FOURTH EDITION 影印版

HANDBOOK OF PETROLEUM REFINING PROCESSES

石油精炼工艺手册

石油化工基础理论

Robert A. Meyers

- The latest petroleum refining processes and techniques
- Fully explains the latest shale gas and oil excavation and refining procedu
- Product-by-product specs, budgeting, and environmental coverage
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影印版说明

本书是美国 McGraw-Hill Education 公司 2016 年出版的 *Handbook of Petroleum Refining Processes* Fourth Edition 的影印版。本书深入讲解了当今最先进的炼油技术、工艺和方法，并介绍了符合环保要求的燃料和石化中间体以及石油炼制工艺的最新发展成果。

考虑到使用方便，影印时进行了内容整合，并分为 5 册 ：

1 石油化工基础理论

2 裂化与焦化

3 脱氢、加氢处理与氢化工艺

4 萃取脱硫与分离工艺

5 产品生产工艺与技术

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Robert A. Meyers, Ph.D. Editor-in-Chief

Fourth Edition

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New York Chicago San Francisco Athens London
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Singapore Sydney Toronto

PREFACE

The *Handbook of Petroleum Refining Processes* is a compendium of licensable technologies for the refining of petroleum and production of environmentally acceptable fuels and petrochemical intermediates.

This fourth edition is being published as technological advances in the production of shale, offshore and lower-quality gas, and petroleum resources require new, advanced refining technologies. Advanced methanol-to-olefins processes will provide a pathway to convert cost-advantaged alternative feedstocks such as coal, natural gas, biomass, and petroleum coke to light olefins, such as ethylene and propylene. There is emphasis on low-sulfur fuels, driven by regulations requiring the average annual sulfur content of all gasoline used in the United States to be phased down according to Tier III regulations beginning in 2017, reducing the sulfur content in motor gasoline to <10 wt ppm.

Also, regulations on the benzene content in gasoline have continued to be more stringent, with the intent of further reducing hazardous air pollutants. In the United States, the Environmental Protection Agency (EPA) has implemented a Mobile Source Air Toxics (MSAT2) rule for reducing the benzene content in gasoline. Regulations started in July 2012, limiting gasoline to a maximum annual average benzene content of 1.3 vol%. Benzene also is being regulated in other regions such as Europe, with the Euro V fuel specifications set at a maximum benzene content of 1.0 vol%. Many other nations such as China, Russia, Canada, and Japan have adapted the 1.0 vol% benzene maximum. Diesel fuel in Europe and most parts of Asia already has to adhere to very low sulfur and multiple other specifications related to emissions. On the fuel oil side, International Maritime Organization (IMO) specifications will severely impact the residual fuel oil market within the next 5 years, and most major refiners are either implementing or planning to implement residue upgrading utilizing either desulfurization or hydrocracking.

This Handbook presents technology for meeting all of these challenges while providing exceptionally high yields, superior product quality, lower investment and operating costs, reliable long-run operations, operating versatility, reduced water usage, and minimization of wastes and pollution.

The Handbook has been prepared by a group of eight major global licensors of petroleum refining technology. These are Amec Foster Wheeler USA Corporation, Axens, Badger, CB&I, Chevron Lummus Global, Honeywell UOP, Sinopec, and Technip Stone & Webster.

The Handbook is divided into 15 parts, containing 53 chapters:

Part 1, "Alkylation and Polymerization," presents technologies for combining olefins, or olefins with paraffins, to form clean-burning, high-octane, aromatic-free alkylate, for gasoline or distillate transportation fuel blending, and olefins with benzene to produce cumene and linear alkylbenzene.

Part 2, "Base Aromatics Production Processes," presents technologies to convert petroleum naphtha, LPG, and pyrolysis gasoline into the basic petrochemical intermediates benzene, toluene, and xylene (BTX). Technologies to recover aromatics from hydrocarbon and aromatic mixtures and processes to convert alkylbenzenes to high-purity benzene, xylene, or naphthalene also are covered.

