

Ammonia Synthesis For Fertilizer Production

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Ammonia - Max Appl 1999-04-22

Ammonia is one of the most important inorganic basic chemicals, not only for the manufacture of fertilizers (85%) but also for the production of plastics, fibers, explosives, and intermediates for dyes and pharmaceuticals. It is an essential reaction component for the synthesis of numerous organic chemicals used as solvents and intermediates. The book provides a practical and up-to-date account of the product properties, synthesis and reaction mechanisms, including catalysis and commercial catalysts, modern production technology for different feedstocks, quality specifications and environmental health and safety aspects, uses and economic data of this important commodity chemical. It also discusses perspectives of future developments of commercial ammonia production. Over 1400 references to the relevant literature complete this concise presentation, whose aim is to inform the reader of the present status of the theory and practice of industrial ammonia production. Chemical engineers, engineers and chemists in industry, engineering companies, catalyst manufacturers, equipment makers and chemical engineering university departments will certainly profit from this comprehensive review based on the author's long practical experience in a leading technical management position of one of the largest European ammonia producers.

Thermal Design and Optimization - Adrian Bejan 1995-12-12

A comprehensive and rigorous introduction to thermal system design from a contemporary perspective Thermal Design and Optimization offers readers a lucid introduction to the latest methodologies for the design of thermal systems and emphasizes engineering economics, system simulation, and optimization methods. The methods of exergy analysis, entropy generation minimization, and thermoeconomics are incorporated in an evolutionary manner. This book is one of the few sources available that addresses the recommendations of the Accreditation Board for Engineering and Technology for new courses in design engineering. Intended for classroom use as well as self-study, the text provides a review of fundamental concepts, extensive reference lists, end-of-chapter problem sets, helpful appendices, and a comprehensive case study that is followed throughout the text. Contents include: * Introduction to Thermal System Design * Thermodynamics, Modeling, and Design Analysis * Exergy Analysis * Heat Transfer, Modeling, and Design Analysis * Applications with Heat and Fluid Flow * Applications with Thermodynamics and Heat and Fluid Flow * Economic Analysis * Thermoeconomic Analysis and Evaluation * Thermoeconomic Optimization Thermal Design and Optimization offers engineering students, practicing engineers, and technical managers a comprehensive and rigorous introduction to thermal system design and optimization from a distinctly contemporary perspective. Unlike traditional books that are largely oriented toward design analysis and components, this forward-thinking book aligns itself with an increasing number of active designers who believe that more effective, system-oriented design methods are needed. Thermal Design and Optimization offers a lucid presentation of thermodynamics, heat transfer, and fluid mechanics as they are applied to the design of thermal systems. This book broadens the scope of engineering design by placing a strong emphasis on engineering economics, system simulation, and optimization techniques. Opening with a concise review of fundamentals, it develops design methods within a framework of industrial applications that gradually increase in complexity. These applications include, among others, power generation by large and small systems, and cryogenic systems for the manufacturing, chemical, and food processing industries. This unique book draws on the best contemporary thinking about design and design methodology, including discussions of concurrent design and quality function deployment. Recent developments based on the second

law of thermodynamics are also included, especially the use of exergy analysis, entropy generation minimization, and thermoeconomics. To demonstrate the application of important design principles introduced, a single case study involving the design of a cogeneration system is followed throughout the book. In addition, Thermal Design and Optimization is one of the best newsources available for meeting the recommendations of the Accreditation Board for Engineering and Technology for more design emphasis in engineering curricula. Supported by extensive reference lists, end-of-chapter problem sets, and helpful appendices, this is a superb text for both the classroom and self-study, and for use in industrial design, development, and research. A detailed solutions manual is available from the publisher.

Synthetic Nitrogen Products - Gary Maxwell 2006-02-08

Industrial products that are made from, or contain, nitrogen are described in parts of some encyclopedias and standard reference works. However it is not always simple to determine from these varied sources the present status of the technology and markets for various nitrogen products. We therefore perceived a need for a text that provides a comprehensive description of: 1) products that are made from or that contain nitrogen; 2) the processes that produce these products; and 3) the markets that consume these products. I have attempted to present the material in a standardized format that should make this book easy to use and helpful to the readers. The standard format for each product is: Introduction, Process, Production, and Uses, with some variations in different chapters. This book provides information that could be used by a wide range of readers: Fertilizer companies—to evaluate different production processes and review general trends in the market. Basic chemical companies—to evaluate different production processes and review general trends in the market. Specialty chemical companies—to investigate new chemical production and/or sales opportunities and the processes that could make those sales a possibility. Chemical distributors—to obtain a feel for the general market size for some chemicals and the basic handling and distribution procedures for various chemicals. Engineering Companies—to evaluate different production processes and review general trends in the market. Engineering and Chemistry Students—to learn more about practical applications of the principals that they have experienced in their classrooms and laboratories.

