Book Review

Advances in Nuclear Science and Technology, Vol. 7. Edited by Ernest J. Henley and Jeffery Lewins. Academic Press, New York and London (1973). $24.50.

Nuclear science and technology (or, if one prefers to keep within the nomenclature of the present journal, nuclear science and engineering) encompasses a broad interdisciplinary area corresponding to the interaction, *inter alia*, of applied mathematics; atomic, nuclear, and solid-state physics; metallurgy; inorganic and physical chemistry; and electrical and electronic engineering. This series of review volumes amply demonstrates the breadth and scope of the field.

The present volume follows the pattern of its predecessors in sampling from this scope. Of the five reviews in this volume, two are in the field of metallurgy, two cover complementary aspects of the theory of analytical solutions of the linear transport equation, and the fifth is a discussion of thermal explosion hazards.

The first review, by A. L. Bement, Jr., on radiation-induced voids in stainless steel, is an extensive presentation of both the experimental observations and the theoretical analysis of the nucleation and growth of voids. The practical aspects of the problems induced by void formation are not neglected. The microscopic question of the physics and thermodynamics of void formation is, of course, only the first step in the analysis of the problem. The importance of voids in steel lies in their influence on strength, ductility, creep, and dimensional changes in the reactor structure. Although the problem of voids has not been solved, the understanding of the phenomena involved is improving and guidelines are being defined for the metallurgical specification of alloys and treatment that will tend to minimize the deleterious effects with the potential of ultimate significant cost reduction in fuel cycles and reactor operations.

A related problem affecting long-term operation of high-temperature reactors is material transport in fast reactor fuels by thermal diffusion. In oxide fuel pins, certain fission products (cesium, zirconium, etc.) tend to migrate toward the center while oxygen can migrate toward the periphery. In addition, voids and other defects can also migrate in a temperature gradient, and the resultant redistribution of matter can produce dimensional changes and stress concentrations in the fuel pins. Bober and Schumacher give a careful review of this complex and important problem. An understanding of the processes involved must, of course, precede the development of metallurgical and compositional specifications for the fuel that can reduce or eliminate these effects.

McCormick and Kuščer's discussion of singular eigenfunction methods in neutron transport theory is an extensive review of the method and the range of problems that can be solved by its use. The method is, in general, restricted to one-dimensional problems, for which it can yield exact solutions. Some limited progress has been achieved in three dimensions, but the applicability here is limited either to the infinite medium case or to certain spherically symmetric problems that can be reduced to equivalent plane problems. Apparently the singular eigenfunction technique does not yield useful results (i.e., cannot be applied to nontrivial problems) if the geometry requires more than one coordinate and one angular variable in an essential (nonremovable) manner. However, the past 15 years have seen an extensive application and development of the method for those problems to which it is applicable. This has provided if nothing else a foundation of mathematical and physical insight into the structure of the transport equation.

M. M. R. William's complementary review of the Wiener-Hopf technique discusses particularly cylindrical and spherical geometry systems which go beyond those that can be solved by the singular eigenfunction approach. Together, the two reviews give an excellent survey of the present state of the field of exact solutions of the transport equation. Each review attempts to explain why one technique is superior to the other while still (almost grudgingly) allowing that the other has its advantages.

In the final review, Witte and Cox discuss an entirely different area of nuclear technology—thermal explosions. The rapid introduction of hot molten or solid bodies into a liquid under conditions of high heat transfer leads to the nonchemical explosive generation of vapor. (In a thermal explosion the production of gases by chemical reaction is at most of only secondary importance.) The experimental observation of the process is of necessity restricted by the short time scale involved (<1 msec), and some of the experimental techniques are still somewhat unsophisticated. The review, however, brings together a great deal of experimental data as well as the theoretical models that have been used to characterize the phenomenon. The situation is, however, extremely complicated because a large number of variables can affect the development of the explosion. The problem, according to Witte and Cox, can be compared to the status of the understanding of boiling heat transfer (with which it is, of course, connected) 20 years ago, and the authors have to admit that little is yet known about the details of the mechanical processes involved. The need for continuing efforts (and perhaps for new approaches) is, therefore, obvious.

In summary, the five reviews in this volume cover a broad range of topics, and although few readers would be interested in detail in all the articles, there is certainly something here for almost everyone. Such an evaluation is perhaps the best that can be said of any anthology.

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January 14, 1976

About the Reviewer: We again welcome Dick Cohen to our Book Review Section with these remarks on Advances. *Dr. Cohen, a member of the technical staff of the Rockwell International Science Center, is well known for his careful evaluation of basic physical constants and studies of the behavior of neutrons in various media. His graduate training was at Cal Tech. He was a recipient of a Lawrence Award in 1968.*