BOOK REVIEWS

Selection of books for review is based on the editor's opinions regarding possible reader interest and on the availability of the book to the editor. Occasional selections may include books on topics somewhat peripheral to the subject matter ordinarily considered acceptable.

Driven Magnetic Fusion Reactors

Editor	B. Brunelli
Publisher	Pergamon Press, Inc., Elmsford, New York (1979)
Pages	476
Price	$60.00
Reviewer	David M. Woodall

This book contains the written lectures of the International School of Fusion Reactor Technology course held in Erice-Trapani, Italy, on September 18-26, 1978. Entitled *Driven Magnetic Fusion Reactors*, the course followed three others in fusion reactor technology in which more conventional fusion energy devices were considered. Much of the value of the book to the fusion energy community is in the concatenation of the ideas of those lectures into a single reference. The devices and physics described in this text are not emphasized in the mainline fusion energy programs of our country or others.

The book has 20 chapters summarizing the lectures of the course and was authored by about 15 individuals. As one would expect from such a collection, the book does not read smoothly. There is a great deal of variation among chapters, with some being highly technical expositions of particular research activities, while others are more prosaic discussions of fusion reactor concepts. Nevertheless, the content is quite worthwhile for the initiate and novice alike in the fusion engineering field.

The strength of the book is in its broad perspective of concepts on the periphery of ignited-fusion research programs. The review of mirror reactors is fairly comprehensive, while that of two-component tokamaks is skimpy but adequate. The book provides a useful insight into potential alternative applications of fusion, such as fusion-fission hybrids or "fuel factories."

More of the thought contained in this text is necessary in order for us to formulate wise, long-term plans for the role of fusion plasmas in our society. The book is recommended reading for those who desire to keep abreast of the changing perspective of fusion energy as well as those who are firmly embedded in research in more conventional fusion areas. There are chapters that may be valuable to individuals needing information in a particular area, even though much of the status-of-technology portion of the text, which is about half, will soon be out of date. While the book is recommended, it is unlikely to be a valuable long-term addition to any personal library, belonging instead in a competent technical or university library.

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Nuclear Engineering for an Uncertain Future (in English)

Editors	Keichi Oshima, Yoshitsugu Mishima, and Yoshio Ando
Publisher	Plenum Press, New York (1981)
Pages	279
Price	$45.00
Reviewer	Lee M. Hively

This is the "official record" of a two-day symposium held in November 1980 in honor of the 20th anniversary of the Nuclear Engineering Department at the University of Tokyo. Contrary to the title, however, the contents are optimistic in their outlook for both fission and fusion power. Each of the seven parts consists of papers by one or two eminent American or European authors together with a companion paper by a Japanese expert, followed by a short discussion. The topics include: international cooperation, the nuclear fuel cycle, safety, fast breeders, fusion, the impact of nuclear technology on other fields, and the role of nuclear engineering education (a panel discussion). As an assessment of current issues and problems in nuclear engineering, the book would be interesting and comprehensible to a general engineering audience. Even so, there is sufficient detail to benefit nuclear specialists. While this is a good attempt to comprehensively review the above topics, the coverage is uneven, depending on the authors' interests and expertise.

