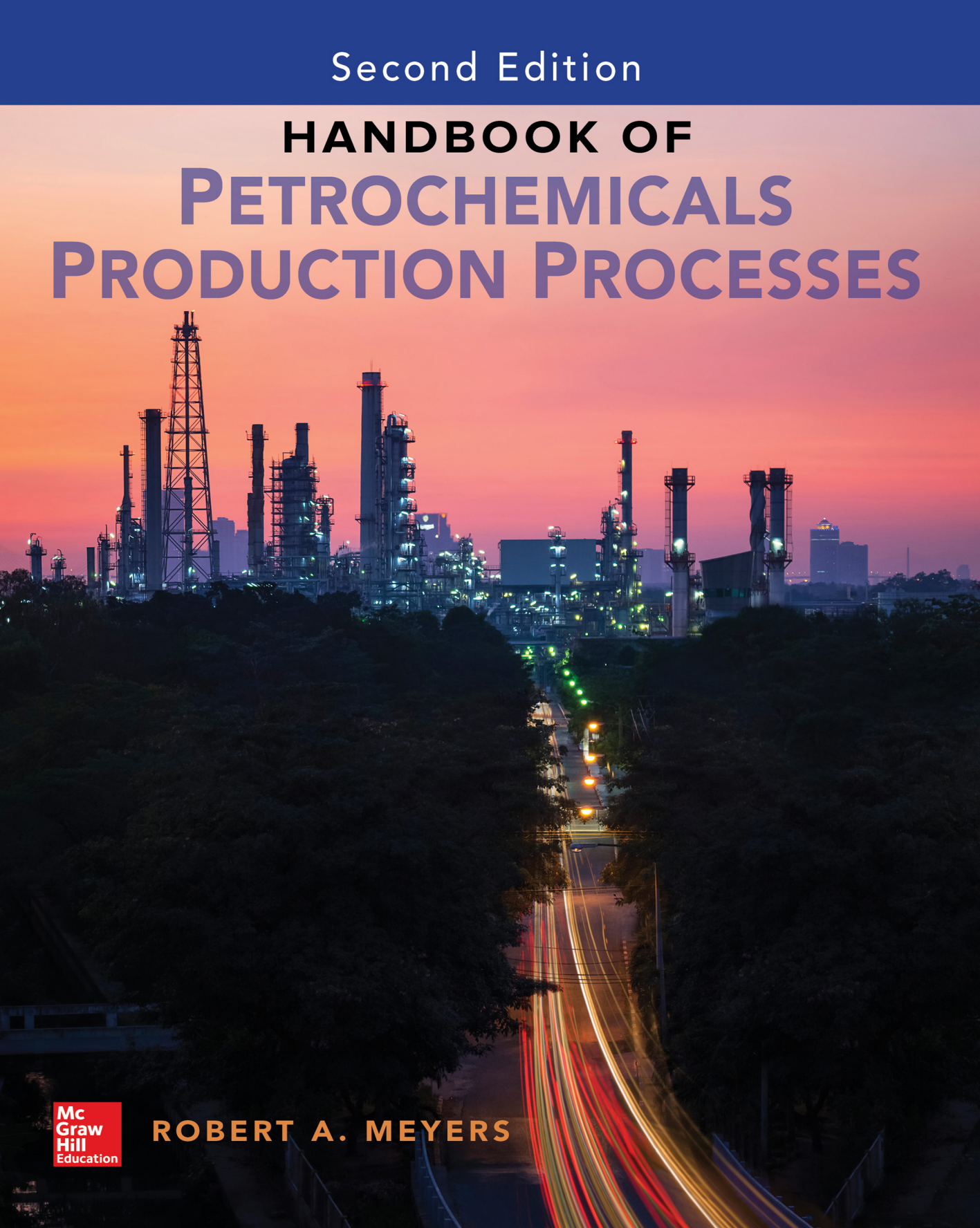


Second Edition

# HANDBOOK OF PETROCHEMICALS PRODUCTION PROCESSES

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ROBERT A. MEYERS



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**HANDBOOK OF  
PETROCHEMICALS  
PRODUCTION PROCESSES**

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**Robert A. Meyers**

**Second Edition**



**New York Chicago San Francisco Athens London  
Madrid Mexico City Milan New Delhi  
Singapore Sydney Toronto**

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# CONTRIBUTORS

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- Jari Äärilä** *Borealis Polymers Oy, Finland (Chap. 7.1)*
- Kauno Alastalo** *Borealis Polymers Oy, Finland (Chap. 7.2)*
- Cedric Allemand** *TechnipFMC Process Technology, Lyon, France (Chap. 7.9)*
- Ilya Aranovich** *GTC Technology US, LLC, Houston, Texas (Chap. 1.4)*
- Manish Bhargava** *GTC Technology US, LLC, Houston, Texas (Chap. 1.9)*
- Debasis Bhattacharyya** *Indian Oil Corporation Ltd., R&D Centre, Faridabad, Haryana, India (Chap. 2.7)*
- Jeannie Blommel** *UOP LLC, Des Plaines, Illinois (Chap. 3.5)*
- Ernest Boehm** *Honeywell UOP, Des Plaines, Illinois (Chap. 1.14)*
- Greg Boughey** *UOP LLC, Des Plaines, Illinois (Chaps. 2.9, 3.5)*
- Diego Castañeda-Zúñiga** *SABIC, Geleen, The Netherlands (Chap. 7.9)*
- Linda Shi Cheng** *UOP LLC, Des Plaines, Illinois (Chap. 1.15)*
