

## “Industrial Tomography: Systems and Applications”

**Edited by Mi Wang (University of Leeds, UK), Woodhead Publishing Series in Electronic and Optical Materials, No. 71, Woodhead Publishing, an imprint of Elsevier Ltd, Cambridge, UK, 2015, 744 pages, ISBN: 978-1-78242-118-4, £230.00, US\$365.00, €260.00**

### **Reviewed by Hugh Stitt**

Johnson Matthey Technology Centre,  
PO Box 1, Belasis Avenue, Billingham, TS23 1LB, UK

**Email:** [hugh.stitt@matthey.com](mailto:hugh.stitt@matthey.com)

This book represents the latest *magnum opus* in a line of multi-author books on process tomography, with the first dating from 20 years ago. Following in the tradition of Beck and Williams (1) this book presents a comprehensive overview of process relevant tomographic modalities, reconstruction techniques and industrial applications. The editor Professor Mi Wang has done an excellent job in obtaining contributions from many leaders in the field.

The technical scope and application of process tomography has grown enormously since the landmark Beck and Williams book (1) from a technology of significant potential to one of substantial impact. While it may be true that medical tomography is notably leading, the challenges of applying tomographic approaches at meaningful scale for the process industries and the complications of using it on manufacturing plant or even offshore, all within the tighter cost constraints of the manufacturing industry

are steadily being overcome. There are now a number of companies that specialise in supplying the equipment or services into the process industries. Geir Anton Johansen (Bergen University College, Norway) for example highlights three different commercially available gamma tomography-based offerings. Equally there are competitive offerings for electrical resistance and capacitance tomography, purpose-developed for process tomography. Process tomography is no longer a pet research area and a research tool, but rather it is now becoming an important measurement approach for industry. This book is therefore timely, coming at a time when industrial activity is markedly increasing and while the pace of academic progress is being maintained.

### **Modalities**

The book is broken down into three sections: modalities, image reconstruction and applications. The section on modalities is meticulous, including well established and exploited routes such as soft field electrical capacitance and impedance (including resistance) tomographies and hard field X-ray and gamma ray techniques (**Figure 1**) as well as electromagnetic induction, magnetic resonance and radioisotope methods. Attention is also given to



Fig. 1. The Tracerco Discovery™ tool for sub-sea pipe inspection by gamma-ray tomography (Image courtesy of Tracerco)

infrared (IR)-based chemical species tomography and (electrical impedance-based) spectro tomography. Overall this section is well balanced with the chapters for the most part being of similar length and depth and also largely concentrating on describing the fundamentals of the technique and its relevance to process tomography while remaining distinct from the outright applications focused chapters later in the book. The chapter on imaging in sensor networks is a bit of an outlier in the sense that its relationship to process imaging seems a little tenuous. Nonetheless it is well written and a thought provoking addition.

## Image Reconstruction

The second section, on image reconstruction is however less thorough and somewhat less balanced. The chapters on mathematical concepts and statistical techniques are well considered as two of the basic approaches to reconstruction. Both are effectively written and structured, and serve as very useful guides and introductions. Between them lie dedicated chapters on hard field tomography (mainly on X-ray tomography although clearly more widely applicable) and electrical capacitance tomography; both are informative. For the other modalities the image reconstruction is covered within the earlier chapters. It is not evident why only these two are singled out for special treatment. This makes the book less useful as a general reference for image reconstruction techniques.

## Applications

The final section of the book presents eleven chapters on different applications in process tomography. They vary a little in their thrust and aspect according to their titles. Some are quite specific in terms of modality and subject of interrogation: for example a chapter each on X-rays and electrical capacitance tomography for gas-solid fluidised beds. Others are particular only in the application but wide ranging in the modalities used: general chapters on tomography for bubble columns and trickle bed reactors, reaction engineering (mixing processes) and microreactors. The final category of chapter is the general industry sector summaries: tomography in mineral transportation, oil and gas industry (two chapters, the first of which actually focuses on oil field and well imaging, and explains the otherwise incongruous inclusion of the earlier chapter on sensor networks), food inspection and the nuclear industry. There is also a stand-alone chapter on tomographic velocimetry; which seems somehow out of place dealing as it does with the basic principles of the methods and may better have been included in the opening section. Some of the chapters are however slightly more restrictive in their subject matter than their titles may suggest. The report on food inspection actually considers only X-ray based systems.

While it is easy to be critical of the unevenness of this final section it should not be seen to detract from the overall impact; the collation provides a wide-ranging review of the application of various tomographic modalities to a number of different measurement problems and operations relevant across the process industries such as flows, filtering, mixing, drying processes and chemical reactions inside vessels and pipelines. The editor has assembled a broad cross-section of applied process tomography written by leading practitioners.

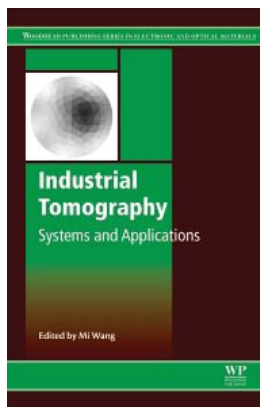
## Summary

In conclusion this compilation presents a broad coverage of tomographic techniques that can be applied to process measurements. The method sections feature a diverse range of modalities and provide in depth analysis of their respective techniques, equipment and data processing. There is detailed study of some aspects of image reconstruction and an extensive investigation of process tomography in

applications. The new book thus offers an up to date compendium that will be invaluable to those involved in process tomography research and those looking to utilise tomographic methods for process measurement either as a research tool or for industrial application.

## Reference

1. "Process Tomography: Principles, Techniques and Applications", eds. R.A. Williams and M. S. Beck, Butterworth-Heinemann Ltd, Oxford, UK, 1995



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## The Reviewer



E. Hugh Stitt is a Scientific Consultant at Johnson Matthey Technology Centre, Billingham, UK. He is a Visiting Professor at the University of Birmingham, UK, and at Queen's University Belfast, Fellow of the Institution of Chemical Engineers and a Fellow of the Royal Academy of Engineering. He has 25 years of industrial research experience across a variety of themes related to catalytic reaction engineering and catalysts with over 100 refereed publications.