Process Intensification Engineering For Efficiency Sustainability And Flexibility Isotopes In Organic Chemistry


Process integration and intensification explore novel techniques for intensifying transport and reaction in liquid-liquid and related systems with this essential toolkit. Topics include discussion of the principles of process intensification, the nexus between process intensification and sustainable engineering, and the fundamentals of liquid-liquid contacting, from an expert with over forty-five years’ experience in the field. Providing promising directions for investment and for new research in process intensification, in addition to a unique review of the fundamentals of the topic, this book is the perfect guide for senior undergraduate students, graduate students, developers, and research staff in chemical engineering and biochemical engineering.

Novel Process Windows Current Trends and Future Developments in (Bio-) Membranes: Cogeneration Systems and Membrane Technology offers an exhaustive overview of the status of cogeneration systems as they relate to advanced membrane technologies for energy savings. The different options for cogeneration are analyzed, both for large (district) and small (residential) scale, with different primary fuels. Energy efficiency is reported and lifecycle analysis is carried out for all different options. The book outlines strategies for engineering development and process intensification of interest to both industrial and developing countries. Finally, the book includes three chapters on lifecycle analysis (LCA) and economic analysis. Provides an overview of the interconnections between membrane technology and the systems used for the cogeneration of electricity, such as exhaust gas cleaning, carbon capture and sequestration, and low temperature fuel cell systems. Includes two different studies on LCA and a case study on economic analysis. Presents comprehensive reviews on various traditional cogeneration systems and compares them to alternative membrane-based technologies. Covers membrane based technologies and their application in co-generation systems. Addresses key issues on the introduction of process intensification in energy production.

Process Intensification for Sustainable Energy Conversion This book addresses the application of process intensification to sustainable energy production, combining two very topical subject areas. Due to the increasing process of petroleum, sustainable energy production technologies must be developed, for example bioenergy, blue energy, chemical looping combustion, concepts for CO2 capture, etc. Process intensification offers significant competitive advantages, because it provides more efficient processes, leading to outstanding cost reduction, increased productivity and more environment-friendly processes.

Modeling of Process Intensification This comprehensive work shows how to design and develop innovative, optimal and sustainable chemical processes by applying the principles of process systems engineering, leading to integrated sustainable processes with ‘green’ attributes. Generic systematic methods are employed, supported by intensive use of computer simulation as a powerful tool for mastering the complexity of physical models. New to the second edition are chapters on product design and batch processes with applications in specialty chemicals, process intensification methods for designing compact equipment with high energetic efficiency, plantwide control for managing the key factors affecting the plant dynamics and operation, health, safety and environment issues, as well as sustainability analysis for achieving high environmental performance. All chapters have been revised. This new edition is suitable as teaching material for Chemical Process and Product Design courses for graduate MSc students, being compatible with academic requirements worldwide. The inclusion of the newest design methods will be of great value to professional chemical engineers. Systematic approach to developing innovative and sustainable chemical processes. Presents generic principles of process simulation for analysis, creation and assessment Emphasis on sustainable development for the future of process industries.

Alternative Energy Sources for Green Chemistry Sustainable development is an area that has world-wide appeal, from developed industrialized countries to the developing world. Development of innovative technologies to achieve sustainability is being addressed by many European countries, the USA and also China and India. The need for chemical processes to be safe, compact, flexible, energy efficient, and environmentally benign and conducive to the rapid commercialization of new products poses new challenges for chemical engineers. This book examines the newest technologies for sustainable development in chemical engineering, through careful analysis of the technical aspects, and discussion of the possible fields of industrial development. The book is broad in its coverage, and is divided into four sections: Energy Production, covering renewable energies, innovative solar technologies, cogeneration plants, and smart grids. Process Intensification, describing why it is important in the chemical and petrochemical industry, the engineering approach, and nanoparticles as a smart technology. Forbiremediation Bio-based Platform Chemicals, including the production of bioethanol and biodiesel, biopolymers production, and biodegradability, and biosurfactants. Soil and Water Remediation, covering water management and reuse, and soil remediation technologies. Throughout the book there are case studies and examples of industrial processes in practice.