- Charlie Chou** *GTC Technology US, LLC, Houston, Texas (Chap. 1.7)*
- Andrei Cimpeanu** *GTC Technology US, LLC, Houston, Texas (Chaps. 1.10, 5.2)*
- Lucia Cretoiu** *GTC Technology US, LLC, Houston, Texas (Chap. 1.8)*
- Mircea Cretoiu** *GTC Technology US, LLC, Houston, Texas (Chaps. 1.10, 5.2)*
- Vinél Daniel-Jean** *Axens, Rueil-Malmaison, France (Chap. 2.2)*
- Saurav De** *GTC Technology US, LLC, Houston, Texas (Chap. 1.4)*
- Christine M. Deane** *McDermott, Bloomfield, New Jersey (Chap. 3.4)*
- Jan De Ren** *Honeywell UOP, Des Plaines, Illinois (Chap. 7.8)*
- Christopher DiGiulio** *UOP LLC, Des Plaines, Illinois (Chap. 3.5)*
- Zhongyi Ding** *GTC Technology US, LLC, Houston, Texas (Chap. 1.11)*
- Grant Donahoe** *Badger Licensing LLC, Boston, Massachusetts (Chap. 5.1)*
- Jan Duchateau** *SABIC, Geleen, The Netherlands (Chap. 7.9)*
- Joseph Duff** *TPC Group, Houston, Texas (Chap. 3.5)*
- Kerman N. Dukandar** *McDermott, Bloomfield, New Jersey (Chap. 2.5)*
- Thomas A. Dwyer** *McDermott, Bloomfield, New Jersey (Chap. 3.4)*
- Thomas Eck** *Air Liquide Global E&C Solutions Germany GmbH, Germany (Chap. 3.6)*
- Erno Elovainio** *Borealis Polymers Oy, Finland (Chap. 7.1)*
- Barry R. Engle** *W. R. Grace Technologies, Inc., Columbia, Maryland (Chap. 7.7)*
- Kevin J. Fallon** *Badger Licensing LLC, Boston, Massachusetts (Chaps. 1.1, 4.1)*
- Chris Fawcett** *Johnson Matthey, London (Chap. 4.2)*

