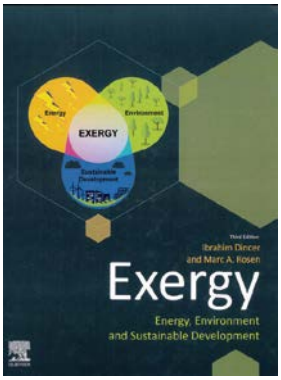

Exergy: Energy, Environment and Sustainable Development, Third Edition. Ibrahim Dincer and Marc A. Rosen. Elsevier, Radarweg 29, P.O. Box 211, 1000 AE Amsterdam, The Netherlands. 2021. xx + 703 pages. Price: US$ 165.

It has become a cliché to state that human development in the past two centuries has been resting on the ability to transform various forms of (stored) energy into useful work. Indeed, Carnot and Gibbs, in classical thermodynamics (in the late 19th century), made references to the notion of useful work through their respective terms of 'work extracted' or 'work obtainable'. Although many researchers on thermodynamics alluded to this concept during working on the concept of entropy and the second law of thermodynamics, the term 'exergy' was eventually suggested in the 1950s by a Slovenian scientist Zoran Rant. He used it to denote 'technical working capacity'. It has taken 50 years for this term to be widely adopted and accepted in the field. The modern definition of exergy is as follows: 'The exergy of a thermodynamic system S in a certain state S_A is the maximum theoretical useful work obtained if S is brought into thermodynamic equilibrium with the environment by means of ideal processes in which the system interacts only with this environment'.

This book by Dincer and Rosen is now in its third edition with enhanced chapters.

Given the importance of the topic, there are several books that cover the essentials of exergy analysis in a number of sectors/domains, including refrigeration to thermal plant analysis and issues related to economics as well as broader environmental and sustainability challenges. To their credit, the authors have been able to bring all of this together in a single book. They have refined their presentation of the material in multiple editions. This book is clearly meant to not only introduce the reader to the subject, but also to serve as a reference resource. It is targeted towards senior undergraduate and graduate students as well as practitioners working in energy systems.

The book can be divided into three broad sections. The first section containing five chapters is devoted to providing a sound introduction. The second section covers exergy analysis for various systems and processes (specifically for the industry) and all the relevant applications. This second section consists of 14 chapters and forms the 'heart' of the book. The third and last section covers broader issues such as economics, large-scale systems for countries/regions, life-cycle assessments, industrial ecology and its application to energy policy-making. This makes the treatment of the subject comprehensive and useful to the student interested in the theory, as well as the practitioner who is interested in specific applications/problems encountered in real life. The authors provide ample references to help the readers access more details on specific topics if they choose to explore them. The book is replete with case studies and problems – thus providing the reader with adequate material and opportunity to absorb the topic in depth.

The first few chapters provide a brief introduction just enough to refresh the reader's memory on the fundamental principles and concepts of energy, entropy and thermodynamics. This section is clearly for those who are familiar with the concepts being described. Readers who are just being introduced to these concepts should look up introductory books in thermodynamics, where they are explained and explored in more detail. The authors also cover the essentials of chemical exergy given its importance in a number of industrial systems such as gas turbines, fuel cells and petrochemical processing, to name a few. Chemical exergy analysis is important for any process where chemical reactions are central. Given its importance, coverage of environmental concerns is aptly done. The first section concludes with a chapter on the use of exergy techniques by the industry for various systems and processes, and in activities such as design and optimization.

The second section describes exergy analysis for several processes, namely psychrometric processes, refrigeration and heat pumps, absorption cooling, thermal storage, drying, renewable energy systems, steam power plants, cogeneration and district energy, cryogenics and liquefaction, trigeneration and multigeneration, crude-oil distillation, hydrogen production, fuel cells and aircraft systems. As can be seen, this is a fairly exhaustive and comprehensive list of industrial processes.