Intensification of Sorption Processes Advanced Biomass Gasification: New Concepts for Efficiency Increase and Product Flexibility provides a thorough overview on new concepts in biomass gasification and consolidated information on advances for process integration and combination, which could otherwise only be gained by reading a high number of journal publications. Heidenreich, Muller and Foscolo, highly respected experts in this field, start their exploration with the compact UNIQUE reactor, gasification and pyrolysis, gasification and combustion, and membrane processes, taking into account the energy balance of the overall conversion process, and look into oxygen-steam gasification and solutions for air separation, including new options for integration of O2-membranes into the gasifier. Several polygeneration strategies are covered, including combined heat and power (CHP) production with synthetic natural gas (SNG), biofuels and hydrogen, and new cutting-edge concepts, such as plasma gasification, supercritical water gasification, and catalytic gasification, which allows for insights on the future technological outlook of the area. A valuable resource for industry and academia-based researchers, as well as graduate students in the energy and chemical sectors with interest in biomass gasification, especially in areas of power engineering, bioenergy, chemical engineering, and catalysis. Explores state-of-the-art technologies that allow for greater efficiency and flexibility in gasification, including process integration, combination, and polygeneration strategies. Consolidates information that was, up until now, scattered among several sources, including journal articles. Provides a valuable resource for industry and academia-based researchers, as well as graduate students in the energy and chemical sectors with interest in biomass gasification, especially in areas of power engineering, bioenergy, chemical engineering, and catalysis.
Process Synthesis and Process Intensification "Process intensification: engineering for efficiency, sustainability and flexibility" is the first book to provide a practical working guide to understanding process intensification (PI) and developing successful PI solutions and applications in chemical process engineering, civil, environmental, and energy, pharmaceutical, biological, and biochemical systems. Process intensification is a chemical and process design approach that leads to substantially smaller, cleaner, safer, and more energy efficient process technology. It improves process flexibility, product quality, speed to market and inherent safety, with a reduced environmental footprint. This book represents a valuable resource for working with those involved in development and those involved in design and development of chemical, process, environmental, pharmaceutical, and bioscience systems. No other reference covers both the technology and application of PI, addressing fundamentals, industry applications, and including a development and implementation guide. Covers hot and high growth topics, including emission prevention, sustainable design, and pinch analysis. World-class authors: Colin Ramsay pioneered PI atICI and is widely credited as the father of the technology.

Process intensification Special Distillation Processes, Second Edition focuses on the latest developments in the field, such as separation methods that may prove useful for solving problems encountered during research. Topics include extraction, membrane and adsorption distillation involving the separation principle, process design and experimental techniques. The relationship between processes and technologies are also presented. Composed in an easy-to-read, this book provides key information needed to understand processes. It will be a valuable reference source for chemical engineers and students wishing to branch out in chemical engineering. Provides the only comprehensive book available on special distillation processes. Contains a thorough introduction to recent developments in the field. Presents a valuable reference for students, academics and engineers in chemical engineering.

Process intensification This advanced textbook covering the fundamentals and industry applications of process intensification (PI) discusses both the theoretical and conceptual basis of the discipline. Since interdisciplinarity is a key feature of PI, the material contained in the book reaches far beyond the classical area of chemical engineering. Developments in other relevant disciplines, such as chemistry, catalysis, energy technology, applied physics, electronics and materials science, are extensively described and discussed, while maintaining a chemical engineering perspective. Divided into three major parts, the first introduces the PI principles in detail and illustrates them using practical examples. The second part is entirely devoted to fundamental approaches of PI in four domains: spatial, thermodynamic, functional and temporal. The third and final part explores the methodology for applying fundamental PI approaches in practice. As well as detailing technologies, the book focuses on safety, energy and environmental issues, giving guidance on how to incorporate PI in plant design and operation -- safely, efficiently and effectively.