Ammonia - Anders Nielsen 2012-12-06

Ammonia is one of the 10 largest commodity chemicals produced. The editor, Anders Nielsen, is research director with one of the largest industrial catalyst producers. He has compiled a complete reference on all aspects of catalytical ammonia production in industry, from thermodynamics and kinetics to reactor and plant design. One chapter deals with safety aspects of ammonia handling and storage.

Gyn/Ecology - Mary Daly 2016-07-26

This revised edition includes a New Intergalactic Introduction by the Author. Mary Daly's New Intergalactic Introduction explores her process as a Crafty Pirate on the Journey of Writing Gyn/Ecology and reveals the autobiographical context of this "Thunderbolt of Rage" that she first hurled against the patriarchs in 1979 and no hurls again in the Re-Surging Movement of Radical Feminism in the Be-Dazzling Nineties.

The Fertilizer Encyclopedia - Vasant Gowariker 2009-04-08

Fertilizers are key for meeting the world's demands for food, fiber, and fuel. Featuring nearly 4,500 terms of interest to all scientists and researchers dealing with fertilizers, The Fertilizer Encyclopedia compiles a wealth of information on the chemical composition of fertilizers, and includes information on everything

from manufacturing and applications to economical and environmental considerations. It covers behavior in soil, chemical and physical characteristics, physiological role in plant growth and soil fertility, and more. This is the definitive, up-to-date reference on fertilizers. This book is not available for purchase from Wiley in the country of India. Customers in India should visit Vasudha Research & Publications Pvt. Ltd. at www.fertilizer-encyclopedia.com

Environmental considerations of selected energy conserving manufacturing process options - United States. Environmental Protection Agency. Office of Research and Development 1976

Fertilizer Strategies - 1987

Real-Time Monetization of the Flared Natural Gas Stream via Various Options - Azunna I. B. Ekejiuba

Petroleum is produced from Onshore, Offshore Shallow water and Offshore Deep waters of the Niger Delta in Nigeria at depth of approximately 3,600m (12,000ft), by 5 major operators in partnership with the Nigerian National Petroleum Corporation (NNPC). In Nigeria, associated stranded natural gas flaring commenced in 1956 with the first successful well drilled at Oloibiri by Shell D'Acry, present day Shell Petroleum Development Company (SPDC). According to SPDC, on the average, about 1,000scf of gas is produced with every barrel of oil, and presently about 40-50% of it is flared daily. The wasted associated stranded natural gas is mainly methane, a compound in great demand as chemical feedstock, commercial and industrial products, gas-to-methanol (GTM), liquefied natural gas (LNG), et cetera. Precisely, this work is motivated by four broad factors (a) the fact that in most crude oil/natural gas operational terminals/base in Nigeria and around the world, some quantities of the flared associated stranded natural gas stream are bypassed through a gas scrubber, to the gas turbine which supplies electricity to the entire terminal operations facilities, (b) the fact, that the demand for electricity, both domestically and industrially are very high, (c) the fact, that the generation of electricity from the flared associated stranded natural gas would immensely reduce the quantity released into the atmosphere hence reduce its contribution to greenhouse gas (GHG) causing global warming (d) the fact, that repeatedly, through various medium, a lot of people have stated the daily, monthly and yearly quantities of the Nigerian Associated Natural Gas being flared, as well as the financial losses associated with the continued flaring, the possible alternative power and industrial values of the flared natural gas, the environmental and health impacts associated with flaring.