- Herminio Febres II** *McDermott, Bloomfield, New Jersey* (Chap. 3.3)
- Carmen A. Fornarotto** *McDermott, Bloomfield, New Jersey* (Chap. 2.6)
- Gregory Funk** *Honeywell UOP, Des Plaines, Illinois* (Chap. 1.14)
- Joseph C. Gentry** *GTC Technology US, LLC, Houston, Texas* (Chaps. 1.10, 5.2)
- Rolland Gildas** *Axens, Rueil-Malmaison, France* (Chap. 2.2)
- Martin Gorny** *Air Liquide Global E&C Solutions Germany GmbH, Frankfurt am Main, Germany* (Chaps. 2.1, 4.6)
- Thomas Gutermuth** *Air Liquide Global E&C Solutions Germany GmbH, Frankfurt am Main, Germany* (Chaps. 5.4, 5.5)
- Antti Härkönen** *Borealis Polymers Oy, Finland* (Chaps. 7.1, 7.2)
- Bernd Heida** *BASF SE, Ludwigshafen, Germany* (Chap. 3.1)
- Heiko Hofmann** *Air Liquide Global E&C Solutions Germany GmbH, Frankfurt am Main, Germany* (Chap. 4.6)
- Jillian Horn** *TPC Group, Houston, Texas* (Chap. 3.5)
- Douglas Hubbell** *Badger Licensing LLC, Boston, Massachusetts* (Chap. 5.1)
- Stefan Iselborn** *BASF SE, Ludwigshafen, Germany* (Chaps. 2.3, 4.4)
- Eseoghene Jeroro** *Honeywell UOP, Des Plaines, Illinois* (Chap. 4.7)
- Weihua Jin** *GTC Technology US, LLC, Houston, Texas* (Chap. 1.5)
- Volker Jörres** *McDermott, Lummus Novolen Technology GmbH, Germany* (Chap. 7.3)
- Sachin Joshi** *GTC Technology US LLC, Houston, Texas* (Chaps. 1.6, 4.5)
- Roomi Kalita** *GTC Technology US, LLC, Houston, Texas* (Chap. 1.9)
- Alisa Kammafoo** *SCG Chemicals, Rayong, Thailand* (Chap. 1.6)
- Tahir Khan** *McDermott, Bloomfield, New Jersey* (Chap. 4.8)
- Nicholas M. Kinnis** *McDermott, Bloomfield, New Jersey* (Chap. 2.4)
- Tarja Korvenoja** *Borealis Polymers Oy, Finland* (Chaps. 7.1, 7.2)
- Peter Kuzma Jr.** *McDermott, Bloomfield, New Jersey* (Chap. 2.4)
- Homok Lee** *McDermott, Bloomfield, New Jersey* (Chap. 1.3)
- Cliff Maat** *TPC Group, Houston, Texas* (Chap. 3.5)
- Brian Maerz** *Badger Licensing LLC, Boston, Massachusetts* (Chap. 1.2)
- Andreas Magnusson** *Johnson Matthey, London* (Chap. 8.3)
- Dennis P. Maloney** *McDermott, Bloomfield, New Jersey* (Chaps. 2.6, 3.3)
- Rama Rao Marri** *McDermott, The Woodlands, Texas* (Chap. 2.7)
- Michael Marsh** *UOP LLC, Des Plaines, Illinois* (Chap. 2.8)
- Daniel McKenzie** *McDermott, Bloomfield, New Jersey* (Chap. 2.5)
- Sabine Mittelstädt** *Air Liquide Global E&C Solutions Germany GmbH, Germany* (Chaps. 1.13, 3.6, 5.4, 5.5)
- Gregory J. Nedohin** *UOP LLC, Des Plaines, Illinois* (Chap. 2.8)
- Peter Neuteboom** *SABIC, Geleen, The Netherlands* (Chap. 7.9)
- Michael Nutt** *TPC Group, Houston, Texas* (Chap. 3.5)
- Klaus Nyfors** *Borealis Polymers Oy, Finland* (Chap. 7.2)
- Tobias Oelmann** *Air Liquide Global E&C Solutions Germany GmbH, Frankfurt am Main, Germany* (Chap. 2.1)
- Pradeep Pawar** *GTC Technology US, LLC, Houston, Texas* (Chap. 1.11)

