lab., Univ. Leiden, No. 131A (1912), Proc. Acad. Sci., Amsterdam **15**, 667–673 and 960–965 (1912); Verslag Gewone Vergader Wis- En Natuurk. Afdeel. Kon. Akad. Wetenschap, 700–706 and 893–898 (1912); Ann. Phys. **17**, 442–455 (1922).

[18] Guggenheim, E. A., The principle of corresponding states, J. Chem. Phys. **13**, 253–261 (1945).

[19] Stewart, R. B., The Thermodynamic Properties of Oxygen, State Univ. of Iowa, Iowa City, Ph. D. Thesis (June 1966).

[20] Hust, J. G., and McCarty, R. D., Curve-fitting techniques and applications to thermodynamics, Cryogenics **7**, **4**, 200–206 (Aug. 1967).

[21] Hoge, H. J., Vapor Pressure and Fixed Points of Oxygen and Heat Capacity in the Critical Region, J. Res. NBS **44**, 321–345 (1950) RP2081.

[22] Gosman, A. L., Thermodynamic Properties of Argon in the Liquid and Gaseous State for Temperatures From the Triple Point to 300 °K With Pressures to 1000 Atmospheres, State Univ. of Iowa, Iowa City, Ph. D. Thesis (Aug. 1965).

[23] Benedict, M., Webb, G. B., and Rubin, L. C., An empirical equation for thermodynamic properties of light hydrocarbons and their mixtures, J. Chem. Phys. **8**, 334–345 (Apr. 1940).

[24] Bloomer, O. T., and Rao, X. N., Thermodynamic properties of nitrogen, Inst. Gas Tech. Res. Bull. **18** (Oct. 1952).

[25] Strobridge, T. R., The Thermodynamic Properties of Nitrogen from 64 to 300 °K between 0.1 and 200 Atmospheres, NBS Tech. Note No. 129, PB 161630 (1962).

[26] Onnes, H. K., and Crommelin, C. A., Isotherms of monatomic gases and of their binary mixtures. VII. Isotherms of argon between 20 degrees and −150 degrees, Proc. Acad. Sci. Amsterdam **13**, 614–625 (1911) reprinted in Communs. Phys. Lab. Univ. Leiden No. 118b (1911).

[27] Hilsenrath, J., Beckett, C. W., Benedict, W. S., Fano, L., Hoge, H. J. Masi, J. F., Nuttall, R. L., Touloukian, Y. S., and Woolley, H. W., Tables of Thermal Properties of Gases, NBS Circ. No. 564 (1955), reprinted as Tables of Thermodynamic and Transport Properties of Air, Argon, Carbon Dioxide, Carbon Monoxide, Hydrogen, Nitrogen, Oxygen, and Steam (Pergamon Press, Oxford, 1960) 478 pp.

[28] Private communication from J. M. H. Levelt-Sengers, National Bureau of Standards, Gaithersburg, Md (1964).

[29] Private communication from C. R. Barber, National Physical Laboratory, Teddington, Middlesex, England (1967).

[30] Hust, J. G., and Gosman, A. L., Functions for the calculation of entropy, enthalpy, and internal energy for real fluids using equations of state and specific heats, Advances in Cryogenic Engineering **9**, 227–233 (1964).

[31] Din, F., Argon, Thermodynamic Functions of Gases, Vol. **2**, pp. 146–201 (Butterworths Scientific Publications, London, 1956).

[32] Goodwin, R. D., and Weber, L. A., A Comparison of Two Melting-Pressure Equations Constrained to the Triple Point Using Data for Eleven Gases and Three Metals, NBS Tech. Note 183 (Oct. 1963).

[33] Michels, A., and Prins, C., The melting lines of argon, krypton and xenon up to 1500 atm; representation of the results by a low of corresponding states, Physica **28**, No. 2, 101–116 (Feb. 1962).

[34] Lahr, P. H., and Eversole, W. G., Compression isotherms of argon, krypton, and xenon through the freezing zone, Chem. Eng. Data **7**, No. 1, 42–47 (Jan. 1962).

[35] Bridgman, P. W., The melting curves and compressibilities of nitrogen and argon, Proc. Am. Acad. Arts Sci. **70**, 1 (1935).

[36] Frank, A., and Clusius, K., Prazisionsmessungen der Verdampfungswarme Der Gase O_2, H_2S, PH_3, A, COS, CH_4, and CH_3D (Precision measurements of the heat of vaporization of gases oxygen, hydrogen sulphide, phosphene, argon, carbon oxisulphide, methane and deuteromethane)

[37] Eucken, A., Uber das thermische verhalten einiger komprimierter und kondonsierter gase bei tiefen temperaturen (On the thermal behavior of a compressed and condensed gas at low temperatures) Verhandl. Deut. Physik. Ges. **18**, 4–27 (1916).

[38] Hirschfelder, J. O., Curtiss, C. F., and Bird, R. B., Molecular Theory of Gases and Liquids (John Wiley & Sons, New York, 1954).

[39] Kerr, E. C., I. Second Virial Coefficient of Argon at Low Temperature and Low Pressure., II. Heat Capacity of Liquid Nitric Oxide Above its Normal Boiling Point., University Microfilms (Ann Arbor, Mich.), Publ. No. 21480, Dissertation Abstracts **17**, 1232 (1957).

[40] Fender, B. E. F., and Halsey, G. D., Jr., Second virial coefficients of argon, krypton, and argon-krypton mixtures at low temperatures, J. Chem. Phys. **36**, 1881–1888 (1962).