Communications

Temperature-Oxygen Fugacity Tables for Selected Gas Mixtures in the System C-H-O at One Atmosphere Total Pressure

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For at least two decades, many institutions throughout the world have computerized various calculations of the fO_2 values produced at various temperatures by gaseous mixtures within the C-H-O system. The fO_2 calculations included within this new compilation were first started at the Pennsylvania State University in 1962; an early approximate unpublished version of T-fO_2 tables for mixtures of CO-CO_2, H_2-H_2O, and H_2-CO_2 were finished in 1963 by Vern Porter* and

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G. C. Ulmer. In the ensuing years, the necessary algebraic equations were freed from all their simplifying assumptions, the data-base for the fO_2-T calculation was changed from Coughlin[1] (1954) to JANAF[2] (1965), and the graphs of Muan and Osborn[3] (1965) presenting temperature vs the log of the mixing ratio have been corrected and extended. The goals of this new set of tables are directed at mixtures of CO-CO_2, H_2-H_2O, and H_2-CO_2 with a three fold purpose:

1) to provide at one atmosphere total pressure the most unequivocal set of equilibrium fO_2-temperature data mathematically possible from the JANAF (1965) data base.

2) to provide data for the initial mixing of gases expressed in vol pct with sufficient detail to cover a temperature range of 500 to 2000°C in 5°C steps and to cover an oxygen fugacity range of 10^{-4} to 10^{-26} atms in 0.10 log-unit steps.

3) to accurately compare calculated fO_2-temperature relationships among five commonly used sources of C-H-O data, $i.e.$, Wagman $et\ al$[4] (1954), Coughlin[1] (1954), Elliot and Gleisser[5] (1960), Wicks and Block[6] (1963), and JANAF[2] (1965).

In the twenty eight pages of the introduction to these tables, the algebraic derivations of the necessary equations are presented along with graphs of fO_2-T-vol pct. These graphs index the information to be found within the tables proper. In addition, ΔfO_2 data are presented in graphic form as contoured plots which allow the comparison of the other data sources with the JANAF data. The final paragraphs of the introduction explain the uses of the tables and very briefly reference the experimental techniques suitable for the utilization of these data.

The computer programs used were written in Fortran. Detailed printouts of the programs can be obtained from Dr. Peter Deines, 204 Deike Building, The Pennsylvania State University, University Park, PA 16802. The complete publication (129 pages) in paper binding is available at $2.00 as Bulletin 88 from the Earth and Mineral Sciences Experiment Station, Mineral Sciences Bldg. College of Earth and Mineral Sciences, The Pennsylvania State University, University Park, PA 16802.

1. J. P. Coughlin: *U.S. Bur. of Mines Bull.*, 1954, no. 542, pp. 1-80.
2. JANAF: *Joint Army, Navy, and Air Force Thermochemical Tables*, 2nd ed., pp. 1-1141, reissued by National Bureau of Standards as Ref. Data Ser. 37, Gaithersburg, Md., 1971.
3. A. Muan and E. F. Osborn: *Phase Equilibria Among Oxides in Steelmaking*, pp. 1-236, Addison-Wesley, Reading, Mass., 1965.
4. D. D. Wagman, J. E. Kilpatrick, W. J. Taylor, K. S. Pitzer, and F. D. Rossini: *J. Res. Nat. Bur. Stand.*, 1945, vol. 34, pp. 143-62.
5. J. F. Elliot and M. Gleiser: *Thermochemistry for Steelmaking*, vol. 1, pp. 1-296, Addison-Wesley, Reading, Mass., 1960.
6. C. E. Wicks and F. E. Block: *U.S. Bur. of Mines Bull.*, 1963, no. 605, pp. 1-147.

Cooling Effect of Iron-Selenium Briquets Added to Liquid Steel

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In the processing of liquid steel for casting in a mold, it is necessary to control the temperature to avoid excessive cooling, which could cause inferior ingot characteristics. Consequently it is important to know the temperature change that results from the addition of cold, solid additives to the teeming stream. A recent paper has calculated the cooling effect of alloy additives and reviewed the prior literature,[1] but nothing has been written on the addition of volatile elements which are only partially recovered.

This work is based on the addition of blended and compressed iron and selenium powders, in the shape of $1/4 \times 1/2$ in. (0.00635 × 0.0127 m) diam. briquets, each containing 85 pct iron and 15 pct selenium, added in sixteen 2 lb (0.91 kg) bags during the filling of a 5 ton (4.535 tonne) ingot mold with low alloy steel. Since the average recovery of selenium in top-poured ingots in air is two-thirds of the amount added, it is assumed that two thirds of the selenium added forms iron selenide (FeSe) at 960°C (1233 K), the eutectic temperature of FeSe and iron saturated with selenium.[2] The remaining one-third of the selenium is lost by volatilization between its boiling point 685°C (958 K) and 1600°C (1873 K), the temperature of the liquid steel. 32 lbs (14.53 kg) of additive in a 5 ton (4.535 tonne) ingot is equivalent to 6.4 lbs (2.906 kg) per ton of steel or 3200 gms. (3.200 kg) per metric ton. The cooling calculation follows:

<u>Gram atoms of components</u> in 3200 gm. (3.200 kg) of briquets

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Manuscript submitted August 15, 1975.

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Manuscript submitted June 24, 1975.