The fusion discussion (Part V) would be of particular interest to *Nuclear Technology/Fusion* readers. The first paper is by Hugh Bodin (Culham Laboratory, United Kingdom) whose recent interests include reversed-field pinches (RFPs). Bodin's introduction (Sec. 1) sketches the development of fusion research over the last 20 years, then looks toward the planning of a power-producing reactor. The discussion of fusion physics (Sec. 2) includes the basic fusion reactions, bremsstrahlung loss, the Lawson criterion, magnetic confinement (tokamak, RFP, stellarator), and inertial confinement. There is a well-illustrated description of magnetohydrodynamic instabilities and a good, intuitive derivation of why the driver energy to a pellet varies as (particle density)$^{-2}$. Section 3 deals with fusion reactors and some of the technology problems (tritium-breeding lithium blankets, superconducting magnets, first wall, remote maintenance, material problems, and power supplies). Fission-fusion hybrids are mentioned in the context of mirror confinement, followed by a brief discussion of fusion's impact on the environment. The current status of magnetic confinement research (as of November 1980) is the highlight of the paper (Sec. 4). Tokamak results include work on divertors, Alcator scaling, high temperatures on Princeton Large Torus, high beta on Impurity Studies Experiment-B, pellet injection, ion-cyclotron heating on Tokamak Fontenay-aux-Roses (TFR), and neutral beam-driven currents on the Divertor and Injection Tokamak Experiment (DITE). The status of RFPs, theta pinches, stellarators, compact tori, bumpy tori, and linear mirrors is briefly summarized. The marked improvement in tandem mirror confinement is described with good illustrations of the electrostatic potential barrier results. Inertial confinement (Sec. 5) concentrates on laser fusion followed by the pros and cons of various drivers (lasers, light/heavy ions, electrons); a summary table would have greatly simplified the discussion. The tables listing the laser and beam facilities, together with the figure of various laser pellet designs, are excellent. As noted in the discussion portion, Fig. 21 (p. 176) is misleading because the laser efficiency ($\leqslant 1\%$) is not included in the diagram of (thermonuclear energy out/laser energy in) versus calendar year. There is no mention of weapons-classification issues. Section 6 turns to future research, specifically the next generation of tokamak experiments, with a good outline of their goals, time scale, participants, and cost. Bodin concludes (Sec. 7) that the large uncertainties in confinement physics, cost, and time schedules make international collaboration attractive for International Tokamak Reactor (INTOR)-size experiments.

The second fusion paper is by Taijiro Uchida (professor of nuclear engineering at the University of Tokyo), who describes the Japanese effort. Historically, Japan's fusion research began with basic studies in 1956 to 1961, and progressed to successively larger experiments in tokamaks, laser fusion, the tandem mirror, and heliotrons. The role of universities is concentrated on basic science and technology, while the national laboratories pursue development and demonstration. In pursuit of burning-plasma studies, alternate confinement approaches, and related research studies, Japan spent ~\$180 million in fiscal year 1980 (excluding salaries). There is a fine summary of the high beta and lower hybrid heating experiments on JAERI Fusion Torus-II (JFT-II), similar rf results from Japan Institute of Plasma Physics-Torus-II (JIPP-T-II), and low-Q operation on DIVertor Assembly (DIVA) with ion cyclotron resonance heating (ICRH). Notable results from several small university tokamaks are also included. Of the magnetic alternatives, stellarator results from Heliotron E and JIPP-T-II are highlighted along with brief summaries about compact tori, pinches, and tandem mirror and cusp confinement. Inertial confinement is being studied in the universities, including lasers (glass, KrF, and CO_2), relativistic electron beams, and light ion beam fusion. There is a correspondingly large theoretical effort, as well as a computing center in Institute of Plasma Physics-Nagoya University. The technology development includes a 20-MW neutral beam injector for Japanese Torus (JT-60), a 1-MW Klystron (1.7 to 2.2 GHz), superconducting magnets (e.g., an 8-T coil for the Large Coil Project at Oak Ridge National Laboratory), tritium handling, fusion materials, blanket engineering, and reactor design studies. Japan is also involved in numerous collaborations within the international fusion community on a multilateral basis (e.g., INTOR) and bilateral exchanges (United States and Soviet Union). Beyond JT-60, the Japanese are aggressively pursuing an ignition experiment with $\geqslant$100-s burn time and tritium breeding, ultimately toward a fusion power supply in the 2010s.

This is a nice summary of nuclear technology as it stood in November 1980, but the long publication lag (21 months at this writing) makes this book more of an historical snapshot than a current review. In addition, the broad overview of the research areas tends to slight the critical issues being addressed in the major confinement programs. For example, the motivations for noninductively driven currents, better impurity control, and increased beta in tokamaks are not mentioned. There is also an all-too-frequent use of unexplained abbreviations (e.g., ICRH, LHH, TH, etc.) and technical jargon (e.g., bumpy torus, Rayleigh Taylor instabilities, Raman scattering) that will baffle the nonspecialist. In spite of these deficiencies, this book is recommended to general engineers as well as nuclear specialists who want a recent and authoritative overview.

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