Journal of
Applied Physics

Temperature Gradients for Convection in Well Models

Mary Jane Auld

Citation: J. Appl. Phys. **19**, 218 (1948); doi: 10.1063/1.1698404
View online: http://dx.doi.org/10.1063/1.1698404
View Table of Contents: http://jap.aip.org/resource/1/JAPIAU/v19/i2
Published by the American Institute of Physics.

the U. S. Atomic Energy Commission. The iron was the Westinghouse spectroscopic standard, Puron.

Measurements covered the temperature range 715 to 887°C in the alpha-phase and 935 to 1112°C in the gamma-phase. When both curves are extrapolated to the transformation temperature, 910°C, it is found that the rate of self-diffusion in alpha-iron is about 100 times as great as the rate in gamma-iron. This in itself is not surprising since J. L. Ham[2] found molybdenum to diffuse 80 to 90 times as fast in alpha-iron as in the gamma-phase at the same temperatures. However, unlike Ham, we observe a great difference in the activation energies in the two phases with correspondingly larger differences in the frequency factor.

The equations giving the best agreement with the six measured points in the alpha-phase and the eight points in the gamma-phase are

$$D_{\alpha\mathrm{Fe}} = 34000e^{-77200/RT},$$
$$D_{\gamma\mathrm{Fe}} = 0.00104e^{-48000/RT}.$$

The points have been corrected for the change in diffusion distances introduced by cooling the samples to room temperature for measurement. These corrections are between 2 and 3 percent of the value of D.

Substituting the measured activation energies, Q, and the interatomic distances, d, for iron into the Dushman-Langmiur equation permitted independent calculations of the frequency factor, A. A is given by the expression $A=(Q/Nh)d^2$, where N is Avogadro's number and h is Planck's constant. A comparison (Table I) of the experimental and calculated values shows that the agreement is very unsatisfactory and that this equation will not describe the experimental data.

[1] J. Steigman, W. Shockley, and F. C. Nix, Phys. Rev. **56**, 13 (1939).
[2] J. L. Ham, A.S.M. **35**, 331 (1945).

Temperature Gradients for Convection in Well Models

MARY JANE AULD
University of North Carolina, Chapel Hill, North Carolina
November 14, 1947

PRELIMINARY experimental data have been obtained in small-scale tests in an attempt to check the theoretical calculations of A. L. Hales[1] relative to minimum temperature gradients required for the initiation of convection currents in water-filled wells. Half-meter long glass tubes of 5-, 7-, and 9-mm inside diameters served as "wells;" the bottoms were sealed off, and iron-constantan thermocouples were inserted in wall notches at approximately 12-cm intervals to provide temperature measurements. Each tube was placed in a vertical position, filled with water, and heated at its lower end by a steam bath.

TABLE I.

	Temperature gradient (°/cm) at onset of convection		
Tube radius r(cm)	Local	Average-over-depth	Hales' $0.0014/r^4$
0.25	1.5	0.5	0.35
0.35	0.29	0.23	0.093
0.45	0.17	0.085	0.034

Temperatures and elapsed times were recorded, heat being applied at the time of first recording; and the tubes were constantly watched for signs of convection. Convection was considered observable at the first signs of motion of the inevitable small particles of impurities suspended in the water. As observed, initial convection was definitely localized, i.e., one first observed the motion of particles at the first thermocouple junction above the steam, but could observe no motion 5 cm above; motion was observed at the second thermocouple some time later. From these data, isochronal curves were plotted for 5-minute intervals, showing water temperatures *vs.* distance above steam bath; hence, both local and average-over-depth gradients could readily be determined for the instant of onset of convection.

Columns 1, 2, and 3 of Table I summarize these observations; in column 3, the depth refers to length of column of liquid above the steam bath, generally about 40 cm. Column 4 shows Hales' calculated gradients, which correspond to the radii used in these tests. Although Hales' calculated gradients are systematically less than the observed values, there is a qualitative agreement; indeed, it appears that the observed gradients can be represented as proportional to r^{-4} much better than to r^{-3} and r^{-5}. The significance of the quantitative disagreements shown by Table I is not clear at the moment.

The author is indebted to Mr. C. W. Horton, of the University of Texas, and to Dr. F. T. Rogers, Jr., for suggesting this investigation and for valuable discussions during its course.

[1] A. L. Hales, Mon. Not. Roy. Astron. Soc. Geophys. Supplement **4**, 122 (1937).

New Books

X-Rays in Practice

BY WAYNE T. SPROULL. Pp. 615, McGraw-Hill Book Company, Inc., New York, 1946. Price $6.00.

The jacket of this book declares that the contents furnish "a readable and comprehensive treatment, giving the reader a broad understanding of x-rays, their nature, and the many purposes for which they may be used." The reviewer finds this an accurate description.

This book is not intended as a treatise on any specific field in which x-rays are employed, but, rather, seeks primarily to provide the desirable background for understanding such fields, and secondarily to give introductions to each field. Of the 24 chapters, the first ten are devoted to the fundamental characteristics of x-rays and the equipment for generating them. This is followed by three chapters describing non-diffraction uses, chiefly in the medical and industrial radiology fields. Ten more chapters are concerned, directly or indirectly, with x-ray diffraction