

Chapter 3 Catalytic Combustible Gas Sensors

Covers the timely topic of fuel cells and hydrogen-based energy from its fundamentals to practical applications Serves as a resource for practicing researchers and as a text in graduate-level programs Tackles crucial aspects in light of the new directions in the energy industry, in particular how to integrate fuel processing into contemporary systems like nuclear and gas power plants Includes homework-style problems The book illuminates various aspects of heterogeneous catalysis engineering, from catalysis design, catalyst preparation and characterization, reaction kinetics, mass transfer, and catalytic reactors to the implementation of catalysts in chemical technology. Aimed at graduate students, it is also a useful resource for professionals working in research and development.

Provides an overview of the different pathways to produce Synthetic Natural Gas Covers technological, and economic aspects of this Synthetic Natural Gas Details the most popular technologies and state-of-the-art of SNG technologies while also covering recent and future research trends Covers the main process steps during conversion of coal and dry biomass to SNG: gasification, gas cleaning, methanation and gas upgrading Describes a number of novel processes for the production of SNG with their specific combination of process steps as well as the boundary conditions Covers important technical aspects of Power-to-Gas processes

Heterogeneous catalysis plays a central role in the global energy paradigm, with practically all energy-related process relying on a catalyst at a certain point. The application of heterogeneous catalysts will be of paramount importance to achieve the transition towards low carbon and sustainable societies. This book provides an overview of the design, limitations and challenges of heterogeneous catalysts for energy applications. In an attempt to cover a broad spectrum of scenarios, the book considers traditional processes linked to fossil fuels such as reforming and hydrocracking, as well as catalysis for sustainable energy applications such as hydrogen production, photocatalysis, biomass upgrading and conversion of CO₂ to clean fuels. Novel approaches in catalysts design are covered, including microchannel reactors and structured catalysts, catalytic membranes and ionic liquids. With contributions from leaders in the field, Heterogeneous Catalysis for Energy Applications will be an essential toolkit for chemists, physicists, chemical engineers and industrials working on energy.

Catalytic conversion of hydrocarbons serve an essential role in generating energy and creating high value chemicals. In some cases, as in propylene combustion, a commercial catalyst does exist, however, the catalyst is expensive and inefficient, which calls for a better catalyst. In other cases, such as converting methane to ethylene, there is not a viable catalyst. In both cases, fundamental understanding and new concepts are needed to develop new catalysts. In this thesis, if a commercial catalyst exists, we attempt to shed light on the fundamentals explaining why the catalyst works and how to further improve the catalytic activity. If no catalyst exists for the process, we attempt to fundamentally understand the challenge in the catalytic process, identify the key properties of the ideal catalyst, and present options for developing that catalyst. We employ density functional theory (DFT) coupled with microkinetic modeling tools to achieve those goals.

Experimental data, when available in the literature, are compared to our theoretical predictions to assess their reliability. The conversion of methane into higher value chemicals (i.e. ethane/ethylene) can play a key role in transforming the chemical industry, especially with the recent surge in natural gas production. The catalytic process, however, remains a major challenge due to the difficulty in activating the strong C-H bond in methane without producing the thermodynamically more favorable complete combustion products. The primary objective of Chapters 2 is to fundamentally understand why MgO, one of the rare catalysts that has shown some catalytic activity in the process, works.

Chapter 3 attempts to go beyond the limitations of MgO and proposes new catalysts for the process. The conversion of methanol to formaldehyde presents a similar challenge since the desired product, formaldehyde, is more active than the starting material, methanol. Silver is one of the few catalysts that are used commercially for the process. Chapter 4 attempts to shed light on why silver is an effective catalyst for the process. Efficient hydrocarbon combustion remains imperative until new alternative fuels are developed. The computational study of hydrocarbon combustion, however, remains a major challenge in computational catalysis due to the great many possible intermediates.

