Optimal Design of Supported Catalysts

CATALYST DESIGN: OPTIMAL DISTRIBUTION OF CATALYST IN PELLETS, REACTORS, AND MEMBRANES

BY MASSIMO MORBIDELLI, ASTERIOS GAVRIILIDIS AND ARVIND VARMA, Cambridge University Press, Cambridge, 2001, 227 pages, ISBN 0-521-66059-9, £40, U.S.$59.95

Catalysis plays a major part in our lives even though the majority of us would never give it a moment's thought. A simple but very clear example of how catalysis affects our daily lives is the catalytic converter. What would air quality be like, especially in cities, were it not for the catalytic converters cleaning up exhaust fumes from vehicles? Considering the importance of catalysis, it is thus not surprising that it is a field which has been studied by numerous scientists from diverse scientific backgrounds. Also not surprising is the abundance of literature to be found on the subject in journal articles and text books. Nevertheless, this book is a welcome addition to the existing literature as it looks at a particular and very important aspect of the design of supported catalysts, specifically the optimal distribution of the active component in catalyst pellets, reactors and membrane reactors.

Transport resistance of the porous support leads to concentration, as well as temperature, gradients inside the pellet. As a result, reaction rates can differ depending on the position of the catalyst site within the porous support. This suggests that the performance of a catalyst could be altered by selectively depositing the catalyst inside the support. In fact, it has been shown, by Morbidelli (1), that even for the most general case of reaction and kinetics, the most optimal distribution is a Dirac delta function. Key parameters controlling the effect of the non-uniform distribution are reaction kinetics, transport properties, operating variables, deactivation mechanisms and catalyst cost. The indices by which to measure the performance of the catalyst are effectiveness (conversion related to amount of catalyst), selectivity and yield (desired product in multiple reaction systems), lifetime (deactivation) and attrition (loss of outer inert layer of support, thus saving precious active materials sited towards the interior).

Chapter 1 briefly introduces the concept of non-uniform catalyst distributions. Chapters 2, 3 and 5 examine the effect of catalyst distribution on catalyst performance in a single pellet and in a fixed bed reactor comprised of pellets, and catalyst distributions in membrane reactors – a relatively new subject. Chapter 4 briefly describes the effect of non-uniform catalyst distribution on catalyst deactivation. In Chapter 6 attention is given to catalysts of significant commercial importance (for example, catalytic converters, hydrotreating catalysts, immobilised biocatalysts, etc.). Last, but not least, Chapter 7 addresses catalyst preparation, particularly preparation of pellets with non-uniform catalyst distributions, where the distribution obtained depends on the interplay of competitive adsorption and diffusion of various species in the support.

In conclusion, the book is a well balanced presentation of mathematical analysis and selected experiments of the effects of non-uniform catalyst distributions on catalyst performance and how to obtain an optimum catalyst distribution. It provides a suitable and interesting text for people with a background in catalysis and/or mathematical analysis. With its qualitative and quantitative aspects it is suitable for chemists, who will appreciate the descriptive and experimental sections, and for chemical engineers and applied mathematicians, who will relish the mathematical developments. Overall the book provides a comprehensive review on the subject. The reviewer is enthusiastic about the book and would strongly recommend it to all researchers and postgraduate students interested in heterogeneous catalysis. Y. M. M. VAN LISHOUT

Reference

1 M. Morbidelli, A. Servida and A. Varma, 'Optimal catalyst activity profiles in pellets', *Ind. Eng. Chem. Fundam.*, 1982, **21**, 278–289

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