Fertilizer Abstracts - 1968

The context of natural forest management and FSC certification in Brazil - Claudia Romero 2015-12-30

Management decisions on appropriate practices and policies regarding tropical forests often need to be made in spite of innumerable uncertainties and complexities. Among the uncertainties are the lack of formalization of lessons learned regarding the impacts of previous programs and projects. Beyond the challenges of generating the proper information on these impacts, there are other difficulties that relate with how to socialize the information and knowledge gained so that change is transformational and enduring. The main complexities lie in understanding the interactions of social-ecological systems at different scales and how they varied through time in response to policy and other processes. This volume is part of a broad research effort to develop an independent evaluation of certification impacts with stakeholder input, which focuses on FSC certification of natural tropical forests. More specifically, the evaluation program aims at building the evidence base of the empirical biophysical, social, economic, and policy effects that FSC certification of natural forest has had in Brazil as well as in other tropical countries. The contents of this volume highlight the opportunities and constraints that those responsible for managing natural forests for timber production have experienced in their efforts to improve their practices in Brazil. As such, the goal of the studies in this volume is to serve as the foundation to design an impact evaluation framework of the impacts of FSC certification of natural forests in a participatory manner with interested parties, from institutions and organizations, to communities and individuals.

Diffusion - E. L. Cussler 2009-01-15

This overview of diffusion and separation processes brings unsurpassed, engaging clarity to this complex topic. Diffusion is a key part of the undergraduate chemical engineering curriculum and at the core of understanding chemical purification and reaction engineering. This spontaneous mixing process is also central to our daily lives, with importance in phenomena as diverse as the dispersal of pollutants to digestion in the small intestine. For students, Diffusion goes from the basics of mass transfer and diffusion itself, with strong support through worked examples and a range of student questions. It also takes the reader right through to the cutting edge of our understanding, and the new examples in this third edition will appeal to professional scientists and engineers. Retaining the trademark enthusiastic style, the broad coverage now extends to biology and medicine.

Pollution Control in Fertilizer Production - C.A. Hodge 1994-05-20

"This timesaving guide addresses nearly every aspect of pollution control for the mining, production, transportation, and distribution of chemical fertilizers covering current and emerging technologies for all segments of the industry, including raw materials production, end products, and by-products."

The Alchemy of Air - Thomas Hager 2009-08-18

A sweeping history of tragic genius, cutting-edge science, and the Haber-Bosch discovery that changed billions of lives—including your own. At the dawn of the twentieth century, humanity was facing global disaster: Mass starvation was about to become a reality. A call went out to the world's scientists to find a solution. This is the story of the two men who found it: brilliant, self-important Fritz Haber and reclusive, alcoholic Carl Bosch. Together they discovered a way to make bread out of air, built city-sized factories, and saved millions of lives. But their epochal triumph came at a price we are still paying. The Haber-Bosch process was also used to make the gunpowder and explosives that killed millions during the two world wars. Both men were vilified during their lives; both, disillusioned and disgraced, died tragically. The Alchemy of Air is the extraordinary, previously untold story of a discovery that changed the way we grow food and the way we make war—and that promises to continue shaping our lives in fundamental and dramatic ways.

Enriching the Earth - Vaclav Smil 2004-02-27

Dr. Smil is the world's authority on nitrogenous fertilizer. The industrial synthesis of ammonia from nitrogen and hydrogen has been of greater fundamental importance to the modern world than the invention of the airplane, nuclear energy, space flight, or television. The expansion of the world's population from 1.6 billion people in 1900 to today's six billion would not have been possible without the synthesis of ammonia. In *Enriching the Earth*, Vaclav Smil begins with a discussion of nitrogen's unique status in the biosphere, its role in crop production, and traditional means of supplying the nutrient. He then looks at various attempts to expand natural nitrogen flows through mineral and synthetic fertilizers. The core of the book is a detailed narrative of the discovery of ammonia synthesis by Fritz Haber—a discovery scientists had sought for over one hundred years—and its commercialization by Carl Bosch and the chemical company BASF. Smil also examines the emergence of the large-scale nitrogen fertilizer industry and analyzes the extent of global dependence on the Haber-Bosch process and its biospheric consequences. Finally, it looks at the role of nitrogen in civilization and, in a sad coda, describes the lives of Fritz Haber and Carl Bosch after the discovery of ammonia synthesis.