Chapters 5 and 6 present a methodical way of tackling that problem, focusing on methane, ethylene, and propylene as model compounds.

The last chapter (Chapter 6) discusses a new approach for calculating the C-C transition state energy based on a few simple calculations. It is an attempt to reduce the computational cost of studying complex hydrocarbon conversion processes by reducing the calculations cost. In summary, the dissertation presents a fundamental approach for studying short chain hydrocarbon conversion and highlights the important factors affecting the catalytic activity. The overall goal is to help in guiding experimentalists to a creative design of new catalysts for those processes.

Concerns over an unstable energy supply and the adverse environmental impact of carbonaceous fuels have triggered considerable efforts worldwide to find carbon-free or low-carbon alternatives to conventional fossil fuels. Carbon-Neutral Fuels and Energy Carriers emphasizes the vital role of carbon-neutral energy sources, transportation fuels, and associated technologies for establishing a sustainable energy future. Each chapter draws on the insight of world-renowned experts in such diverse fields as photochemistry and electrochemistry, solar and nuclear energy, biofuels and synthetic fuels, carbon sequestration, and alternative fuel vehicles. After an introductory chapter on different energy options in a carbon-constrained world and proposed measures to stabilize atmospheric CO₂, the book analyzes the advantages and challenges facing the introduction of hydrogen fuel to the marketplace. It then examines the role of nuclear power in the production of carbon-free energy and fuels as well as the efficient use and storage of renewable energy resources, emphasizing the production of solar fuels from water and CO₂. The book also discusses different aspects of bioenergy and biofuels production and use and the potential role of bio-inspired energy systems and industrial processes. The final chapters present a thorough overview and analysis of state-of-the-art fossil fuel decarbonization technologies and clean transportation options. This authoritative work provides the information needed to make more informed choices regarding available clean energy and fuel alternatives. It helps readers to better understand the interconnection between energy and the environment as well as the potential impact of human activities on climate.

Written by an author with over 38 years of experience in the chemical and petrochemical process industry, this handbook will present an analysis of the process steps used to produce industrial hydrocarbons from various raw materials. It is the first book to offer a thorough analysis of external factors effecting production such as: cost, availability and environmental legislation. An A-Z list of raw materials and their properties are presented along with a commentary regarding their cost and availability. Specific processing operations described in the book include: distillation, thermal cracking and coking, catalytic methods, hydroprocesses, thermal and catalytic reforming, isomerization, alkylation processes, polymerization processes, solvent processes, water removal, fractionation and acid gas removal. Flow diagrams and descriptions of more than 250 leading-edge process technologies An analysis of chemical reactions and process steps that are required to produce chemicals from various raw materials Properties, availability and environmental impact of various raw materials used in hydrocarbon processing

These proceedings reflect the extensive fundamental and applied research efforts that are currently being made on the conversion of gas, in particular on the direct conversion of methane. The Symposium in Oslo focused on the following topics: Direct conversion of methane, Fischer-Tropsch chemistry, methanol conversion and natural gas conversion processes. The main aim was to present the state-of-the-art and progress currently being made within each of these areas. The book contains the papers presented and includes plenary lectures, short communications and posters. The papers will be of interest to scientists and engineers working in the field of gas conversion, transportation fuels, primary petrochemicals and catalysis.

A decade ago, the U.S. chemical industry was in decline. Of the more than 40 chemical manufacturing plants being built worldwide in the

