

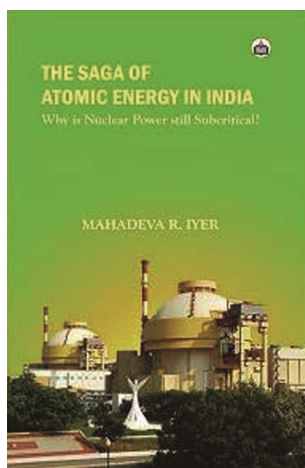
BOOK REVIEWS

general approach as an umbrella concept is good overall in this chapter. It has touched most of the basic procedures, as well as principles of the current day experimental protocols for vaccine and drug development processes.

The book is a concise and valuable contribution towards different aspects of drug design and development. The combination of computational approach and experimental model system makes the book interesting and stimulates further reading.

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The Saga of Atomic Energy in India – Why is Nuclear Power still Subcritical?
Mahadeva R. Iyer. Authorspress, Q-2A Hauz Khas Enclave, New Delhi 110 016, India. 2020. 396 pages. Price: Rs 1575.

This book offers the reader an insider's glimpse of how India's nuclear establishment has evolved and progressed over the past six decades during which the author (Mahadeva R. Iyer) played a key part. The book is unique for its flowing English and focuses on the extensive work that went into making India a comprehensive nuclear power. While many authors have written books on India's nuclear industry, they were more of a description or total criti-

cism. Iyer has brought out both the efforts made and positive outcomes in the saga of atomic energy in India, while pointing out some corrective actions in a constructive manner. The external environment that impacted this national enterprise, mostly adversely, has been brought out lucidly in the book. He has dwelt at length on the growth of atomic energy right from 1944 with the establishment of the Tata Institute of Fundamental Research by Homi Bhabha and later with the setting up of the Atomic Energy Commission in 1949, thanks to the excellent camaraderie between Bhabha and India's first Prime Minister Jawaharlal Nehru.

Iyer's narration is like a story. He explains how the period up to 1974 was a golden one in which India developed indigenous capability to design, construct and operate pressurized heavy water reactors (PHWR), in fuel design, fabrication, reprocessing and waste management. The 1974 Pokhran blast isolated India from all countries, including France and Canada which were cooperating with our nuclear programme. No doubt, the Pokhran blast made the world recognize India as a respectable nuclear power. However, its ramifications were far-fetched. The PHWR construction programmes got delayed due to non-availability of the on-load fuelling machine from Canada. The fuelling machine had already been fabricated in Canada and was ready for shipping to India, but was halted due to international pressure. Iyer describes how the international sanctions provided the drive to rapid indigenization and all PHWRs after the second reactor at Kota were fully indigenous. Pokhran also affected the fast reactor programme, wherein France refused to supply enriched uranium for the core of the fast breeder test reactor (FBTR). Again, this motivated us to develop plutonium-based carbide fuel which was used in a reactor for the first time in the world and successfully operated for more than 20 years without fuel failures.

Iyer describes the three-stage power programme conceived by Bhabha and taken further by Vikram Sarabhai. The irradiation of thorium in PHWRs to convert it to U-233 which is a fissile fuel, its reprocessing at Kalpakkam and its fuelling the KAMINI reactor have been well brought out. Iyer, however, indicates that this experience itself is not sufficient to assume that we have mastered the thorium technology and could go to the third stage of U-233–Th-232 reactors as conceived.

Iyer has allayed the fear of radiation by comparing actual doses received at the boundary of different operating nuclear reactors with natural radiation and those received for medical diagnostics. He shows that the people around nuclear power plants get one-tenth of the natural radiation levels already existing in the absence of the plant. Medical diagnostics, which is essential, needs higher levels of radiation dose. This should be an eye-opener for the public.

Though the Advanced Heavy Water Reactor (AHWR) was conceived at Bhabha Atomic Research Centre (BARC), some new concepts like Advanced Thorium Breeder Reactor (ATBR) are being talked about. Nowadays, this project is not discussed much and also not included in the power profile of the country. Possibly the reason for the delay in the project could be the ready availability of infrastructure and supply of the seed materials of Pu-239 and U-233.