27th European Symposium on Computer Aided Process Engineering This book introduces the concept of novel process windows, focusing on cost improvements, safety, energy and eco-efficiency throughout each step of the process. The first part presents the new reactor and process-related approaches that the book introduces. The book is divided into three major parts. The first part presents the new holistic and systemic approach to processing, while the final part analyses the implications for green and cost-efficient processing. With its practical approach, this is an invaluable reading for those working in the pharmaceutical, fine chemicals, fuels and oils industries.

Intensification of Liquid-Liquid Processes Intensified processes have found widespread application in the chemical and petrochemical industries. The use of intensified systems allows for a reduction of operating costs and supports the "greening" of chemical processes. However, the design of intensified equipment requires special methodologies. This book describes the fundamentals and applications of these design methods, making it a valuable resource for use in both industry and academia.

Process Intensification in Chemical Engineering Beyond the Molecular Frontier The first guide to compile current research and frontline developments in the science of process intensification (PI). Re-Engineering the Chemical Processing Plant illustrates the design, integration, and application of PI principles and structures for the development and design of chemical and industrial plants. This volume updates professional ones on emerging PI equipment and methodologies to promote technological advances and operational efficacy in chemical, biochemical, and engineering environments and presents clear examples illustrating the implementation and application of specific process-intensifying equipment and methods in various commercial arenas.

24th European Symposium on Computer Aided Process Engineering Chemical processes provide a diverse array of valuable products and materials used in applications ranging from health care to transportation and food processing. Yet these same chemical processes that provide products and materials essential to modern economies, also generate substantial quantities of wastes and emissions. Green Chemistry is the utilization of a set of principles that reduces or eliminates the use or generation of hazardous substances in design. Due to extravagant costs needed to manage these wastes, tons of billions of dollars a year, there is a need to propose a way to create less waste. Emission and treatment standards continue to become more stringent, which causes these costs to continue to escalate. Green Chemistry and Engineering describes both the science (theory) and engineering (application) principles of Green Chemistry that lead to the generation of less waste. It explores the use of milder manufacturing conditions resulting from the use of smarter organic synthetic techniques and the maintenance of atom economic principles. Describes chemical processes. By implementing these techniques and efficiencies, chemical processes can become less waste, which will save industry millions of dollars over time. Chemical processes that provide products and materials essential to modern economies generate substantial quantities of wastes and emissions, this new book describes both the science (theory) and engineering (application) principles of Green Chemistry that lead to the generation of less waste. This book contains expert advice from scientists around the world, encompassing developments in the field since 2000. Aids manufacturers, scientists, managers, and engineers on how to implement ongoing changes in a vast developing field that is important to the environment and our lives.

Advanced Biomass Gasification Combining the knowledge involved in process engineering and process modeling, this title covers modeling methods applicable to process intensification. Advances in Process Intensification Through Multifunctional Reactor Engineering Process Intensification is a comprehensive textbook and treats the theory of process intensification design, and all innovation steps from idea generation to commercial implementation, and all focused on contributing to the UN Sustainable Development Goals. This book covers the 'hard' elements of design, modelling, and experimental validations and the 'soft' elements, values of engineers, interests of stakeholders and belief of society.

