

Preface

Today's world faces three critical problems: (1) high fuel prices, (2) climatic changes, and (3) air pollution. Experts suggest that current oil and gas reserves are only sufficient to last a few more decades. It is well-known that transport is almost totally dependent on fossil fuels, particularly petroleum-based fuels such as gasoline, diesel fuel, liquefied petroleum gas, and compressed natural gas. Petroleum-based fuels are well-established products that have served industry and consumers for more than one hundred years, and for the foreseeable future, automotive fuels will still be largely based on liquid hydrocarbons. However, time is running out and petroleum, once considered inexhaustible, is now being depleted at a rapid rate. As the amount of available petroleum decreases, the need for alternate technologies to produce liquid fuels that could potentially help prolong the liquid fuels culture and mitigate the forthcoming effects of the shortage of transportation fuels increases. There are several reasons for biofuels to be considered as relevant technologies by both developing and industrialized countries. They include energy security reasons, environmental concerns, foreign exchange savings, and socioeconomic issues related to the rural sectors of all countries in the world.

This book discusses the production, storage, transportation, usage, economy, policy, and environmental impacts of biohydrogen. Biohydrogen is a replacement for fossil and biorenewable liquid fuels. In this book, the modern biomass-based transportation fuels bioethanol, biomethanol, biodiesel, bio-oil, biogas, and biohydrogen are briefly reviewed. Biomass conversion technologies are important for obtaining biofuels such as bioethanol, biodiesel, bio-oil, and biohydrogen.

A comprehensive definition of biohydrogen is hydrogen produced chemically, thermochemically, biologically, biochemically, and biophotolytically from all biomass materials. Biohydrogen is a renewable biofuel produced from biorenewable feedstocks by chemical, thermochemical, biological, biochemical, and biophotolytical methods. Biohydrogen is an environmentally friendly alternative automotive fuel that can be used in an internal combustion engine.

Hydrogen can be produced from biorenewable feedstocks via thermochemical conversion processes such as pyrolysis, gasification, steam gasification, steam reforming of bio-oils, and supercritical water gasification (SWG) of biomass. Hydrogen can also be produced by renewable biological systems. For example, there are three types of microorganisms that generate hydrogen: cyanobacteria, anaerobic bacteria, and fermentative bacteria.

The hydrogen economy is a vision for a future in which hydrogen replaces fossil fuels. Economically, the wasteful hydrogen process translates to electricity from

hydrogen and fuel cells costing at least four times as much as electricity from the grid. In fact, electricity would be used much more efficiently if it were sent directly to the appliances instead. The transition to a hydrogen economy would require a huge investment in new infrastructure to produce, store and deliver hydrogen to end-users, to establish hydrogen stationary systems, as well as to develop and manufacture fuel cells. The transition to the hydrogen-powered system could take several decades due to the slow turnover of the existing stock of capital. The transition to a hydrogen economy is likely to begin later in most developing economies than in industrialized countries.

Hydrogen is a synthetic energy carrier. The synthesis of hydrogen requires energy. Since production, packaging, storage, transfer and delivery of hydrogen gas, in essence all key components of an economy, are extremely energy consuming, alternatives should be considered. The production technology would be site-specific and include steam reforming of methane and electrolysis in hydropower-rich countries. Conventionally produced hydrogen gas costs about twice that of natural gas or oil and about three times that of coal. At present only the space industry seems to be willing to pay the high cost of hydrogen energy.

Hydrogen can be transported by two systems: (1) a road delivery system (cryogenic liquid trucks, compressed tube trailers), and (2) a pipeline delivery system. Placing the pipelines in sewers, securing utility status, or converting existing natural gas pipelines to carry a mixture of hydrogen and natural gas could reduce hydrogen pipeline costs.

Hydrogen could be a peaceful energy carrier for all countries. Hydrogen might be the next great fuel, as it is available worldwide and water is its only byproduct. Hydrogen has received increased attention as a renewable and environmentally friendly option to help meet today's energy needs.

Policy makers will need to pay more attention to the implications for the transition to a hydrogen economy. A major dilemma now faced by developing countries is how to invest in hydrogen research and development for the transition to a hydrogen economy. Hydrogen's share in the energy market is increasing with the implementation of fuel cell systems for sustainable energy supply. The concept of sustainable development embodies the idea of the interlinking and balance between economic, social and environmental concerns.

Hydrogen is currently more expensive than conventional energy sources. There are different technologies presently being practiced to produce hydrogen economically from biomass. Biohydrogen technology will play a major role in the future since it is able to utilize renewable sources of energy.

The use of biohydrogen for transport in order to reduce greenhouse gas emissions and the environmental impact of transport has a strategic importance. Since hydrogen can be burned in such a way that it produces no harmful emissions, this makes it an attractive alternative to fossil fuels. But hydrogen is only as clean as the technologies used to produce and use it. If hydrogen is produced without emitting any carbon dioxide or other climate-destabilizing greenhouse gases, it could form the basis of a truly sustainable energy system.

Vehicles and stationary power generation fueled by hydrogen are zero-emission devices at the point of use, which benefits local air quality. Hydrogen-powered fuel

cells could contribute to reducing or eliminating emissions of carbon dioxide and other greenhouse gases from road transportation vehicles. The production of hydrogen electrolytically, using clean solar power or other forms of renewable energy is essentially pollution-free. The feedstock, water, is composed of hydrogen and oxygen. Hydrogen production or distribution would produce no CO₂. An internal combustion engine fueled by hydrogen can be adjusted so that the emission of NO_x is 200 times less than in present vehicles. Emissions of NO_x increase with the combustion temperature, the length of the high-temperature combustion period, and the availability of hydrogen, up to a point.

This book on biohydrogen attempts to address the needs of energy researchers, chemical engineers, energy specialists, engineers, agriculturists, crop cultivators, fuel processors, policy makers, environmentalists, environmental engineers, automobile engineers, college students, research faculty and others interested in a practical tool for pursuing their interests in relation to bioenergy. Each chapter in the book begins with fundamental explanations for general readers and ends with in-depth scientific details suitable for expert readers. The book may even be adopted as a textbook for college courses that deal with biohydrogen.

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