On the fast reactor front, Iyer highlights the continuing delays in the commissioning of the prototype fast breeder reactor (PFBR) at Kalpakkam. This was a totally indigenous effort with vetting of the conceptual design by French and Russian nuclear agencies. The problems at site relate to some of the equipment. Such problems are inevitable with total indigenization. However, Iyer mentions that we should have opted for international collaboration in the manufacture of equipment. He says that the civilian nuclear deal with the US should have included fast reactors as well. On the availability of plutonium (Pu), Iyer points out that 'the initial Pu seed needed for the fast reactor has to come out of the use of domestic uranium in PHWR reactors since the fast reactors are expected to be out of the ambit of IAEA Safeguards as per the current GoI policy. It is reported that the first feed of Pu fuel necessary for PFBR is available'. The reprocessing programme is invariably intertwined with the strategic programmes and it is not possible to discuss Pu resources for fast reactors.

Here the present reviewer begs to differ. We were able to assimilate the PHWR technology with building a series of reactors. In the case of fast reactors we started with a French design, but manufactured all the necessary components indigenously. Since the components required for PFBR are large in size, the manufacturing had to overcome many obstacles. We become aware of several problems only when we commission and operate a nuclear plant.

But these should not deter us from going ahead with the FBR on our own. FBRs are needed for India to effectively use the uranium resources. PHWRs burn only 0.7% U-235, while FBRs can convert 99.3% U-238 to fissile Pu-239 and produce fuel for PHWRs. If the PFBR sanction had come by 1990 when the conceptual design report was ready, the firms involved in the manufacture of FBTR would have got involved with PFBR. With delays in sanctions and orders for components, the experienced manpower in Department of Atomic Energy (DAE) and industries superannuate, and the new sets of people start again from scratch. Technology management has been affected by the lack of clear Government policies. Unlike fossil-fired or renewable energy systems for which we have vendors throughout the world, for nuclear power we have to depend on local industries and unless they get substantial orders, it costs more to develop new technologies for just one component.

On the pressurized water reactors (PWR), Iyer mentions that though we have imported the Koodankulam reactors from Russia, all-out efforts must be made to build upon the design of a similar reactor for the naval submarine. This can be done in a reasonable amount of time. However, it will need a huge enrichment facility.

Iyer also stresses on the importance of strictly enforcing the regulatory norms: 'strict enforcement is possible only if the

regulator is armed with sufficient powers'. To the best of the present reviewer's knowledge, the Atomic Energy Regulatory Board (AERB) has acted with determination all these years, though it was under DAE. The Silver jubilee book of AERB (<https://www.aerb.gov.in/english/publications/silver-jubilee-book>) has brought out the fact that the regulation of nuclear power plants and radiation facilities has been very effective.

According to Iyer 'Some 14 years after conclusion of the Indo-US nuclear deal, the euphoria over nuclear power coming of age in India has all but evaporated'. He has also expressed concern over the denial of entry to India to the Nuclear Supplier Group (NSG): 'it would have completed the process of opening up the Indian nuclear industry and have complemented the two nuclear landmarks, viz., India-USA Nuclear Agreement of 2006 and the India specific IAEA Agreement of 2008.' It may be noted that the Westinghouse Company having gone bankrupt, and delays in the European Power Reactor (EPR) construction and issues in France have worsened the situation.

Though Iyer does not mince words at the different types of technology for power production, to a reader it is clear that there are too many eggs in DAE's basket, viz. PHWR, FBR, PWR, AHWR, molten salt breeder, Compact High Temperature Reactor, Accelerator driven systems and fusion.

DAE should concentrate on establishing good coordination between R&D centres and manufacturing industries to continue with PHWRs and FBRs. Also, metal fuel development which is key to higher breeding in FBRs must be given a thrust.

One point that Iyer has not touched upon is the organizational structure of DAE. The present reviewer feels that there should be better cohesion between the R&D centres, and compartmentalization and duplication must be avoided. Areas of research which are being undertaken by other laboratories need not be considered by DAE.

There needs to be an embargo on announcing ambitious targets of nuclear power production, knowing fully well the ground realities. This according to the present reviewer has caused some embarrassment to the scientists at DAE.

In conclusion, this book could be a source of information to the common man and the administrators on what has gone by and what is going on in the field of atomic energy in India. Hope the Government would make use of Mahadeva Iyer's suggestions to speed up the nuclear power programme without affecting the strategic needs of the country.

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Announcement

It is with deep regret and profound sadness that we announce the passing away of G. Madhavan, Executive Secretary of the Current Science Association and former Executive Secretary of the Indian Academy of Sciences, Bangalore, on 1 March 2022. An obituary note will appear in the journal later.

—Editors