The Intergovernmental Panel on Climate Change has mentioned in its latest report (AR-6) that human activities, especially the burning of fossil fuels, have led to warming of the earth's atmosphere, ocean and land. It further documents that this warming has contributed to weather changes and climate extremes. At the recent Conference of Parties (COP 2021) in Glasgow, UK, there was a broad agreement that global warming should be kept below 1.5°C and that all countries should work towards cutting their emissions to achieve this target. In practical aspects, this would mean the need to not only maximize the energy extracted from fossil fuels in the short term, but also work towards discontinuing the use of fossil fuels as a source of energy in the long term. It also means the increased use of renewable energy in industrial processes, residential and commercial establishments, and transportation.

Given this background, a chapter in the second section that stands out is the one covering renewable energy systems (solar photovoltaic, solar ponds, wind, geothermal, biomass and ocean thermal energy conversion). While the book covers solar ponds in relative detail, it is unfortunate that the chapter does not deal with solar–thermal systems (parabolic troughs or solar dishes or solar towers), which are being studied with great interest in the world today. The chapters that are also relevant for fossil fuel-free transition are the ones covering the analysis of hydrogen-production systems and fuel-cell systems. In the hydrogen-production section, electrolysis is limited to electricity generated through thermal systems rather than the currently considered renewable energy sources such as solar, wind and hydropower. However, this aspect of renewable energy use for the production of hydrogen is covered later in the chapter on exergy life-cycle assessment. That said, this book provides a good starting point and serves as a reference resource for the practitioners and students, of recent developments in technology to perform exergy analysis of the emerging systems.

The third section of the book provides a more macro and recent view of the subject with an eye on increasing environmental and economic concerns. The chapters are appropriate and important for the energy-modeller to examine energy efficiency, resource utilization, environmental aspects and development of effective solutions in a

decarbonizing world. The chapters cover sectoral and regional analysis, exergetic life-cycle assessment, exergy and industrial ecology, exergy and multi-objective optimization, and exergy in policy development and education. The sectors under consideration are residential, commercial, industrial and transportation – which form a large fraction of the energy-use sector. The regional comparisons are only between USA and Canada. The Indian researchers might want to take this up as a challenge and as a topic of study to develop similar results for the country. This aspect is important considering our commitments to the Paris Accord and is also in line with the National Mission on Enhanced Energy Efficiency. In the chapter on exergetic life-cycle assessments, it was a pleasant surprise to find aspects related to exergy as well as economic efficiencies and environmental impacts from substituting fossil fuels with renewable energy sources. As also the mention of hydrogen as a fuel, which has garnered significant attention in the past year with the establishment of the Hydrogen Mission. Interesting results on the possible benefits (for Canada) are presented. Given the increasing interest in the concept of circular economy, the chapter on industrial ecology provides the basis for examining the reuse and recycle of industrial waste streams. The chapter on exergy in policy development and education is motivated by the fact that the public is often confused when discussing energy and that people need to be aware of the basic concepts of exergy. The authors argue that similar to the concepts of the second law, entropy and enthalpy, exergy needs to be introduced to all technical personnel.

There is no doubt that exergy analysis is an important and necessary subject of study for anyone interested in energy systems, energy modelling, industrial processes and sustainable development. This book must be on the shelves of most libraries catering to the engineering and technology field. The practitioners might want to keep a copy of the same on their shelves as well.

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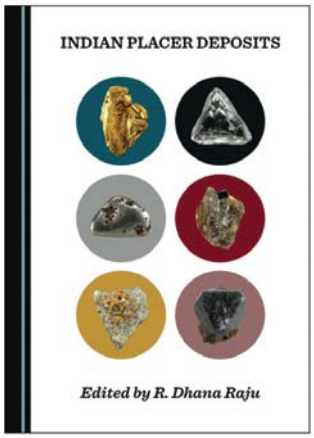

Indian Placer Deposits. R. Dhana Raju (ed.). Cambridge Scholars Publishing, Lady Stephenson Library, Newcastle upon Tyne, NE6 2PA, UK. 2021. xxxv + 621 pages. Price: £95.99.

