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Book Review

BIOREMEDIATION AND SUSTAINABILITY

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Bioremediation consists in a fast growing and promising set of remediation techniques increasingly studied and applied in practical use for environmental clean-up. As a low cost alternative to conventional methods for treating wastes and contaminated media, bioremediation offers the possibility to degrade these contaminats using natural microbial activity mediated by different consortia of microbes. On the other hand, the development of environmental management is promoted by sustainable development, which constantly promotes green technologies to treat a wide range of aquatic and terrestrial habitats contaminated due to anthropogenic activities with the main sources of contaminants.

In this context, the book *Bioremediation and Sustainability* edited by Romeela Mohee and Ackmez Mudhoo provides a thorough inside into the the most cost-effective techniques in bioremediation technologies and the most cutting-edge research on bioremediation and its applications and discusses the sustainability paradigm and the role of "green" bioremediation technologies in environmental science.

The book comprises ten chapters, each of them dealing with different aspects of bioremediation and sustainability. An up-to-date and comprehensive treatment of research and applications for some of the most important low-cost, "green", emerging technologies in chemical and environmental engineering is provided.

Chapter 1, *Elements of Sustainability and Bioremediation*, by Ackmez Mudhoo and Romeela Mohee is an introductory one and deals with the essential features of sustainability and the various *in situ* and *ex situ* bioremediation techniques. This chapter also provides groundwork for the subsequent chapters dealing with bioremediation, such as anaerobic digestion biotechnology, air-sparging, vermistabilization, bioleaching, biobleaching, and many others.

Chapter 2, *Natural Attenuation*, by R. Ryan Dupont, details quantitative methods that can be used to document contaminant natural attenuation rates, site assimilative capacity, source area and plume lifetimes, and the connections between natural attenuation assessments and more proactive source area remediation technologies. In line with the definition of sustainable remediation technologies, the natural attenuation approach acknowledges the potential of natural systems to assimilate a wide range of contaminants released from human activity without human intervention, excessive energy and resource expenditure.

Chapter 3, *Anaerobic Digestion Processes*, by Steven I. Safferman, Dana M. Kirk, Louis L. Faivor and Wei Wu-Haan provides fundamentals on the anerobic digestion. A review of the microbiology involved with anaerobic digestion is discussed. The objectives for the use of an anaerobic digester, including the generation of renewable energy, high strength waste management problems, nuisance avoidance and nutrient management plan are provided in detail in this chapter, although an anaerobic digester is often installed to fulfill a combination of

the above objectives. Included is research on the hydrolysis step, co-feedstocks, modeling, engineering, design, policy, and management.

Chapter 4, *Biosurfactants: Synthesis, Properties and Applications in Environmental Bioremediation*, by Ramkrishna Sen, Ackmez Mudhoo and Gunaseelan D., deals with the enzymatic synthesis of surfactants, aspects of biosynthesis and genetics of microbial surfactants. Properties and the role of biosurfactants in bioremediation are also discussed in detail. The above discussed aspects bear clear evidence that bioremediation coupled with the use of biosurfactants enhances the biodegradation of a variety of environmental pollutants. The results showed in this chaper proved the effectiveness of biosurfactants in improving contaminant biodegradation.

Chapter 5, *Phytoremediation: an Efficient Approach for Bioremediation of Organic and Metallic Ions Pollutants*, by Divya Gupta, Lalit Kumar Singh, Ashish Deep Gupta and Vikash Babu, focuses on the strategies used by the plants to remove inorganic/organic pollutant from surroundings. This chapter also discusses the types of phytotechnologies. The authors emphasized that phytoremediation, a substitute of physical and chemical methods is a newly evolving tract of soil remediation through biological means which utilizes different types of strategies to remove pollutant from soil.

Chapter 6, *Bioleaching*, by Leo G. Leduc and Garry D. Ferroni, provides a brief overview of bioleaching with an emphasis on pyretic ores. Several topics are examined: a) the mechanisms of bioleaching, b) the strategies of bioleaching, c) the microorganisms of bioleaching, d) factors affecting bioleaching and e) environmental considerations. As mentioned by the authors in this chapter, the bacterium *Acidithiobacillus ferrooxidans* dominates the process in pyrite-containing ore deposits because of its unique physiology. In addition, specific supplementary information is provided on uranium bioleaching.

Chapter 7, *Biosorption of Heavy Metals – New Perspectives*, by Teresa Tavares and Hugo Figueiredo, is devoted to biosorption as an integrated system, associating metal entrapment, biological chemical reduction, ion exchange and environmental oxidation catalysis in liquid and in gas phase. A special attention is paid to hexavalent chromium as it is usually present in the anionic status, making uninteresting for ion-exchange in zeolites, the biomass supports herein presented. This chapter aims at discussing on how to enlarge the applications of biosorption in an integrated and sustainable procedure, indicating new ways of using microorganisms able to sorb as well as to change the chemical nature of metal ions, of using cationic ion-exchangers to retain original negative ions and of raising the market value of industrial residues by substitution of very expensive environmetal catalysts.

Chapter 8, *Biofiltration: Essentials, Research and Applications*, by Smita Raghuvanshi, Subhajit Majumder and Suresh Gupta, deals with the biofiltration studies for the removal of VOCs from air and metal ions from water. The chapter discusses the potential of microorganisms in consuming VOCs as carbon source. This makes biodegradation and biofiltration an attractive option for the removal of pollutants from gaseous and liquid waste streams. The essential factors for the development of the biofiltration and the effect of various parameters such as time, flow rate, shock loads and bed heigh are also discussed. A very detailed study on research status of biofiltration for removal of VOCs, ammonia and hydrogen sulphide is given. Another research status on the upcoming field for the removal of toxic metal ions using biofiltration and the mechanism for the removal of organic and inorganic pollutants are also discussed.

Chapter 9, *Modeling and Implementation of Sustainable Remediation Based on Bioventing*, by Hillel Rubin, Eran Rubin and Holger Schüttrumpf, focuses on bioventing which is an *in situ* remediation technology applied to the unsaturated zone, and which uses indigenous microorganisms to biodegrade organic species adsorbed on soil particles in the vadose (unsaturated) zone. The authors discuss the basic features of sustainable remediation based on bioventing. This chapter concerns the analysis, design and implementation of bioventing remediation alternative. Moreover, the authors present the sustainable bioventing remediation as the outcome of the balance among 4 domains and 3 steps of technological evaluations whether bioventing is the method that best fits for the remediation of the particular site.

Chapter 10, *Bioremediation of Xenobiotics*, by Komal Saxena, Gajendra Kumar Aseri, Arish Deep Gupta and Vikash Babu, discusses of bioremediation as a better approach for the remediation of xenobiotc compounds from the environment due to a low operational cost, no need of excavation and requirement of little energy input for the remediation process. The authors provide details on types of bioremediation, methods for the bioremediation of xenobiotic compounds, bioreactors used for the bioremediation of xenobiotic compounds, metabolic pathways and bioremediation of various classes of xenobiotic compounds.

To conclude, the book offers solutions on the most cost-effective techniques in bioremediation technologies. The sustainability paradigm and the role of green bioremediation technologies in environmental science are also discussed. This groundbreaking volume constitutes a valuable resource for the experienced engineer or scientist working in the field.

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