mid-2000s with more than \$1 billion in capitalization, none were under construction in the United States. Today, as a result of abundant domestic supplies of affordable natural gas and natural gas liquids resulting from the dramatic rise in shale gas production, the U.S. chemical industry has gone from the world's highest-cost producer in 2005 to among the lowest-cost producers today. The low cost and increased supply of natural gas and natural gas liquids provides an opportunity to discover and develop new catalysts and processes to enable the direct conversion of natural gas and natural gas liquids into value-added chemicals with a lower carbon footprint. The economic implications of developing advanced technologies to utilize and process natural gas and natural gas liquids for chemical production could be significant, as commodity, intermediate, and fine chemicals represent a higher-economic-value use of shale gas compared with its use as a fuel. To better understand the opportunities for catalysis research in an era of shifting feedstocks for chemical production and to identify the gaps in the current research portfolio, the National Academies of Sciences, Engineering, and Medicine conducted an interactive, multidisciplinary workshop in March 2016. The goal of this workshop was to identify advances in catalysis that can enable the United States to fully realize the potential of the shale gas revolution for the U.S. chemical industry and, as a result, to help target the efforts of U.S. researchers and funding agencies on those areas of science and technology development that are most critical to achieving these advances. This publication summarizes the presentations and discussions from the workshop.

Special edition of the Federal Register, containing a codification of documents of general applicability and future effect ... with ancillaries. Skyrocketing energy costs have spurred renewed interest in coal gasification. Currently available information on this subject needs to be updated, however, and focused on specific coals and end products. For example, carbon capture and sequestration, previously given little attention, now has a prominent role in coal conversion processes. This book approaches coal gasification and related technologies from a process engineering point of view, with topics chosen to aid the process engineer who is interested in a complete, coal-to-products system. It provides a perspective for engineers and scientists who analyze and improve components of coal conversion processes. The first topic describes the nature and availability of coal. Next, the fundamentals of gasification are described, followed by a description of gasification technologies and gas cleaning processes. The conversion of syngas to electricity, fuels and chemicals is then discussed. Finally, process economics are covered. Emphasis is given to the selection of gasification technology based on the type of coal fed to the gasifier and desired end product: E.g., lower temperature gasifiers produce substantial quantities of methane, which is undesirable in an ammonia synthesis feed. This book also reviews gasification kinetics which is informed by recent papers and process design studies by the US Department of Energy and other groups, and also largely ignored by other gasification books.

- Approaches coal gasification and related technologies from a process engineering point of view, providing a perspective for engineers and scientists who analyze and improve components of coal conversion processes
- Describes the fundamentals of gasification, gasification technologies, and gas cleaning processes
- Emphasizes the importance of the coal types fed to the gasifier and desired end products
- Covers gasification kinetics, which was largely ignored by other gasification books

Natural Gas Conversion VElservier

Understanding the chemistry underlying sustainable energy is central to any long-term solution to meeting our future energy needs.

Chemistry of Sustainable Energy presents chemistry through the lens of several sustainable energy options, demonstrating the breadth and depth of research being carried out to address issues of sustainability and the gl

Interest in structured catalysts is steadily increasing due to the already proven, as well as potential, advantages of these catalysts. Updating the comprehensive coverage of the first edition published in 1998 with the latest science and applications, Structured Catalysts and Reactors, Second Edition gives detailed information on all aspects of structured catalysts and reactors, including: materials, mass transfer, selectivity, activity, and stability; catalyst preparation, design, and characterization; process development; modeling and optimization; reactor design; and operation costs and considerations. The book first examines how monolithic catalysts are used to clean exhaust gas from gasoline engines, treat industrial off-gases, burn fuels in commercial settings, and synthesize chemicals in two- and three-phase processes. It discusses configurations, microstructure, physical properties, and manufacture of ceramic and metallic monoliths before directing its focus to arranged catalysts and structured packings in terms of mass transfer. The book then explores catalytically active membranes and filters, featuring metallic membranes, permeation mechanisms, preparation and modeling, commercial membranes, and the latest applications, such as zeolitic membranes. Finally, several chapters present techniques for incorporating catalytic species into the structured catalyst support and controlling catalyst nanoporosity. This book conveys the scientific as well as economic advantages of using these unconventional catalytic techniques. With over 1500 references, tables, drawings, and photographs, as well as in-depth discussions and a new approach to catalytic processes, Structured Catalysts and Reactors, Second Edition is an essential reference for anyone working with or studying catalysis.