Catalysts for Nitrogen Fixation - Barry E. Smith 2013-03-20

Biological nitrogen fixation provides more than 50% of the total annual input of the essential element nitrogen to world agriculture. Thus, it is of immense agronomic importance and critical to food supplies, particularly in developing countries. This book, with chapters authored by internationally renowned experts, provides a comprehensive and detailed account of the fascinating history of the process - including the surprising discoveries of molybdenum-independent nitrogenases and superoxide-dependent nitrogenase; a review of Man's attempts to emulate the biological process - most successfully with the commercially dominant Haber-Bosch process; and the current state of the understanding art with respect to the enzymes - called nitrogenases - responsible for biological nitrogen fixation. The initial chapters use a historical approach to the biological and industrial processes, followed by an overview of assay methodologies. The next set of chapters focuses on the classical enzyme, the molybdenum nitrogenase, and details its biosynthesis, structure, composition, and mechanism of action as well as detailing both how

variants of its two component proteins are constructed by recombinant DNA technology and how computational techniques are being applied. The sophisticated chemical modelling of the metal-containing clusters in the enzyme is reviewed next, followed by a description of the two molybdenum-independent nitrogenases - first, the vanadium-containing enzyme and then the iron-only nitrogenase - together with some thoughts as to why they exist! Then follows an up-to-date treatment of the clearly "non-classical" properties of the superoxide-dependent nitrogenase, which more closely resembles molybdenum-containing hydroxylases and related enzymes, like nitrate reductase, that it does the other nitrogenases. Each chapter contains an extensive list of references. This book is the self-contained first volume of a comprehensive seven-volume series. No other available work provides the up-to-date and in-depth coverage of this series and this volume. This book is intended to serve as an indispensable reference work for all scientists working in this area, including agriculture and the closely related metals-in-biology area; to assist students to enter this challenging area of research; and to provide science administrators easy access to vital relevant information.

Fertilizer Manual - Travis P. Hignett 2013-04-17

This Fertilizer Manual was prepared by the International Fertilizer Development Center (IFDC) as a joint project with the United Nations Industrial Development Organization (UNIDO). It is designed to replace the UN Fertilizer Manual published in 1967 and intended to be a reference source on fertilizer production technology and economics and fertilizer industry planning for developing countries. The aim of the new manual is to describe in clear, simple language all major fertilizer processes, their requirements, advantages and disadvantages and to show illustrative examples of economic evaluations. The manual is organized in five parts. Part I deals with the history of fertilizers, world outlook, the role of fertilizers in agriculture, and raw materials and includes a glossary of fertilizer-related terms. Part II covers the production and transportation of ammonia and all important nitrogen fertilizers-liquids and solids. Part III deals with the characteristics of phosphate rock, production of sulfuric and phosphoric acid, and all important phosphate fertilizers, including nitrophosphates and ammonium phosphates. Part IV deals with potash fertilizers-ore mining and refining and chemical manufacture; compound fertilizers; secondary and micronutrients; controlled-release fertilizers; and physical properties of fertilizers. Part V includes chapters on planning a fertilizer industry, pollution control, the economics of production of major fertilizer products and intermediates, and problems facing the world fertilizer industry.

Fertilizer Requirements in 2015 and 2030 - Food and Agriculture Organization of the United Nations 2000

This is a joint study involving five organisations from both the public and private sectors. The objective is to explore the future need for fertilizer required to support the Food and Agriculture Organization's (FAO) projections of agricultural commodity production for 2015 and 2030. The paper begins by briefly reviewing attempts to identify and quantify the factors influencing the growth in demand and supply for agricultural commodities. Several studies that estimate long-term fertilizer use are also reviewed, followed by a discussion of the forecasting methods and data. The results and implications conclude the paper. The study projects growth rates of between 0.7 and 1.3 per cent, depending on assumptions about nutrient efficiency over the next 35 years

Properties and Management of Soils in the Tropics - Pedro A. Sanchez 2019-01-10

Long-awaited second edition of classic textbook, brought completely up to date, for courses on tropical soils, and reference for scientists and professionals.