- William D. Quitmeier** *McDermott, Bloomfield, New Jersey* (Chap. 2.4)
- Sanjeev Ram** *McDermott, Bloomfield, New Jersey* (Chaps. 4.8, 5.6)
- Venkata K. Ramanujam** *GTC Technology US, LLC, Houston, Texas* (Chap. 3.2)
- Andrew Reynolds** *TechnipFMC Process Technology, Lyon, France* (Chap. 7.9)
- Peter Roberts** *Johnson Matthey, London* (Chaps. 4.3, 8.1)
- Oliver Ruhl** *McDermott, Lummus Novolen Technology GmbH, Germany* (Chap. 7.3)
- Robert J. Schmidt** *Honeywell UOP, Des Plaines, Illinois* (Chap. 4.7)
- Kevin J. Schwint** *McDermott, Bloomfield, New Jersey* (Chaps. 1.12, 5.3)
- John Senetar** *UOP LLC, Des Plaines, Illinois* (Chap. 3.5)
- Atul Shah** *Johnson Matthey, London* (Chap. 8.2)
- Raymond Shih** *Honeywell UOP, Des Plaines, Illinois* (Chap. 7.8)
- Joost Smit** *Johnson Matthey, London* (Chap. 6.1)
- Stephen Sohn** *Honeywell UOP, Des Plaines, Illinois* (Chap. 1.14)
- Wolfgang Spieker** *UOP LLC, Des Plaines, Illinois* (Chap. 2.8)
- Lawrence Stein** *Badger Licensing LLC, Boston, Massachusetts* (Chap. 1.2)
- Jacques Tacx** *SABIC, Geleen, The Netherlands* (Chap. 7.9)
- Carolina Toloza** *SABIC, Geleen, The Netherlands* (Chap. 7.9)
- Peter Trabold** *Air Liquide Global E&C Solutions Germany GmbH, Frankfurt am Main, Germany* (Chaps. 5.4, 5.5)
- Elizabeth Tyson** *McDermott, Bloomfield, New Jersey* (Chap. 1.3)
- Sebastian van Haandel** *Johnson Matthey, London* (Chap. 6.1)
- Betty Vazquez** *McDermott, Bloomfield, New Jersey* (Chap. 5.6)
- Vincent Welch** *Technip Stone & Webster Process Technology, Boston, Massachusetts* (Chaps. 7.5, 7.6)
- Joseph Weller** *GTC Technology US, LLC, Houston, Texas* (Chap. 3.2)
- Yuree Whang** *UOP LLC, Des Plaines, Illinois* (Chap. 2.9)
- Keith Wiseman** *NOVA Chemicals Corporation, Calgary, Alberta* (Chap. 7.4)
- Liege Xavier** *Axens, Rueil-Malmaison, France* (Chap. 2.2)
- Richard Zhang** *UOP LLC, Des Plaines, Illinois* (Chap. 2.9)

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# PREFACE

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It has been 13 years since publication of the technologies comprising the first edition of the *Handbook of Petrochemicals Production Processes*. This second edition is a complete updating and includes many new technologies and new licensors. This publication is a reference and guide to present-day real-world petrochemicals (intermediates, monomers, and polymers) production methods, product properties, and economics. There is no other single source of such information. The focus is on the most economically important petrochemicals, which together represent a nearly \$800 billion market, which is on track to approach \$1 trillion by 2024. The Handbook details 57 chemical process technologies that are slated to play a major role in the expansion of petrochemicals production. These are organized into eight product sections:

1. Petrochemical intermediates (cumene, ethylbenzene, xylenes, benzene, toluene, xylenes).
2. Olefins (ethylene, propylene, butene, hexene).
3. Diolefins (butadiene, isoprene).
4. Alcohols and monomers (bisphenol A, butane diol, propane diols, methanol, cumene, and phenol).
5. Acid, ester, and aromatic monomers (styrene, acrylic acid, and acrylates, dimethyl and diphenyl carbonate).
6. Vinyl chloride monomers.
7. Polymers (polyethylenes, polypropylene, polystyrene, polyethylene terephthalate).
8. Methylamines, formaldehyde, and dimethyl ether.

In order to present the global technology base adequately, it was decided to ask the major licensors of the most advanced and utilized licensable technologies to present their processes and economics in a common format suitable for side-by-side comparison. This resulted in a total of 57 technologies presented by 12 of the largest firms in the petrochemicals licensing business. These are Air Liquide, Axens, Badger, BASF, Borealis, CB&I (now McDermott Technology), GTC, Honeywell UOP, Johnson Matthey, Nova Chemicals, Technip (now TechnipFMC), and W.R., Grace, which—together with their licensing partners or technology originators ExxonMobil, BP, Lummus, Versalis, TOTAL, SABIC, Lurgi, TPC Group, and SINCO—represent a large fraction of global petrochemicals production. Contact information for the 12 presenting firms is given within the licensor contacts listing to follow this preface.

The information presented in this Handbook allows engineers to make a first evaluation of licensable processes for new production and provides the basis for engineering students to perform class exercises in the comparison of technologies, environmental factors, and economics for today's most used processes. This comparison provides a set of real world solutions that engineers and students need for their further evaluations.

Each technology licensor was asked to follow the chapter format below in so far as possible:

## Handbook Technology Presentations Specification

1. *General process description.* Feed definition and product yield and a simplified flow diagram.
2. *Process chemistry and thermodynamics.* For each major processing unit as applicable.
3. *Process perspective.* Developers, location, and specification of all test and commercial plants and near-term and long-term plans.



