Book Review

Lectures on Fast Reactors. By Karl Wirtz. American Nuclear Society, La Grange Park, Illinois (1978). 307 pp. $16.00.

Course lecture notes, prepared either by a teacher or a student, play an important pedagogical function. The teacher achieves good organization for his presentation; the student learns by listening, watching, writing notes, and reading them later. Normally, however, their use is limited to a class or a school. In the case of the topic of fast reactors, the lectures by Professor Karl Wirtz of the University of Karlsruhe and the Karlsruhe Nuclear Research Center were regarded as sufficiently unique and comprehensive that they have been published.

One must resist the temptation to apply textbook standards in evaluating lecture notes. It should be realized that notes are more informal, abbreviated, and sometimes can provide more detail than would be tolerated in a text or reference. They often fill a void in the literature at a small cost for the student or reader.

Professor Wirtz covers many important topics in a series of eight chapters. He presumes the availability of his textbook *Neutron Physics*, coauthored with K. H. Beckurts. Chapter 1 deals with such basic neutron physics data as one-group cross sections, numbers of neutrons per fission, and delayed neutron constants. The only fault is that several different sets of numbers are given, in the manner of "Reactor Physics Constants" (ANL-5800), rather than a recommended set.

Chapter 2 provides a qualitative discussion of breeding, fuel types, and various cooling media. The fundamental facts about fast reactor fuel design are clearly stated. An instructive detailed calculation is presented of breeding ratio for a core plus blanket using a one-neutron-group model.

Chapter 3 deals with the multigroup-multidimensional neutronic analysis required in a fast reactor. This consists of a brief review of transport theory, leading into a matrix form of the multigroup diffusion equations. Little is said about spatial-difference-equation representations, and the author goes immediately into an outline of the computation process and a catalog of programs. This material is probably useful only as reference, however, some good illustrative graphs of fast cross sections and spectra are given.

Chapter 4 explains the application of the point reactor kinetics equations to the dynamics of the fast breeder reactor (FBR), with linear energy feedback (Fuchs model) and the Bethe-Tait model. Rather complete derivations of the approximate formulas are given along with graphs of various responses. Four techniques for accounting for spatial effects are analyzed.

Chapter 5 describes the sodium void effect in detail and indicates how to minimize it. Then the theory and practice of the Doppler effect is presented, with a tabulation of coefficients for different reactors. The temperature dependence of the Doppler coefficient is analyzed in easily understood terms.

Chapter 6 reviews the properties and phenomena involving fuel and cladding. Topics are stress and creep, temperatures, burnup, structural effects, fission gas production, and compatibility of coolant and cladding. It probably would have been desirable to show sketches of fuel pins and an assembly first rather than last.

Chapter 7 deals with the historical development of the fast reactor. The first generation included the Experimental Breeder Reactors I and II, and certain reactors abroad. The second generation included larger designs such as PHENIX in France, BN-350 in the USSR, and SNR in Germany, along with experimental reactors such as SEFOR in the U.S. Sodium test facilities are named, and the relative merits of the pool and loop concept itemized. Tabulated features of the third-generation design studies by five U.S. companies in 1969 are given, possibly in more detail than the reader would ever need.

Chapter 8, the final chapter, discusses the very interesting topics "Accidents, Safety, and Engineered Safeguards." A systematic listing of types of failure is given, with emphasis on loss of coolant and excessive reactivity. Calculations on sodium superheat are provided, and a thorough report given on six different analyses of the sodium-fuel interaction. This reader would like to know which method is best, however. The notes end with some discussion of a core catcher.

One subject area that the author does not cover is the role of the FBR in the scheme of fuel resources and economics. As an international nuclear leader, Dr. Wirtz' view on the relationship in the future of converter reactors, breeders, and even fusion and solar energy would be most appreciated.

To understand the notes, the reader must have considerable education or experience in nuclear engineering. Some of the material is found in the reactor physics texts that emphasize thermal reactors, but there is also a great deal of new information. Thus it is a valuable resource for the student and professional.

It is hoped that the author will find time to convert the notes into a textbook, updating the material to account for new developments in theory, computation, experimental measurements, and fast breeder power reactor construction.

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About the Reviewer: Ray Murray has been associated with North Carolina State University since 1950, currently as professor emeritus of nuclear engineering, and has made significant contributions to nuclear engineering education. An earlier nuclear energy activity was in the electromagnetic separation of the uranium isotopes. Dr. Murray has been very active in the American Nuclear Society over the years. His formal education was at the Universities of Nebraska, California, and Tennessee.