With well over 90% of all processes in the industrial chemical production being of catalytic nature, catalysis is a mature though ever interesting topic. The idea of this book is to tackle various aspects of heterogeneous catalysis from the engineering point of view and go all the way from engineering of catalysis, catalyst preparation, characterization, reaction kinetics, mass transfer to catalytic reactors and the implementation of catalysts in chemical technology. Aimed for graduate students it is also a useful resource for professionals coming from the more academic side.

Because evidence that shows that diesel fumes are more toxic than was previously thought, there has been increased interest in the use of natural gas for vehicles operating in cities. Transit buses, traditionally fueled by diesel, are one of the cheapest forms of mass transit. They are also significant polluters and typically operate in heavily congested urban areas, where significant air pollution problems exist. The report provides an overview of the issues that must be considered when evaluating natural gas an alternative to diesel for use in transit buses.

The second edition of a comprehensive textbook that introduces turbomachinery and gas turbines through design methods and examples. This comprehensive textbook is unique in its design-focused approach to turbomachinery and gas turbines. It offers students and practicing engineers methods for configuring these machines to perform with the highest possible efficiency. Examples and problems are based on the actual design of turbomachinery and turbines. After an introductory chapter that outlines the goals of the book and provides definitions of terms and parts, the book offers a brief review of the basic principles of thermodynamics and efficiency definitions. The rest of the book is devoted to the analysis and design of real turbomachinery configurations and gas turbines, based on a consistent application of thermodynamic theory and a more empirical treatment of fluid dynamics that relies on the extensive use of design charts. Topics include turbine power cycles, diffusion and diffusers, the analysis and design of three-dimensional free-stream flow, and combustion systems and combustion calculations. The second edition updates every chapter, adding material on subjects that include flow correlations, energy transfer in turbomachines, and three-dimensional design. A solutions manual is available for instructors. This new MIT Press edition makes a popular text available again, with corrections and some updates, to a wide audience of students, professors, and professionals.

This edited book looks at recent studies on interdisciplinary research related to exergy, energy, and the environment. This topic is of prime significance – there is a strong need for practical solutions through better design, analysis and assessment in order to achieve better efficiency, environment and sustainability. Exergetic, Energetic and Environmental Dimensions covers a number of topics ranging from thermodynamic optimization of energy systems, to the environmental impact assessment and clean energy, offering readers a comprehensive reference on analysis, modeling, development, experimental investigation, and improvement of many micro to macro systems

and applications, ranging from basic to advanced categories. Its comprehensive content includes: Comprehensive coverage of development of systems considering exergy, energy, and environmental issues, along with the most up-to-date information in the area, plus recent developments New developments in the area of exergy, including recent debate involving the shaping of future directions and priorities for better environment, sustainable development and energy security Provides a number of illustrative examples, practical applications, and case studies Introduces recently developed technological and strategic solutions and engineering applications for professionals in the area Provides numerous engineering examples and applications on exergy Offers a variety of problems that foster critical thinking and skill development

Catalysis is central to the chemical industry, as it is directly or involved in the production of almost all useful chemical products. In this book the authors, present the definitive account of industrial catalytic processes. Throughout *Fundamentals of Industrial Catalytic Processes* the information is illustrated with many case studies and problems. This book is valuable to anyone wanting a clear account of industrial catalytic processes, but is particularly useful to industrial and academic chemists and engineers and graduate working on catalysis. This book also: Covers fundamentals of catalytic processes, including chemistry, catalyst preparation, properties and reaction engineering. Addresses heterogeneous catalytic processes employed by industry. Provides detailed data on existing catalysts and catalytic reactions, process design and chemical engineering. Covers catalysts used in fuel cells.