Sustainable Industrial Chemistry Chemistry and chemical engineering have changed significantly in the last decade. They have broadened their scope into biology, nanotechnology, materials science, computation, and advanced methods of process systems engineering and control to such an extent that the programs in most chemistry and chemical engineering departments now barely resemble the classical notion of chemistry. Beyond the Molecular Frontier brings together research, discovery, and invention across the entire spectrum of the chemical
Process Intensification Process Intensification: Engineering for Efficiency, Sustainability and Flexibility is the first book to provide a practical working guide to understanding process intensification (PI) and developing successful PI solutions and applications in chemical process, civil, environmental, energy, pharmaceutical, biological, and biochemical systems. Process intensification is a chemical and process design approach that leads to substantially smaller, cleaner, safer, and more energy efficient process technology. It improves process flexibility, reduces costs and time to market and a superior safety, with a minimal environmental footprint. This book represents a valuable resource for engineers working with leading-edge process technologies, and those involved research and development of chemical, process, environmental, pharmaceutical, and biotech systems. No other comprehensive reference is available on this hot topic or offers the practical tools to reach out to a wide base of professional and academic engineers who are engaged in systematically addressing efficiency of chemical reaction engineering in a cost-effective manner. Covers hot and high growth topics, including separation, sustainable design, and pinch analysis World-class authors: Colin Ramshaw pioneered PI at ICI and is widely credited as the father of the technology

Green Chemistry and Engineering Intensification of Sorption Processes: Active and Passive Mechanisms introduces a number of selected, advanced topics in sorption processes/process intensification, from theoretical and applicable aspects. The first part of the book is devoted to the study of sorption processes based on active mechanisms, including ultrasonic, microwave, high-gravity, electrical and magnetic fields, while the second part covers passive mechanisms like nanostructures and nanofluids, membrane, supercritical fluids and sorption processes based on geometry design and equipment structure. The focus of the book is on key aspects of novel process intensification technologies (processes and equipment), i.e., absorption and adsorption, working principles, and design and applications. Covers all developments in the field of active and passive mechanisms for sorption processes/process intensification at different stages of scale-up. This book presents a comprehensive overview focused specifically on the present state, future challenges and opportunities for separation and purification methods and technologies in biorefineries. Topics covered include: Equilibrium Separations: Distillation, liquid-liquid extraction and supercritical fluid extraction. Affinity-Based Separations: Adsorption, ion exchange, and simulated moving bed technologies. Membrane Based Separations: Microfiltration, ultrafiltration and diafiltration, membrane nanofiltration, membrane pervaporation, and membrane distillation. Solid-Liquid Separations: Conventional filtration and solid-liquid extraction. Hybrid/Integrated Reaction-Separation Systems: Membrane bioreactors, extractive fermentation, reactive distillation and reactive absorption. For each of these processes, the fundamental principles and design aspects are presented, followed by a detailed discussion and specific examples of applications in biorefineries. Each chapter also considers the market needs, industrial challenges, future opportunities, and economic importance of the separation and purification methods. The book concludes with case studies in membrane-based technologies, extraction of active pharmaceutical ingredients, membrane bioreactors, and biodegradation of biopolymers. Separation and Pore-Enhancement Techniques in Biorefineries is an essential resource for scientists and engineers, as well as researchers and academics working in the broader conventional and emerging bio-based products industry, including biomaterials, biochemicals, biofuels and biotechnology.
cover major classical themes, at the same time exploring a new range of applications that address the production of renewable forms of energy, environmental footprints and sustainable use of resources and water.

Process Intensification This book addresses the application of process intensification to sustainable energy production, combining two very topical subject areas. Due to the increasing process of petroleum, sustainable energy production technologies must be developed, for example bioenergy, blue energy, chemical looping combustion, concepts for CO2 capture etc. Process intensification offers significant competitive advantages, because it provides more efficient processes, leading to outstanding cost reduction, increased productivity and more environment-friendly processes.

Process Intensification In its second edition, Sustainable Process Integration and Intensification continues the presentation of fundamentals of key areas of both fields. Thoroughly updated and extended to include the latest developments, the reader also finds illustrated working sessions for deeper understanding of the taught materials. The book is addressed to graduate students as well as professionals to help the effectively application in plant design and operation.