Catalytic Ammonia Synthesis - J.R. Jennings 2013-06-29

The phenomenon of catalysis is found in many homogeneous and heterogeneous systems undergoing chemical change, where it effects the rates of approach to the equilibrium state in processes as diverse as those found in the stars, the earth's mantle, living organisms, and the various chemistries utilized by industry. The economies and the living standards of both developed and developing countries depend to varying degrees upon the efficacy of their chemical industries. Consequently, this century has seen a wide exploration and expansion of catalytic chemistry together with an intensive investigation of specific, essential processes like those contributing to life-supporting agricultures. Prime among the latter must surely be the "fixation" of atmospheric nitrogen by catalytic hydrogenation to anhydrous ammonia, still the preferred synthetic precursor of the nitrogenous components of fertilizers. In each decade contemporary

concepts and techniques have been used to further the understanding, as yet incomplete, of the catalyst, the adsorbates, the surface reactions, and the technology of large-scale operation. The contributors to the present volume review the state of the art, the science, and the technology; they reveal existing lacunae, and suggest ways forward. Around the turn of the century, Sabatier's school was extending the descriptive catalytic chemistry of hydrogenation by metals to include almost all types of multiple bond. The triple bond of dinitrogen, which continued to be more resistant than the somewhat similar bonds in carbon monoxide and ethyne, defied their efforts.

Ammonia Fuel Cells - Ibrahim Dincer 2020-04-09

Ammonia Fuel Cells covers all aspects of ammonia fuel cell technologies and their applications, including their theoretical analysis, modeling studies and experimental investigations. The book analyzes the role of integrated ammonia fuel cell systems within various renewable energy resources and existing energy systems. Covers the types of ammonia fuel cells that have been developed over history Features explanations of the underlying fundamentals and principles of ammonia fuel cells, along with methods to assess the performance of different types of cell Includes case studies considering different applications of ammonia fuel cells and their significance in the future of clean energy

Biofuels and Biorefining - Fernando Israel Gomez Castro 2022-05-26

Biofuels and Biorefining: Volume One: Current Technologies for Biomass Conversion considers the conventional processes for biofuels and biomass-derived products in single and biorefinery schemes. Sections address the fundamentals of the transformation of biomass into fuels and products, including a discussion of current and future scenarios, potential raw materials that can be used, the main processing technologies and their commercial potential, and a description of the concept of biorefinery and the opportunities offered by this approach. Each chapter is supported by industry case studies covering the development of each product, fuel type, and biorefinery. This book provides an integrated approach to biofuels production and process intensification that will be useful to researchers involved in all aspects of bioenergy, particularly those interested in cost reduction, environmental impact and enhanced production. Includes all fundamental concepts related to the production of biofuels and value-added products from biomass Provides a comprehensive biorefinery scheme that addresses all biofuel types (liquid, solid and gaseous) and related bio-based products Presents state-of-the-art information on production processes Covers all required information for the modeling and economical assessment of biofuels production in single process or under a biorefinery scheme

Ammonia Synthesis Catalysts - Huazhang Liu 2013-03-21

This book provides a review of worldwide developments in ammonia synthesis catalysts over the last 30 years. It focuses on the new generation of Fe_{1-x}O based catalysts and ruthenium catalysts — both are major breakthroughs for fused iron catalysts. The basic theory for ammonia synthesis is systematically explained, covering topics such as the chemical components, crystal structure, preparation, reduction, performance evaluation, characterization of the catalysts, the mechanism and kinetics of ammonia synthesis reaction. Both theory and practice are combined in this presentation, with emphasis on the research methods, application and exploitation of catalysts. The comprehensive volume includes an assessment of the economic and engineering aspects of ammonia plants based on the performance of catalysts. Recent developments in photo-catalysis, electro-catalysis, biocatalysis and new uses of ammonia are also introduced in this book. The author, Professor Huazhang Liu, has been engaged in research and practice for more than 50 years in this field and was the inventor of the first Fe_{1-x}O based catalysts in the world. He has done a lot of research on Fe₃O₄ based- and ruthenium based-catalysts, and has published more than 300 papers and obtained 21 patents during his career. Contents: Historical Evolution of Catalysts for Ammonia Synthesis Catalytic Reaction Mechanisms of Ammonia Synthesis Chemical Composition and Structure of Fused Iron Catalysts Preparation of Fused Iron Catalysts Reduction of Fused Iron Catalysts Ruthenium Based Ammonia Synthesis Catalysts Performance Evaluation and Characterization of Catalysts Performance and Application of Catalysts Effect of Catalyst Performance on the Economic Benefits of Catalytic Process Innovation and Speculation Readership: Researchers in academia and industry working on catalysts for ammonia synthesis. Keywords: Ammonia Synthesis; Catalysts; Catalytic; Iron Catalyst; Fused Iron Catalyst; Ruthenium Catalyst Key Features: Provides a review of worldwide developments in ammonia

synthesis catalysts over the last 30 years
Focuses on the new generation of Fe_{1-x}O based catalysts and ruthenium catalysts
Combines theory and practice, with emphasis on research methods and industrial exploitation