4. *Detailed process description.* Process flow diagram with mass and energy balances for major process variations, and feeds and details on unique or key equipment.
5. *Product and by product specifications.* Detailed analyses of all process products and by-products as a function of processing variation and feeds.
6. *Wastes and emissions.* Process solid, liquid, and gas wastes and emissions as a function of processing variation and feeds.
7. *Process economics.* Installed capital cost by major section, total capital investment, operating costs, annualized capital costs with the basis, and price range for each product if applicable.

This Handbook is a companion to the fourth edition of the *Handbook of Petroleum Refining Processes*. That Handbook, in the same format, consists of 54 licensor technology chapters for the processing of petroleum to gasoline and other fuels and products. The two handbooks, together, provide a comprehensive set of technologies for converting crude oil to fuels, intermediates, commodity chemicals, and the major plastics.

*Robert A. Meyers, Ph.D.*

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# LICENSING CONTACTS

---

## ***Air Liquide***

Ingo F. Litzenger, E&C Director Sales Technology & Central Europe  
ingo.litzenger@airliquide.com  
Phone: +49 - 69 - 5808 4282  
petrochemicals@airliquide.com

## ***Axens***

Eric Benazzi  
Vice-President  
Marketing & External Communications  
Tél. : +33 1 47 14 24 34  
eric.benazzi@axens.net www.axens.net

## ***BASF***

Stefan Iselborn  
stefan.iselborn@basf.com

## ***Borealis Group***

Tarja Korvenoja, Licensing manager, +358-50-3794154,  
Tarja.korvenoja@borealisgroup.com

Ludo Vanshoren, Technology Transfer manager, +32-475290404,  
ludo.vanshoren@borealisgroup.com

## ***McDermott (Lummus Technology)***

Brian Muldoon, Vice President, Petrochemicals, Lummus Technology  
brian.muldoon@mcdermott.com

## ***GTC Technology US LLC***

900 Threadneedle St., Suite 800  
Houston, Texas 77079 USA  
inquiry@gtctech.com.  
281-597-4800 Office  
281-597-0942 Fax  
www.gtctech.com

## ***Honeywell UOP***

John Simley  
Director, Corporate Communications  
25 E. Algonquin Rd., Des Plaines, IL 60016  
Office: +1 847.391.2278  
Mobile: +1 847.612.1484  
john.simley@honeywell.com  
www.uop.com

Johnson Matthey  
Email: [Licensing@matthey.com](mailto:Licensing@matthey.com)  
Phone: +44 (0)20 7957 4120  
Address: Johnson Matthey, 10 Eastbourne Terrace, London W2 6LG UK  
Web: [www.matthey.com](http://www.matthey.com)

***NOVA Chemicals Corporation***

Keith Wiseman—Product Technology Manager-Licensing  
NOVA Chemicals Corporation  
1000—7th Avenue S.W.  
Calgary, Alberta  
Canada T2P 5C6  
E-Mail: [keith.wiseman@novachem.com](mailto:keith.wiseman@novachem.com)

***TechnipFMC***

Ronald Birkhoff  
Vice President, Process Technology  
11740 Katy Freeway  
Houston, Texas 77079  
Email: [ronald.birkhoff@technipFMC.com](mailto:ronald.birkhoff@technipFMC.com) or [PT@technipfmc.com](mailto:PT@technipfmc.com)  
Phone: +1 281 848 5068  
Website: [technipfmc.com](http://technipfmc.com)

***Badger Technologies***

Dana Johnson  
Director, Licensing  
One Financial Center  
Boston, Massachusetts 02111  
Email: [dana.johnson@badgerlicensing.com](mailto:dana.johnson@badgerlicensing.com) or [PT@technipfmc.com](mailto:PT@technipfmc.com)  
Web: [www.badgerlicensing.com](http://www.badgerlicensing.com)

***W. R. Grace***

Ella Chen  
Commercial Director  
UNIPOL® PP Licensing  
W. R. Grace  
7500 Grace Drive  
Columbia, MD 21044  
[ella.chen@grace.com](mailto:ella.chen@grace.com)  
203 364 0638

Tracy Cleckler  
Global Business Director  
UNIPOL® PP Licensing  
W. R. Grace  
7500 Grace Drive  
Columbia, MD 21044  
[tracy.cleckler@grace.com](mailto:tracy.cleckler@grace.com)  
410 531 8770

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**HANDBOOK OF  
PETROCHEMICALS  
PRODUCTION PROCESSES**

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# INTERMEDIATES