One-stop, multi-application guide to gas detection technology Find all the help you need to understand, select, and implement proper gas detection instrumentation for any application in this guide. The range of data, and a full-color format with superb graphics illustrating key points, make this an invaluable tool for environmental health and safety engineers, industrial hygienists, and plant managers. The guide packs crystal-clear explanations of basic technical terminology, including definitions of toxicity of gases, combustibility of gas, and occupational health and fire safety terms. You get a complete, up-to-date picture of gas analysis that includes an inside-out look at five of the most common types of sensor technologies in use today, as well as ten additional detecting technologies.

Natural gas has traditionally been used as a feedstock for the chemical industry, and as a fuel for process and space heating. Recent advances in exploration, drilling techniques and hydraulic fracturing have made it possible for natural gas to become available in abundance (as of 2012). As natural gas displaces traditional petroleum use in various sectors, a certain amount of disruption is likely. In such a changing landscape, this book tries to chronicle the state-of-the-art in various aspects of natural gas: exploration, drilling, gas processing, storage, distribution, end use and finally the impact on financial markets. Review articles as well as research papers contributed by leading authorities around the world comprise individual chapters of this book. Modeling approaches, as well as, recent advances in specific natural gas technologies are covered in detail.

Oxidation reactions are an important chemical transformation in both academia and industry. Among the major advances in the field has been the development of catalytic processes, which are not only selective and efficient, but also allow the replacement of common stoichiometric oxidants with molecular oxygen, ideally from air at atmospheric pressure. This results in processes with higher atom efficiency, where water is the only side product in line with the principles of green chemistry. Focusing on the use of molecular oxygen as the terminal oxidant, this book covers recent advances in both heterogeneous and homogeneous systems, with and without metals and on the "taming" of the highly reactive oxygen gas by use of micro-flow reactors and membranes. A useful reference for industrial and academic chemists working on oxidation processes, as well as green chemists.

This book deals with the physics and chemistry of all kinds of energy resources - coal, gas, oil, hydropower, and nuclear. After a brief introduction to the concepts of force, work, and energy, the book discusses energy resources and reserves, followed by discussions of electric power and methods for generating electricity. The discussion then turns to the uses of energy in agriculture, transportation, etc., and the pollution that accompanies these uses. The book concludes with material on energy conservation and energy supplies for the future. This volume contains peer-reviewed manuscripts describing the scientific and technological advances presented at the 6th Natural Gas Conversion Symposium held in Alaska in June 2001. This symposium continues the tradition of excellence and the status as the premier technical meeting in this area established by previous meetings. The 6th Natural Gas Conversion Symposium is conducted under the overall direction of the Organizing Committee. The Program Committee was responsible for the review, selection, editing of most of the manuscripts included in this volume. A standing International Advisory Board has ensured the effective long-term planning and the continuity and technical excellence of these meetings.

Publisher Description

We cannot continue on a business-as-usual, carbon fuel dependent mode of operation, because the consequences of doing so are catching up with us. So, what must we do to ensure there is a tomorrow? In this book, experts from around the world come together to shed light on what we can do to preserve and expand resources key to the survival of human civilization — from the state-of-the-art of innovative engineering; to the latest status on energy, energy mix, and advancements in renewable energy — including the complementary energy storage using hydrogen; or innovative architecture for more sustainable buildings, including retrofitting of aging tall buildings; innovative ways to improve our air, water and coastline with nearshore biodiversity reclamation; to the subject of sustainable development through the water-energy-food nexus. This volume is recommended for research and graduate courses on energy and sustainability, and policymakers interested in the subjects.

The Code of Federal Regulations is the codification of the general and permanent rules published in the Federal Register by the executive departments and agencies of the Federal Government.

