According to Bowie, "the problems of the immediate future in relation to the discovery of new fields do not lie in detailed petrographic or mineragraphic descriptions of host rocks and ore minerals or in classification into types depending on minor differences in mineralogical composition, temperature of formation or wall-rock alteration. Rather they should be aimed at such problems as how to recognize major uranium provinces, at obtaining more quantitative data on the environmental conditions of uranium accumulation and preservation, and at understanding the role of organic material in uranium solution and complexing." He also questions the generally accepted view that the earth's atmosphere was devoid of oxygen prior to about 2.2 billion years ago. These thought-provoking ideas led to a heated discussion by the participants.

The book contains several interesting case histories of the uranium prospectings currently in progress in various parts of the world: Meghalaya, northeastern India; uraniferous area of mainland Argentina; the Arjeplog-Arvidsjaur uranium province, Sweden; Northern Black Forest, Germany; recent volcanoes and uranium mineralizations north of Rome, Italy; southern Cape Province, South Africa; the use of remote sensing method in uranium exploration in the U.S.; and uranium prospecting of areas covered by lake waters in Canada.

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*He has been active in research in the fields of nuclear and geochemistry for many years. He is noted for his theory on the existence of natural reactors (1956) and his research on the occurrence of plutonium in the early history of the solar system. He has a list of approximately 260 publications.*

### Thermal Analysis of Liquid-Metal Fast Breeder Reactors

| | |
|---|---|
| *Authors* | Y. S. Tang, R. D. Coffield, and R. A. Markley, Jr. |
| *Publisher* | American Nuclear Society (1978) |
| *Pages* | 395 |
| *Price* | $39.65 |
| *Reviewer* | L. Bernath |

The authors have undertaken the difficult task of providing a reference text to satisfy the needs of knowledgeable engineers and to serve as an introductory text for the uninitiated. In doing so, they have fallen somewhat short of the mark. Rather, they have produced a compendium of *American* thermal analysis techniques—and, even here, they have slighted the work of domestic authors less directly involved in the Fast Test Reactor (FTR) and Clinch River Breeder Reactor (CRBR) programs. As a consequence, one cannot find a comparison of *foreign* thermal analysis methods with those employed domestically; rather, the Westinghouse, U.S. Energy Research and Development Administration-approved methodologies are presented to the virtual exclusion of all others.

Similarly, in reviewing design criteria and philosophies, detailed presentations of the FTR and CRBR designs are provided, while descriptions of reactors that have successfully operated for many years, namely, Phenix, PFR, BN-350, as well as smaller earlier plants, are either superficial or nonexistent. Thus, *unproven* design bases and techniques are presented as most desirable and most likely to be successful, with no comparison of these with results from time-tested operational fast breeder reactor systems, currently being scaled to commercial plant designs. Thus, the British CFR and French-German Superphenix are not even mentioned! As a consequence of the myopic view, we find in Fig. 1-3 a "Diagram of an LMFBR Power Plant" that is specifically the CRBR Plant and atypical of plant designs much farther along toward commercialization. Specific nontypical features of the CRBR include: recirculation steam generators, relatively low steam turbine throttle conditions, and the "hockey-stick" design of superheaters and steam generators.

This text suffers from several technical flaws, e.g.,

1. Chapter 1 is a "sales pitch" for the liquid-metal fast breeder reactor; the comparison in Table 1-I utilizes obsolete information for the helium-cooled breeder. (More accurate data appear in CONF-74050 by the U.S. Atomic Energy Commission.)

2. Lithium-8 is identified as the primary activation product of concern with lithium coolant; it dissociates almost instantaneously into helium atoms.

3. It is stated (p. 11) that fast reactor control system response is "required" to be more rapid than for thermal reactors. Such a statement is not strictly accurate and is misleading. Speed of response requirements depends on the *margin* between limitations on operational or safety parameters and the full-power value of that parameter. Thus, for a "fast" system with wide margin, the control system response required may be significantly less stringent than for a "slower" system with a very small margin.

4. The description of core-restraint concepts assumes that the reader possesses a working knowledge of "steel swelling" phenomena (not described) and is aware of the sensitivity of fast reactor stability to fuel motion effects (also not described). Hence, the reasons for core restraint remain a mystery to the "uninitiated" reader.

5. Fuel-cladding chemical interaction in blanket rods may be more serious than implied on p. 51, due to the presence of excess oxygen which, in the core fuel, can be avoided by specifying a reduced oxygen-to-metal ratio, but cannot be avoided with pure $UO_2$.

It also suffers from editorial inconsistencies and oversights, such as:

1. Inconsistent designation of references in early chapters, both superscripts and parenthetical.

2. In Table 2-III, the entries for "sodium velocity" encroach on "reactor outlet temperature"; the note—(free stream)—should be below the numerical values, not above, and the definition of "free stream" should be provided in a footnote.

3. Inconsistent temperature equivalents, e.g., 1200F (649C), not (650C), and "1400F" = "760C," not "762C."

4. Equation 1.5 should have brackets around the fission mass terms in the denominator. Note: I have *not* verified the accuracy of every equation throughout the text!

5. Inconsistent terminology: Table 1-VI lists reactors of the "LOOP" type—the text refers to them as "pipe" designs. The established literature has long settled upon the terms LOOP and "POOL"; why have the authors departed from accepted usage? Also, the authors use "fuel assemblies," "bundles," and "element bundle" interchangeably, and also "fuel pins," "rods," and "elements"—sloppy!

6. On p. 79: Thermal design limit "9" is very poorly stated: "Leakage flows around the reactor vessel."

7. Westinghouse authors cited as references are identified by name, non-Westinghouse only by number!

In summary, my assessment of this textbook is that it is probably most useful as a handbook for CRBR designers; it may also find application as a college text (senior undergraduate or first-year graduate level) for illustrative purposes. However, for the latter, lecturers must caution students that it is not an authoritative, all-encompassing treatment of the subject.

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