Hydrogen Energy Progress—X (Proceedings, 10th World Hydrogen Energy Conference, Cocoa Beach, Florida, U.S.A., 20–24 June 1994). Edited by D. L. Block and T. N. Veziroğlu, International Association for Hydrogen Energy, Coral Gables, FL 33124, U.S.A.: 3 Volumes, 2066 pages. Hardcover price: U.S.$350/set.

The volumes under review contain a total of 207 papers, covering nearly all important aspects of hydrogen energy technology and development. They are grouped under 18 chapters, entitled after the topics covered.

Volume 1 begins with status reviews of hydrogen energy development plans in different countries, economics, environmental considerations, safety issues and hydrogen's role in sustainable energy systems. The progress reports on the Euro-Quebec and HYSOLAR projects are convincing practical demonstrations of hydrogen's emerging role in world energy trade, similar to that of oil and natural gas today. Hydrogen will open up a profitable trade outlet for the export of surplus renewable energy from one country or region to another over land and sea routes. The chapter on hydrogen safety includes papers on hydrogen detection and sensing devices. The last two chapters of this volume convey the experiences of different research groups, mostly on electrolytic hydrogen production with solar photovoltaic power and the related plant designs and details. Innovations and improvements in electrolyser components (particularly electrodes) reported in several of these papers reflect growing industrial interest in electrolysis technology, especially small electrolyser outfits for on-site PV power storage.

A couple of papers on fuel cells which should have been placed in Chapter 16 (Volume 3) are included, rather anomalously, in Chapter 5. One of these, reporting on the status of development of solid oxide fuel cells in Germany, is particularly interesting, as it presages a certain future for solid oxide fuel cells and encourages intensified research investment on solid oxide electrolyte systems.

The second volume has 67 papers distributed in five chapters, of which the first three contain contributions on light-actuated and thermochemical water-splitting processes for hydrogen production. The papers on photoic processes include an excellent review paper by Köningstein and Bauer of Austria, research papers on semiconductor suspensions and SC septum cells, and photobacterial action on cellulosic agrowastes like straw and bagasse. There is an interesting overview of Japan's photobiological hydrogen production research program, its goals, methodology, experimental technologies and current status. Though photolytic hydrogen production techniques are still in the basic research stage, the papers presented in these chapters inspire hopes of their technological realization, provided work in this area is pursued more vigorously than at present.

The few papers on closed cycle thermochemical water-splitting for hydrogen production indicate the decline of interest in these processes, which only a few years ago appeared to be heading for industrial adoption. The one notable exception to this trend is the sustained development of the UT-3 process of Japan. Iron-catalysed gasification of lignite and improvements in steam-reforming of methane are notable contributions in this chapter.

Chapter 10 deals with a variety of topics related to hydrogen storage such as LH_2 for urban transportation, enhanced pressurized storage by carbon-sorption, advantages of electrolytic hydrogen over other options for storage of off-peak surplus power in utility power stations and biomass ethanol as a source of "stored" hydrogen.

Nearly half of Volume 2 is taken up by the chapter on metal hydrides with 31 papers reporting on a variety of studies such as new alloy compositions for hydridic hydrogen storage as well as for use as electrodes in hydride batteries. Most of these new alloys are based on titanium in combination with zirconium and other transition metals. A new improved experimental set-up for thermal analysis is described for precise determination of hydride thermodynamics. Included at the end of this voume is a very useful overview from Arthur D. Little of the U.S.A. on various modes of hydrogen storage, its industrial applications and economic benefits.

The third volume has seven chapters with 68 contributions devoted entirely to appliations of hydrogen as substitute and supplement for petroleum fuels in internal combustion engines, including aeroengines, as industrial and domestic burner fuel, as the fuel of choice for fuel cells for mobile and stationary power generation, as a high thrust rocket propellant for space vehicles and as circulatory working fluid in chemical heat pumps. The papers on engine applications include hydrogenized diesel power generation plants, direct fuel injection systems, field demonstration of H-fueled public utility vehicles and gasoline–hydrogen dual fuel operation systems for automobiles. An interesting paper in this group in that of Dini of Italy on an unusual type of reciprocating (Stirling) engine operated with nitrogen gas (externally heated by hydrogen combustion) as the working fluid. Another paper, worth a special mention, reports a detailed study of the performance and emission characteritics of hydrogen-fueled engines and ways to secure optimal engine efficiency with minimum NO_x emission.

Of the two chapters on fuel cells, one (Chapter 16) is devoted mainly to fuel cell technology in general and there are papers an all four types of fuel cell: phosphoric acid, proton exchange membrane, alkaline and molten carbonate types. Of these, I would pick for special mention two good reviews of on-going R&D work on PEM fuel cells at Texas A&M University and Humbold State University, California, U.S.A. The other chapter on fuel calls (Chapter 13) is given to the deployment of fuel cells as on-board power sources for electric vehicles. This is a theme that has attracted concerted R&D effort in recent years because of the well-known advantages of fuel cells *vis-à-vis* combustion engines. The chapter includes reports of fabrication and field trials of fuel cell-powered electromobiles, which reflect the rapid development in fuel cell vehicles taking place in several countries across the globe.

Of the 10 papers on aerospace fuel applications (Chapter 18), only two relate to air transportation and both are of commercial importance. The first of these is an interim report on a joint German–Russian investigative project involving the aeronautical industries of the two countries. The report surveys the economic, commercial and engineering implications of switching to natural gas and hydrogen (both in liquefied form) as aviation fuel for jet aircraft. The other paper, besides summarizing the technical merits of liquid hydrogen as aerofuel, identifies the important technlogical prerequisites for the realization of a viable hydrogen-fueled international air-carrier system. The remaining eight papers in this group relate to the use of liquid hydrogen (along with liquid oxygen) as a rocket propellant for space vehicles, including motor development and ground servicing infrastructure at the launching sites.

Hydrogen energy is now at the cross-roads of energy options and is poised for a big leap foward in the coming years. Its virtues as a highly energetic and environmentally benign fuel are now widely recognized. The greenhouse syndrome alone is a sufficient argument to start retreating from carbon-fuels and eventually to banish their use altogether. Transition to hydrogen energy will ensure a sustainable clean energy prospect for the future, free from shortages and pollution. Various compulsions make the switch to hydrogen invevitable, if not imminent. Most analysts have predicted a sizeable share of the global energy market for hydrogen in the next 15–20 years. *Hydrogen Energy Progress—X* (1994) is a useful compendium of global developments, technical, economic and societal, that portend to take the world to the hydrogen energy era early next century.

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