This is the first comprehensive guide to the principles and techniques of chemical looping partial oxidation. With authoritative explanations from a pioneer of the chemical looping process, you will: • Gain a holistic overview of metal oxide reaction engineering, with coverage of ionic diffusion, nanostructure formation, morphological evolution, phase equilibrium, and recyclability properties of metal oxides during redox reactions • Learn about the gasification of solid fuels, the reforming of natural gas, and the catalytic conversion of methane to olefins • Understand the importance of reactor design and process integration in enabling metal oxide oxygen carriers to produce desired products • Discover other applications of catalytic metal oxides, including the production of maleic anhydride and solar energy conversions Aspen Plus® simulation software and results accompany the book online. This is an invaluable reference for researchers and industry professionals in the fields of chemical, energy and environmental engineering, and students studying process design and optimization.

There is an increasing challenge for chemical industry and research institutions to find cost-efficient and environmentally sound methods of converting natural resources into fuels chemicals and energy. Catalysts are essential to these processes and the *Catalysis Specialist Periodical Report* series serves to highlight major developments in this area. This

series provides systematic and detailed reviews of topics of interest to scientists and engineers in the catalysis field. The coverage includes all major areas of heterogeneous and homogeneous catalysis and also specific applications of catalysis such as NO_x control kinetics and experimental techniques such as microcalorimetry. Each chapter is compiled by recognised experts within their specialist fields and provides a summary of the current literature. This series will be of interest to all those in academia and industry who need an up-to-date critical analysis and summary of catalysis research and applications. Catalysis will be of interest to anyone working in academia and industry that needs an up-to-date critical analysis and summary of catalysis research and applications. Specialist Periodical Reports provide systematic and detailed review coverage in major areas of chemical research. Compiled by teams of leading experts in their specialist fields, this series is designed to help the chemistry community keep current with the latest developments in their field. Each volume in the series is published either annually or biennially and is a superb reference point for researchers.

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Our NEET Foundation series is sharply focused for the NEET aspirants. Most of the students make a career choice in the middle school and, therefore, choose their stream informally in secondary and formally in senior secondary schooling, accordingly. If you have decided to make a career in the medical profession, you need not look any further! Adopt this series for Class 9 and 10 today.

Addressing a field which, until now, has not been sufficiently investigated, *Essentials of Natural Gas Microturbines* thoroughly examines several natural gas microturbine technologies suitable not only for distributed generation but also for the automotive industry. An invaluable resource for power systems, electrical, and computer science engineers as well as operations researchers, microturbine operators, policy makers, and other industry professionals, the book: Explains the importance of natural gas microturbines and their use in distributed energy resource (DER) systems Discusses the history, development, design, and operation of gas microturbines Introduces the Evolutionary Algorithm for pollutant emissions and fuel consumption minimization Analyzes the power electronics for grid connection of natural gas microturbines Includes actual power quality measurements—graphical representations and numerical data—from a real system Contains 39 color figures Readers benefit from the clarity and practicality of *Essentials of Natural Gas Microturbines*, ultimately learning new techniques to increase electrical load efficiency, keep the environment cleaner, and improve equipment exploitation based on mathematical results.

Direct Natural Gas Conversion to Value-Added Chemicals comprehensively discusses all major aspects of natural gas conversion and introduces a broad spectrum of recent technological developments. Specifically, the book describes heterogeneous and homogeneous catalysis, microwave-assisted conversion, non-thermal plasma conversion, electrochemical conversion, and novel chemical looping conversion approaches. Provides an excellent benchmark resource for the industry and academics Appeals to experienced researchers as well as newcomers to the field, despite the variety of contributing authors and the complexity of the material covered Includes all aspects of direct natural gas conversion: fundamental chemistry, different routes of conversion, catalysts, catalyst deactivation, reaction engineering, novel conversion concepts, thermodynamics, heat and mass transfer issues, system design, and recent research and development Discusses new developments in natural gas conversion and future challenges and opportunities This book is as an excellent resource for advanced students, technology developers, and researchers in chemical engineering, industrial chemistry, and others interested in the conversion of natural gas.