Impact of Rising Natural Gas Prices on U.S. Ammonia Supply -

Green Urea - Noorhana Yahya 2018-01-16

This book presents a game changing technology of lower energy-intensive urea production of urea which is used as fertilizer. The technology, from a resource to a knowledge-intensive based industry, investigates a new synthesis approach employing electromagnetic induction and nano-catalyst at lower energy consumption. This clean and green method for a sustainable future might change the landscape of future chemical processes. It is made possible due to the enhancement in nanotechnology where quantum mechanical understanding is called into play. New reactor designs are elaborated on and discussed explicitly. Hematite and nickel oxide nanocatalysts are proposed for the green urea synthesis process, in the presence of static and oscillating magnetic fields. Strategies to increase single to triplet conversion rate are given for better understanding of the improved urea rate. The focus is deliberately on scrutinizing the greenhouse gas effect on the urea yield, in this case CO₂ flow rate. Coating techniques for slow release strategies are provided to reduce the volatilization of ammonia and leaching effect, hence offering a complete solution of Green Technology. Agriculture 4.0 that creates the new patterns and precision monitoring of crop rotation and livestock utilization will be able to pave the way for better crop yield. Development of advanced technology in agriculture is important for the implementation of Agriculture 4.0 and currently an inevitable trend of the socioeconomic development in the context of broader international integration for the sustainable future. The author would like to acknowledge Ministry of Higher Education (MOHE) for the grant worth RM 12 million to accomplish Green and Economical Urea project and to have full understanding on Green Technology in Urea. This book is a collaborative effort by her colleagues, Ku Zilati, Khanif, Shahrina, Zainovia, Azizah, Zakaria, and who have carried out the research over the past five years which started in 2011. Their unconditional commitment had brought us together and we completed the project with success. I wish to also thank Dr Menaka Ganeson and all my PhD students, Dr. Saima, Dr. Bilal, Mr. Zia and Mr. Irfan for their commitment to assist me to complete the book. Last but not least, thank you very much to Professor Mike Payne (Cambridge University) and Professor Koziol (Cranfield University) for the comments.

Sustainable Ammonia Production - Inamuddin 2020-01-09

This book presents sustainable synthetic pathways and modern applications of ammonia. It focuses on the production of ammonia using various catalytic systems and its use in fuel cells, membrane, agriculture, and renewable energy sectors. The book highlights the history, investigation, and development of sustainable pathways for ammonia production, current challenges, and state-of-the-art reviews. While discussing industrial applications, it fills the gap between laboratory research and viable applications in large-scale production.

Electrochemical Energy Systems - Artur Braun 2018-12-03

This book is for anyone interested in renewable energy for a sustainable future of mankind. Batteries, fuel cells, capacitors, electrolyzers and solar cells are explained at the molecular level and at the power plant level, in their historical development, in their economical and political impact, and social change. Cases from geophysics and astronomy show that electrochemistry is not confined to the small scale. Examples are shown and exercised.

Photo-Electrochemical Ammonia Synthesis - Mohammadreza Nazemi 2021-07-27

Ammonia holds great promise as a carbon-neutral liquid fuel for storing intermittent renewable energy sources and power generation due to its high energy density and hydrogen content. Photo-Electrochemical Ammonia Synthesis: Nanocatalyst Discovery, Reactor Design, and Advanced Spectroscopy covers the synthesis of novel hybrid plasmonic nanomaterials and their application in photo-electrochemical systems to convert low energy molecules to high value-added molecules and looks specifically at photo-electrochemical nitrogen reduction reaction (NRR) for ammonia synthesis as an attractive alternative to the long-lasting thermochemical process. Provides an integrated scientific framework, combining materials

chemistry, photo-electrochemistry, and spectroscopy to overcome the challenges associated with renewable energy storage and transport
Reviews materials chemistry for the synthesis of a range of heterogeneous (photo) electrocatalysts including plasmonic and hybrid plasmonic-semiconductor nanostructures for selective and efficient conversion of N₂ to NH₃
Covers novel reactor design to study the redox processes in the photo-electrochemical energy conversion system and to benchmark nanocatalysts' selectivity and activity toward NRR
Discusses the use of advanced spectroscopic techniques to probe the reaction mechanism for ammonia synthesis
Offers techno-economic analysis and presents performance targets for the scale-up and commercialization of electrochemical ammonia synthesis
This book is of value to researchers, advanced students, and industry professionals working in sustainable energy storage and conversion across the disciplines of Chemical Engineering, Mechanical Engineering, Materials Science and Engineering, Environmental Engineering, and related areas.