Part 3, "Catalytic Cracking," covers fluid catalytic cracking technologies for converting vacuum gas oils, coker gas oils, and some residual oils, as well as aromatic lube extracts, to gasoline, C3 to C5 olefins, and light cycle oil.

Part 4, "Dehydrogenation," presents technology for the dehydrogenation of light and heavy paraffins to the corresponding monoolefins.

Part 5, "Synthesis Gas and Hydrogen Production," covers production of hydrogen from natural gas by steam reforming, or partial oxidation followed by shift conversion, and also hydrogen production via an initial gasification of bituminous, sub-bituminous, and lignitic coals.

Part 6, "Hydrocracking," presents technologies to convert any petroleum fraction from naphtha to cycle gas oil and coker distillates into LPG, gasoline, diesel, jet fuel, and lubricating oils while removing sulfur, nitrogen, oxygen, and saturating olefins.

Part 7, "Hydrotreating," covers technologies for improving the quality of various oil fractions by removing sulfur, nitrogen, carbon residue, metals, and wax, while increasing the hydrogen content by saturating olefins, dienes, acetylenes, and aromatics. Simultaneous cracking of heavy residua also is covered in this part.

Part 8, "Isomerization," presents technologies for converting light, straight-chain naphthas (C4 to C6 and benzene-containing reformates) to branched and higher-octane products while saturating benzene.

Part 9, "Separation Processes," presents technologies for recovery of catalysts from high-metal residua; olefins from mixtures of olefins and paraffins; and normal paraffins from isoparaffins, naphthenes, and aromatics; and separation of vacuum residua into an uncontaminated, demetallized oil and highly viscous pitch.

Part 10, "Sulfur Compound Extraction and Sweetening," contains technologies for the removal of sulfur from refinery streams and the production of ultralow sulfur diesel and gasoline fuels as well as sulfur by-products.

Part 11, "Visbreaking and Coking," contains technologies for rejection of metals and coke, gasification of coke, and recovery of lighter hydrocarbons from distillation unit bottoms.

Part 12, "Catalytic Reforming," covers conversion of naphthas, paraffins, naphthenes, and aromatics, by contact with a platinum-containing acidic catalyst at elevated temperatures, to a product that is rich in aromatic hydrocarbons.

Part 13, "Oxygenates Production Technologies," presents methods for production of refinery ethers for the oxygenate portion of the gasoline pool.

Part 14, "Olefins from Methanol," contains methods to (1) convert natural gas to ultraclean liquid fuels (naphtha, kerosene, diesel/gas oil) that contain no sulfur, aromatics, or heavy metals, which can also be used as cracker feed for ethylene and propylene production, and (2) produce methanol and then convert to ethylene and propylene as feed to a polyolefins plant.

Part 15, "Hydrogen Processing," is a comprehensive historical treatment of hydrogen use within the refinery covering fundamentals, design, and process capabilities.

The authors of the various chapters were asked to follow the technology-presentation specification given below (some of the requested information was not deemed to be disclosable by the licensors for certain of the chapters):

1. *General process description.* Including charge and product yield and purity, and a simplified flow diagram.
2. *Process chemistry and thermodynamics.* For each major process unit.
3. *Process perspective.* Developers, locations, and specifications 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 variations and feeds.

6. *Wastes and emissions.* Process solid, liquid, and gas wastes and emissions as a function of processing variations and feeds.
7. *Process economics.* Installed capital cost by major section, total capital investment, operating costs, annualized capital costs with the basis, and a price range for each product.

The back matter contains a glossary of terms and a list of abbreviations and acronyms, which are meant to be useful for the nonspecialist in understanding the content of the chapters.

Robert A. Meyers, Ph.D.
Editor-in-Chief

ACKNOWLEDGMENTS

A team of more than 90 distinguished scientists and engineers prepared the 53 chapters of this Handbook. These contributors are listed on pp. xix to xxi. They were supported by additional staff and management at each firm.

Amanda Quinn, our McGraw-Hill Education editor, deserves special recognition for her hands-on leadership in bringing the project to completion.

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ALKYLATION AND POLYMERIZATION