To ask the right question, one needs to have some idea of what the answer might be. So it is with remediation. There is no such thing as too much information when it comes to characterizing a site, as information can aid in selecting the best remediation options. Unfortunately, the collection of data for making an informed decision is often costly, forcing professionals to make decisions on incomplete data. The lack of accurate data can also lead to the wrong remediation method selections, unwanted surprises, and extra expense. Based on the author's more than 40 years of experience working on environmental projects, *Remediation Manual for Contaminated Sites* provides a practical guide to environmental remediation and cleanups. It presents a broad overview of the environmental remediation process, distilled into what one needs to know to evaluate a specific challenge or solve a remediation problem. The text offers guidance on tasks that range from managing consultants and contractors to gathering data, selecting a suitable remediation technology, and calculating remediation costs. The book includes remediation strategies for a variety of contaminants and examines a wide range of technologies for the remediation of water and soil, including excavation, wells, drainage, soil venting, vapor stripping, incineration, bioremediation, containment, solidification, vitrification, and phytoremediation. Written as a down-to-earth reference for professionals faced with the challenges of remediating a contaminated site, this book is also useful as a primer for students and those new to the field. It includes numerous figures, photographs, tables, and helpful checklists.

Natural gas is a vital component of the world's supply of energy and an important source of many bulk chemicals and speciality chemicals. It is one of the cleanest, safest, and most useful of all energy sources, and helps to meet the world's rising demand for cleaner energy into the future. However, exploring, producing and bringing gas to the user or converting gas into desired chemicals is a systematical engineering project, and every step requires thorough understanding of gas and the surrounding environment. Any advances in the process link could make a step change in gas industry. There have been increasing efforts in gas industry in recent years. With state-of-the-art contributions by leading experts in the field, this book addressed the technology advances in natural gas industry.

Energy and feedstock materials for the chemical industry are in increasing demand and, with constraints related to the availability and use of oil, the energy and chemical industry is undergoing considerable changes. In recent years, major restructuring has occurred in the oil, petrochemical, and chemical industry, with increasing attention devoted to the use of natural gas, methane in particular, as a chemical feedstock rather than just as a fuel. The conversion of remote natural gas into liquid fuels or other transportable chemicals is a challenge to industrial catalysis. Few processes exist so far with the major ones involving the conversion of natural gas to synthesis gas by steam reforming, CO₂ reforming, or partial oxidation, followed by the syntheses of methanol, hydrocarbons (Fischer-Tropsch synthesis), or ammonia. In this book, a comprehensive overview of the field of

processing natural gas is given, through a series of chapters written by leading scientists and engineers in the field. New developments are discussed and current work relevant to the area is shown by a series of recent works by researchers working in this and related fields.

On January 1988, the ascertained and economically accessible reserves of Natural Gas (NG) amounted to over 144,000 billion cubic meters worldwide, corresponding to 124 billion tons of oil equivalents (comparable with the liquid oil reserves, which are estimated to be 138 billion TOE). It is hypothesized that the volume of NG reserve will continue to grow at the same rate of the last decade. Forecasts on production indicate a potential increase from about 2,000 billion cubic meters in 1990 to not more than 3,300 billion cubic meters in 2010, even in a high economic development scenario. NG consumption represents only one half of oil: 1.9 billion TOE/y as compared to 3.5 of oil. Consequently, in the future gas will exceed oil as a carbon atom source. In the future the potential for getting energetic vectors or petrochemicals from NG will continue to grow. The topics covered in Natural Gas Conversion V reflect the large global R&D effort to look for new and economic ways of NG exploitation. These range from the direct conversion of methane and light paraffins to the indirect conversion through synthesis gas to fuels and chemicals. Particularly underlined and visible are the technologies already commercially viable. These proceedings prove that mature and technologically feasible processes for natural gas conversion are already available and that new and improved catalytic approaches are currently developing, the validity and feasibility of which will soon be documented. This is an exciting area of modern catalysis, which will certainly open novel and rewarding perspectives for the chemical, energy and petrochemical industries.

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