

Anaerobic Biotechnology for Bioenergy Production: Principles and Applications

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Chapter 1 presents an overview of anaerobic fermentation, including definitions, biochemical reactions, major considerations in an anaerobic system, benefits, limitations, and calculations of the energy generation from various feedstocks. Chapter 2 covers the common metabolic stages of the anaerobic fermentation of organics and microbiological processes, and aims to provide readers with the necessary basics of microbiology, biochemistry and stoichiometry involved in an anaerobic system. Chapter 3 focuses on the effect of environmental factors such as temperature, pH, nutrients, and toxicity on the growth of key microbial groups involved in bioenergy production. Chapter 4 describes the biokinetics of anaerobic systems and application of mathematical modeling (e.g. anaerobic digestion model 1 (ADM1)) as a tool in design, operation and optimization of anaerobic processes for bioenergy production. Chapter 5 covers bioreactor configurations and growth systems (e.g., attached, granular and suspended) used in anaerobic processes. Appropriate reactor selection and design for bioenergy production are also addressed.

The modern molecular techniques in anaerobic fermentation and their application for the generation of methane, hydrogen, ethanol and butanol are presented in Chapter 6. Chapter 7 outlines the selection of a suitable reactor design and operating conditions for bioenergy production from a sulfate-rich feedstock without sulfide inhibition. Strategies for sulfide control by converting aqueous and gaseous sulfides to elemental sulfur are also discussed. The next chapter covers bioenergy production from residues of emerging biofuel industries, including feedstocks, biofuel production processes from these feedstocks, stillage and glycerin generation, and anaerobic digestion of these residues. Also covered are water reclamation/reuse and biosolids disposal issues in biofuel industries. Chapter 9 describes the fundamentals of fermentative hydrogen production, including the hydrogen production pathway, strategies of obtaining enriched cultures, factors affecting hydrogen yield, process engineering, and microbiology. In addition, the concept of a bio-electrochemical-based microbial reactor for hydrogen production is also covered. The focus of Chapter 10 is development of the microbial fuel cell (MFC), with emphasis on principles, stoichiometry, energetics, microbiology, design, and operation. Different pretreatment technologies to enhance hydrolysis of high solids feedstocks are discussed in Chapter 11. The last chapter provides an overview of digester gas production from various feedstocks along with a discussion of the cleaning requirements and energy use options.