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"Alcoholic Fuels"

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This book is Volume 112 of the Chemical Industries Series, a set of references and textbooks. The majority of previous publications in the series have been concerned with topical chemical processes, and the catalyst technology relevant to them at the time of publication. This volume is no exception. The chemical industry, together with oil and automotive interests, have made a major contribution in the last thirty years to the reduction of emissions from motor vehicles using conventional fossil fuels (1, 2). This book describes technology that takes this work an important step further, namely the production and use of alcoholic fuels, notably but not exclusively for use by the transport sector.

Alcohols as Fuels

The idea of using alcohol as a fuel in motor vehicles is not new. Henry Ford, when he launched the Model T, envisaged that it would run on alcohol produced from renewable sources (3). Brazil has been using alcohol derived from sugar cane for many years. It is from this experience that alcohol is considered to be a viable proposition as an alternative to fossil fuels.

The book is a compilation of some 15 chapters covering the production of methanol and ethanol, the use of alcohol blended fuels in automotive applications, and the use of alcohols in fuel cells. The chapters have been produced individually by some 26 authors from the U.S.A. and Europe, reflecting the wide scope of the book and the international dimensions of the subject. The future availability of oil, its security of supply and, increasingly, the impact of its use on climate change, have all motivated the search for alternative sources of energy, notably those that are sustainable, with minimal or zero impact on the environment. Alcohol produced from renewable sources is one of the major contenders to meet these challenges. To encourage these changes, government initiatives and fiscal incentives in the U.S.A., Brazil, Europe and the Far East not only encourage the development and production of alcohol fuels, but also stipulate the phased introduction of alcohol-blended fossil fuels.

This book is therefore timely in providing for the first time a comprehensive review of the production of alcohols, their use as fuels in internal combustion engines, and also of more advanced concepts such as fuel cells and fuel cell powered portable energy applications. The book will appeal to a wide range of readers. People new to the subject but interested in the development of renewable fuels will find much of value in the book, even if they fail to follow the more technical chapters on biochemistry and catalyst developments for fuel cell applications. Equally, people knowledgeable in the subject or interested in specific areas such as the challenge of developing catalysts for direct alcohol fuel cells, will find the book and its extensive references of particular value.

Role of Catalysts

For readers of *Platinum Metals Review*, the question arises as to what role platinum group metals (pgms) might play in the production and use of alcoholic fuels. The book, like others in the series, emphasises the important role that catalysts play in both the production and use of alcoholic fuels. Concerning the benefits of using alcoholic fuels for carbon dioxide reduction, there is as yet no consensus on these. The work of the U.S. Department of Agriculture contradicts that of Cornell University, who have both studied the 'well to wheels' energy use and content of alcoholic fuels. It is suggested that the discrepancy arises in part from the dramatic increase in energy efficiency due to lower energy use in the fertiliser industry and advances in fuel conversion technology in the last decade. The type of fertiliser is not mentioned. However, assuming that it is nitrogen-based, improvements to the pgm catalyst gauze (4) and the process technology used to produce nitrogen-based fertilisers may have had a significant impact on the energy balance of alcoholic fuels.

Ethanol fuel also has a beneficial effect on automotive emissions *via* its addition to gasoline and diesel fuels. While emission control using platinum, palladium and rhodium catalysts is important for conventionally fuelled engines, it is essential where alcoholic additives are used. The additives reduce (but do not eliminate) some emissions, but they increase the output of oxygenated species such as aldehydes, which must be catalytically controlled.

Fuel Cell Catalysts

Of particular interest is the role of pgm catalysts in the development of fuel cells using alcoholic fuels (5). The challenging development of high current density, durable anode catalysts for the direct use of methanol in polymer electrolyte membrane fuel cells is described in detail. Progress has been made with platinum and platinum-ruthenium systems for use in portable and consumer electronic applications such as mobile telephones and laptop computers. Work continues on making direct methanol fuel cells a viable option for transport applications. Similarly, it would be beneficial if catalysts were developed for direct ethanol fuel cells, but so far this has proved to be more challenging than the direct methanol system.

All fuel cell systems work most effectively on hydrogen-rich gas, which is produced from methane or liquid fuels by steam reforming. Hydrogen from a renewable CO_2-neutral source such as ethanol is attractive. Unfortunately, the catalytic reforming of ethanol is not without its challenges, as nickel and cobalt catalysts produce undesirable side products such as acetic acid. The catalyst systems currently preferred use rhodium or palladium on a range of oxide supports. These developments are described in detail, supported by extensive literature references.

Conclusions

Overall, the book is timely, as interest in sustainable sources of energy that are CO_2-neutral gathers pace. However, while the book covers all aspects of the subject from production of alcohol fuels to their use, there is one omission. This is the production of ethanol from sugar cane and sugar beet. Sugar cane is an established source of ethanol, notably in Brazil, while sugar beet, potentially a preferred starting material in Europe, has recently been selected by BP, British Sugar and DuPont for their butanol plant in the U.K.

I would like to have seen a comparison of the attributes of various starting materials for ethanol and butanol production, but obviously that must await further study.

References

1. G. J. K. Acres and B. J. Cooper, *Platinum Metals Rev.*, 1972, **16**, (3), 74
2. M. V. Twigg, *Platinum Metals Rev.*, 1999, **43**, (4), 168
3. *The New York Times*, 20 Sept. 1925, p. 24
4. Johnson Matthey Noble Metals, Gauze, www.noble.matthey.com
5. Platinum Metals Review fuel cell articles on Fuel Cell Today, www.fuelcelltoday.com/FuelCellToday/PMRLinks

The Reviewer

Gary Acres is a graduate of Nottingham University. Following five years with the United Kingdom Atomic Energy Authority at Harwell, he joined the newly formed catalyst research group of Johnson Matthey in 1963, becoming Director responsible for research and development operations from 1974 to 1985, and then Director, Corporate Development until 1994 when he retired from full time employment. Since then he has held a number of advisory roles and is currently a Consultant to Johnson Matthey on fuel cell and related activities. He is Chairman of the Grove Fuel Cell Symposium and the first Chairman of the European Fuel Cell Group. Since 2000, he has been a Royal Academy of Engineering Visiting Professor on Sustainable Development at the University of Birmingham. His awards include the Queen's Award for Technology and the MacRobert Award for the development of automobile emission control catalyst systems.