

## “Fuel Processing: for Fuel Cells”

BY GUNTHER KOLB (Institut für Microtechnik Mainz GmbH, Germany), Wiley-VCH, Weinheim, Germany, 2008, 434 pages, ISBN 978-3-527-31581-9, £130, €156, U.S.\$215

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Fuel processing, where carbon-based fuels are efficiently reformed to produce hydrogen, provides one route to a more extensive utilisation of fuel cell technology. This multi-staged process requires catalysis for each step. Rhodium is often used as a reforming catalyst, platinum for carbon monoxide clean-up and platinum/palladium for combustion. Base metals such as copper and zinc also find widespread application.

Gunther Kolb, in “Fuel Processing: for Fuel Cells”, sets out to understand the current state of the fragmented effort to solve the problems of fuel processing for niche applications. His book offers a timely and welcome overview of the expanding body of work in which fuel processing technology is finding application in fuel cell power (from watt to kilowatt scale).

The author is a well-known expert in this field and Head of Energy Technology and Catalysis at IMM, Germany. While the text is written to be instructive towards the beginner, it is clearly directed at those who wish to understand the current issues in some detail. Kolb collates and summarises current information on the development of fuel processing technology in various areas, and highlights the achievements that have been made to date. Throughout the book, he capitalises on his understanding of both the science and the engineering involved in this complex interdisciplinary field. The early chapters serve as an excellent introduction to the subject, outlining the basic chemistry and engineering concepts associated with pre-reforming, partial oxidation, steam and autothermal reforming, as well as shift reactions and other methods of cleaning up the reformed fuel.

After introducing the components, the author encourages the reader to see the system as more than the sum of its parts, emphasising that a fairly comprehensive awareness of all aspects of the

chemistry involved is required for the selection of appropriate operating conditions. The best choice of steam: fuel and oxygen: fuel ratios and flow rates are critical to gain optimum efficiency, but consideration of the physical chemistry involved is also important when designing a system for efficiency, selectivity and durability. Engineering considerations are also critical, and performance constraints require difficult decisions to be made, for example in the choice of reactor bed type (monolith, fixed bed, membrane etc.). The later chapters detail the specifics of engineering, design concepts and different types of fuel processor.

Where the book occasionally fails is in its illustrations – some figures are difficult to read and lack sufficient annotation. Although the author outlines the considerable contribution that computer modelling continues to make towards our understanding, a lack of distinction between real-world and simulated results may cause confusion. Further, the author’s strong interest in microchannel technology emerges in Chapter 10, which deals with cost and production issues; however, in the context of the volume as a whole, this seems acceptable.

By mid-volume, the reader cannot be in any doubt as to the complexity of the task facing those who design and improve fuel processors. Kolb also warns against common yet unsafe assumptions, such as the idea that the engineering technology of large systems can be scaled down to smaller systems. This kind of assumption can lead to years of misdirected development work. Kolb advocates that each situation should be considered on its own merits, and should balance the technical requirements with the economic requirements over its entire lifetime. The inclusion of a decision tree to map out and exemplify the types of decision that are required would have been very helpful to

the reader. This could have shown that, despite the higher initial cost of precious metal catalysts, their higher activity, better catalyst utilisation and greater resistance to poisoning mean that they are the most appropriate option under some circumstances.

One of the challenges of the book was to deal with the difficult issue of intellectual property. Any book such as this that describes state-of-the-art technology will find it difficult to be completely current, as there is much knowledge that is held outside the public domain. However, Kolb outlines the basic science and engineering behind the work being done, and supports it with evidence from the literature. This provides sufficient detail for the educated reader to form an opinion, and sufficient referencing to help the more curious to investigate further. This will make the later chapters particularly useful to the growing numbers of scientists and engineers who are turning their attention and applying their skills to the technical and commercial challenges of fuel processing.

For the general reader, this can mean that much of the text is more detailed than they require, although the author rewards the dedicated reader with occasional gems of insight. Throughout the book, the author offers a balanced approach as he deals with different theories and experimental and engineering approaches. However, he does occasionally point out incorrect assumptions or misguided endeavours. At these points the text

comes alive, as the author adopts a cautionary tone to underline his key message.

The book's key message throughout is that technological progress is being made, albeit in a fragmented fashion, by experts in various disciplines applying their knowledge and skills to the complex science and engineering involved. The examples of wasted effort may be a symptom of the fragmentation of the work, but Kolb's book may well inspire a more coordinated approach, emphasising that much can be achieved when materials scientists, chemists and engineers work together.

### Further Reading

For more information on policy aspects of fuel processing and fuel cells, refer to:

U.S. Department of Energy, 'On-Board Fuel Processing Go/No-Go Decision', DOE Decision Team Committee Report, U.S.A., 6th August, 2004:  
[http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/committee\\_report.pdf](http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/committee_report.pdf) (Accessed on 15th June 2009)

Fuel Cell Today Industry Review 2008, "Fuel Cells: Commercialisation", Fuel Cell Today, U.K., 30th January, 2008:  
<http://www.fuelcelltoday.com/events/industry-review> (Accessed on 5th May 2009)

### The Reviewer

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