

remediation of contaminate ground water. Chapter 8 covers water-quality processes in oceans and estuaries, with particular emphasis on the design and operation of domestic wastewater outfalls, and water-quality control in estuaries as they relate to the physical, chemical, and biological conditions in the estuary. Chapter 9 covers water-quality-based watershed management where the primary focus is on estimating the contaminant loading on receiving waters from activities within the watershed. Detailed attention is given to sources of pollution and fate and transport processes associated with urban and agricultural watersheds. Atmospheric loading on natural waters due to airshed activities is also covered."

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**Resource Recovery and Recycling from Metallurgical Wastes, S. Ramachandra Rao. Elsevier, Amsterdam, The Netherlands (2006). 580 pp., Price: US\$ 150.00, ISBN: 0-08-045131-4**

In the evolving world of pollution control, the current "hot topic" is sustainability, one facet of which is resource recovery from waste materials. In this book, Rao addresses that topic, focusing "... on metallurgical wastes, different sources where they occur, what they contain, which marketable materials can be recovered and the quantity of waste reduced, and the physical, chemical, biological and high temperature techniques used to achieve the objective."

Rao succinctly outlines the book's content in the preface, writing as follows: "An introductory chapter is followed by a chapter devoted to techniques of waste characterization. The next four chapters of the book describe the principles of various techniques and processes used in recycling and resource recovery. The next five chapters discuss the subject under specific topics each focusing on recycling and resource recovery from specific class of metallurgical waste. The last chapter discusses some of the newly developed and currently developing technologies, some of which may be successfully adopted for industrial use in future years."

The chapters are as follows:

1. Introduction
2. Waste characterization
3. Physical and physico-chemical processes

4. Hydrometallurgical processes
5. Biotechnological processes
6. Pyrometallurgical processes
7. Metal recycling
8. Metallurgical slags, dust and fumes
9. By-product processing and utilization
10. Resource recovery from process wastes
11. Recycling of water and reagents

The material provided by the author is explained in great detail and it appears (to this reader who is not a metallurgist) to be comprehensive covering virtually every metallurgical waste source. To illustrate my point, I will briefly describe the material in the Resource Recovery from Process Wastes chapter. In this chapter, the author has the following six sections, each of which has from 2 to 13 subsections. These subsections are by title: (1) Mineral process tailings, (2) Metallurgical effluents and residues, (3) Recovery of metal concentrates from waste sludges, (4) Solid wastes, (5) Resource recovery from discarded batteries, and (6) Metal recovery from spent petroleum catalysts.

Two chapters (discussed below) were of considerable interest to me personally as I am a biochemical/environmental engineer. The first chapter discusses biotechnological processes. To say the least, I was surprised to see this topic covered in a metallurgy text. The chapter was well written and one in which Rao discusses bacteria and bacterial processes including the description of bacterial morphology and growth. The rationale for the chapter in this book is that biomass can be used to recover metals.

The second of these chapters deals with water and its reuse. Removal of dissolved metals is not unexpectedly discussed. Adsorption on activated carbon and clay minerals as well as biosorption is briefly discussed. Ion exchange, removal by membranes, complexation, precipitate flotation and anaerobic treatment are among a host of other metal removal processes mentioned, albeit briefly. References are given for the interested reader who wishes more detail. Indeed, the author cites more than 700 articles in the reference section at the end of the book.

I must commend the author on his writing of this book. He has written an excellent, detailed technical treatise that comprehensively covers this topic. The book will be utilized, I am sure, for many years by professionals in the field.

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