A History of Technology and Environment - Edward L. Golding 2016-12-08

This book provides an accessible overview of the ways that key areas of technology have impacted global ecosystems and natural communities. It offers a new way of thinking about the overall origins of environmental problems. Combining approaches drawn from environmental biology and the history of science and technology, it describes the motivations behind many technical advances and the settings in which they occurred, before tracing their ultimate environmental impacts. Four broad areas of human activity are described: over-harvesting of natural resources using the examples of hunting, fishing and freshwater use; farming, population, land use, and migration; discovery, synthesis and use of manufactured chemicals; and development of sources of artificial energy and the widespread pollution caused by power generation and energy use. These innovations have been driven by various forces, but in most cases new technologies have emerged out of fascinating, psychologically rich, human experiences. This book provides an introduction to these complex developments and will be essential reading for students of science, technology and society, environmental history, and the history of science and technology.

Fertilizer Nitrogen - A. I. More 1982

Plasma Catalysis - Annemie Bogaerts 2019-04-02

Plasma catalysis is gaining increasing interest for various gas conversion applications, such as CO₂ conversion into value-added chemicals and fuels, N₂ fixation for the synthesis of NH₃ or NO_x, methane conversion into higher hydrocarbons or oxygenates. It is also widely used for air pollution control (e.g., VOC remediation). Plasma catalysis allows thermodynamically difficult reactions to proceed at ambient pressure and temperature, due to activation of the gas molecules by energetic electrons created in the plasma. However, plasma is very reactive but not selective, and thus a catalyst is needed to improve the selectivity. In spite of the growing interest in plasma catalysis, the underlying mechanisms of the (possible) synergy between plasma and catalyst are not yet fully understood. Indeed, plasma catalysis is quite complicated, as the plasma will affect the catalyst and vice versa. Moreover, due to the reactive plasma environment, the most suitable catalysts will probably be different from thermal catalysts. More research is needed to better understand the plasma-catalyst interactions, in order to further improve the applications.

Contemporary Catalysis - Paul C J Kamer 2017

Providing an integrated approach to the various aspects of catalysis, this textbook is ideal for graduate students from catalysis, engineering, and organic synthesis.

Developing a Fundamental Understanding of Dynamic Electrode-electrolyte Interfaces During Electrochemical Ammonia Production - Sarah Jane Blair 2022

While industrial ammonia production for fertilizers has been critical to the support of the food supply for our dramatically increasing global population, this process is responsible for as much as 1.4% of global CO₂ emissions, contributing to the rise in global temperatures, and is highly energy-intensive, using 1% of the world's global energy supply. There is consequently a need for developing a more sustainable, decentralized means of fertilizer production to address such environmental consequences and provide fertilizer in heavily populated regions that lack transportation infrastructure. Electrochemical ammonia synthesis has attracted recent attention because of its potential for being coupled with renewable sources of electricity and operation at ambient temperatures and pressures. This dissertation describes work