Amongst diverse types of mineral deposits, the 'placer deposits' have the following unique attributes. They (i) are economically important, mechanical, secondary, present or past accumulations/denudations of chemically resistant, stable, inert, hard, heavy minerals with specific gravity of >2.89; (ii) are separated from light minerals by weathering and erosion of diverse geologic source materials; (iii) are transported by moving water and/or air, based on natural gravity; (iv) are deposited for profit in an aquatic and aeolian regime; (v) have been mined since metals were first used by humans; (vi) are mostly of the Phanerozoic age (<542 million years (Ma)) and rarely of older ages (Palaeo-placers); (vii) are formed predominantly in the Cenozoic (<65 Ma), derived from the Mesozoic (<251 Ma) and older primary mineralizations, disseminations, regional background levels and lithified intermediate sources; (viii) occur worldwide at all elevations and at most latitudes, though majority is generally confined to the tropical and subtropical belts and, hence, economically important deposits occur in Australia, India, Brazil, Sri Lanka, Malaysia, Thailand, Myanmar, Vietnam, Mozambique, Sierra Leone, Madagascar, South Africa and Southeast USA; (ix) host many diverse precious, semi-precious, industrial and high-tech heavy minerals and metals, which include gold, platinum and other gemstones, magnetite, ilmenite, rutile, zircon, monazite, xenotime, chromite, cassiterite, columbite–tantalite, sillimanite, garnet, etc. (x) have yielded historically a significant part of the world's total supply of gold, platinum, tin and diamonds; (xi) are presently the source of most of the world's titanium; (xii) have a wide spectrum of mineralization, including precious, semi-precious, industrial, strategic and critical minerals required for the ornamental, conventional, high-tech and cutting-edge technologies-based industries; (xiii) are easy and less costly to mine, mostly by surface and open-pit mining, as they occur at very shallow depth either at the surface or near-surface; (xiv) have diverse controls, such as the source-rock geology, disintegration of minerals, resistance to weathering, transportation media, gradient, density difference, favourable locales, geomorphology, different environments of lacustrine, fluvial, beach, dune, marginal marine, marine and glacial waves and long-shore currents and (xv) have minerals and metals ranging widely in cost from a few hundred US dollars per tonne (e.g. ilmenite, sillimanite and garnet) to a few thousand US dollars per ounce (31.1 g of gold) and carat (200 mg of diamond).

This book has 11 chapters, followed by an eight-page subject index. In chapter 1, Dhana Raju presents an overview of the placers of gold, platinum, diamond and other gemstones; tin, rare metals, rare earths and heavy mineral sand (HMS) deposits, encompassing the historical–economic aspects of placers, their provenance rocks, exploration, mining and post-mining operations. In chapter 2, Sangurmath deals with the primary supergene lateritic and placer gold occurrences, prospects and 42 micro-mines opened up by the ancient/modern artisanal miners over an area of ~1200 km^2 in the Wayanad–Nilambur sector, Kerala, within the granulitic terrain of southwest India. These have been known for over two centuries and are the earliest ones explored for gold in India. In chapter 3, Satyanarayana *et al*. present an account of India's inland diamond placer and primary deposits/occurrences, their source/host-rocks, geology, geomorphology, distribution, exploration, mining and processing at Majhgawan, the country's only plant for diamonds, and resources, besides India's pre-eminent position in the world from the pre-historic times for diamonds and their trading as also some world-famous diamonds, such as the *Koh-i-Noor*. Ramesh Babu presents in chapter 4 a detailed account of the eluvial, deluvial, colluvial and alluvial rare metal (RM: Nb–Ta, Be, Li and Cs) placer deposits, associated with the primary mineralized source rocks – zoned rare metal and rare earth (RMRE) granite