toward such a system in two areas: 1) wastewater recycling for NH₃ production via aqueous nitrate reduction and 2) non-aqueous, Li-mediated direct electrochemical N₂ reduction to NH₃. More than 50% of the fertilizer applied to crops is lost to groundwater as runoff, leading to eutrophication of water sources and human health concerns. Conversion of these nitrate pollutants to NH₃ would be a means of closing the nitrogen cycle and "recycling" such pollutants. By mapping selectivity toward NH₃ across a comprehensive range of electrochemical conditions on a Ti cathode, we identified a low pH and relatively high concentration of nitrate as providing high, stable NH₃ selectivity. Thus, a higher availability of nitrate anions within an electrolyte with a high proton concentration allowed for the suppression of the HER while promoting reaction of these protons with adsorbed N-O intermediate species. We additionally found that the ability of this catalyst to suppress the HER in acidic conditions may be related to the formation of TiH₂, with the Ti lattice preferentially absorbing protons during electrochemistry rather than facilitating the HER. An alternative to wastewater recycling would be the direct electrochemical reduction of N₂ to NH₃. A non-aqueous, Li-mediated method (Li-N₂R) that proceeds via the electrodeposition of Li and subsequent reaction with N₂ and a proton source is the only such system that has thus far been demonstrated to reliably produce NH₃, but there remains little experimental understanding of the electrode-electrolyte interface under reaction conditions. Here, an air-free electrochemical flow cell was designed for in situ synchrotron GI-XRD measurements and used to study the effect of the presence of N₂ and a proton source on the formation of Li₃N and additional Li-containing species. Li₃N formation appears to be the slow step of this reaction, with the presence of EtOH limiting the accumulation of crystalline Li metal and Li₃N during reaction, suggesting these species react quickly. To shed more light on these system dynamics, we used time-resolved in situ neutron reflectometry to probe the electrode-electrolyte interface under conditions relevant to Li-N₂R. The interface was found to be highly dynamic, with Li-containing species having high mobility depending on the applied current density and porous SEI formation occurring on a short timescale. This dissertation demonstrates the necessity for in situ characterization methods in developing mechanistic understandings of complicated non-aqueous electrochemical systems, as well as the general importance of electrochemical environment in tuning selectivity to desired products. Further work is required to conclusively identify the composition of SEI and Li-containing species in Li-N₂R systems in order to engineer the SEI layer toward controlling electrolyte species diffusion rates to optimize NH₃ selectivity toward more commercially relevant values.

Feature Papers for Celebrating the Fifth Anniversary of the Founding of Processes - Michael A. Henson 2019-01-24

This book is a printed edition of the Special Issue "Feature Papers for Celebrating the Fifth Anniversary of the Founding of Processes" that was published in Processes

Membrane Reactors for Energy Applications and Basic Chemical Production - Angelo Basile 2015-02-10

Membrane Reactors for Energy Applications and Basic Chemical Production presents a discussion of the

increasing interest in membrane reactors that has emerged in recent years from both the scientific and industrial communities, in particular their usage for energy applications and basic chemical production. Part One of the text investigates membrane reactors for syngas and hydrogen production, while Part Two examines membrane reactors for other energy applications, including biodiesel and bioethanol production. The final section of the book reviews the use of membrane reactors in basic chemical production, including discussions of the use of MRs in ammonia production and the dehydrogenation of alkanes to alkenes. Provides comprehensive coverage of membrane reactors as presented by a world-renowned team of experts Includes discussions of the use of membrane reactors in ammonia production and the dehydrogenation of alkanes to alkenes Tackles the use of membrane reactors in syngas, hydrogen, and basic chemical production Keen focus placed on the industry, particularly in the use of membrane reactor technologies in energy

The Changing U.S. Fertilizer Industry - 1977

Agricultural Anhydrous Ammonia - M. H. McVickar 1966

History of Industrial Gases - Ebbe Almqvist 2012-12-06

Starting at the dawn of science, History of Industrial Gases traces the development of gas theory from its Aristotelian roots to its modern achievements as a global industry. Dr. Almqvist explores how environmental protection, geographical areas, and the drive for higher purity and efficiency affected development in the nineteenth and twentieth centuries, and how they will influence the future of this rapidly expanding industry. The roles of major contributing companies are also discussed to provide an informative and thought-provoking treatise valuable to anyone who studies or works in this fascinating field.

Synthetic Nitrogen Products - Gary Maxwell 2004-05-19

This book provides a comprehensive description of 1) products that are made from or that contain nitrogen, 2) the processes that produce these products and 3) the markets that consume these products. The goal has been to present an abundance of information in one book so that the reader will find the maximum amount of useful information in one place. The first four chapters provide basic information about nitrogen and nitrogen products and processes. Chapters 5 through 20 provide detailed descriptions of various nitrogen or nitrogen-containing products. The material is presented in a standardized format that should make this book easy to use and helpful to all readers. A wide variety of readers in countries around the world should find the book useful - from students to professors, to technical professionals to business marketing personnel.

The Nitrogen Industry - G. D. Honti 1976