The Fundamentals of Process Intensification This project was designed to advance the art of process intensification leading to a new generation of multifunctional chemical reactors. Experimental testing was performed in order to fully characterize the hydrodynamic operating regimes critical to process intensification and implementation in commercial applications. Physics of the heat and mass transfer and chemical kinetics and how these processes are ultimately scaled were investigated. Specifically, we progressed the knowledge and tools required to scale a multifunctional reactor for acid-catalyzed C4 paraffin/olefin alkylation to industrial dimensions. Understanding such process intensification strategies is crucial to improving the energy efficiency and profitability of multifunctional reactors, resulting in a projected energy savings of 100 trillion BTU/yr by 2020 and a substantial reduction in the accompanying emissions.

Separation and Purification Technologies in Biofifineries Improvements in Bio-Based Building Blocks Production Through Process Intensification and Sustainability Concepts discusses new information on the production and cost of bio-based building blocks. From a technical point-of-view, almost all industrial materials made from fossil resources can be substituted using bio-based counterparts. However, the cost of bio-based production in many cases exceeds the cost of petrochemical production. In addition, new products must be proven to perform at least as good as their petrochemical equivalents, have a lower environmental impact, meet consumer demand for environmentally-friendly products, factor in population growth, and account for limited supplies of non-renewables. This book outlines the application of process intensification techniques which allows for the production of clean, efficient and economical processes for bio-based chemical blocks production. Includes synthesis and process design strategies for intensified processes Describes multi-objective optimization applied to the production of bio-based building blocks Presents the controllability of processes where the production of bio-based building blocks is involved Provides examples using aspen and MATLAB Introduces several sustainable indexes to evaluate production processes Presents process intensification techniques to improve performance in productive processes

Process Intensification This book is among the first to address the novel process intensification technologies for biodiesel production, in particular the integrated reactive separations. It provides a comprehensive overview illustrated with many industrially relevant examples of novel reactive separation processes used in the production of biodiesel (e.g. fatty acid alkyl esters): reactive distillation, reactive absorption, reactive extraction, membrane reactors, and centrifugal contact separators. Readers will also learn about the working principles, design and control of integrated processes, while also getting a relevant and modern overview of the process intensification opportunities for biodiesel synthesis. Biodiesel is a biodegradable and renewable fuel that currently enjoys much attention. In spite of the recent advances, the existing biodiesel processes still suffer from problems associated with the use of homogeneous catalysts (e.g. salt waste streams) and the key limitations imposed by the chemical equilibrium, thus leading to severe economic and environmental penalties. The integration of reaction and separation into one operating unit overcomes equilibrium limitations and provides key benefits such as low capital investment and operating costs. Many of these processes can be further enhanced by heat-integration and powered by heterogeneous catalysts, to eliminate all conventional catalyst related operations, using the raw materials efficiently and the reaction volume, while offering high conversion and selectivity, and significant energy savings. The targeted audience of this book includes both academia (students and researchers) and industry (project leaders, technology managers, researchers, biodiesel producers, and equipment suppliers).

Reactive and Membrane-Assisted Separations Intensified processes have found widespread application in the chemical and petrochemical industries. The use of intensified systems allows for a reduction of operating costs and supports the “greening” of chemical processes. However, the design of intensified equipment requires special methodologies. This book describes the fundamentals and applications of these design methods, making it a valuable resource for use in both industry and academia.

Process Intensification for Sustainable Energy Conversion The successful implementation of greener chemical processes relies not only on the development of efficient catalysts but also on the development of reactor-separators technologies which can deliver enhanced processing performance in a safe, cost-effective and energy efficient manner. Process intensification has emerged as a promising field which can effectively tackle the challenges of significant process enhancement, whilst also offering the potential to diminish the environmental impact presented by the chemicalindustry. Following an introduction to process intensification and the principles of green chemistry, this book presents a number of intensified technologies including: membranes, reactive distillation, reactive extraction, reactive absorption, membrane separations for green chemistry. Industry relevant process intensification, including economics and environmental impact, opportunities for energy saving, and practical considerations for industrial implementation. Process Intensification for Green Chemistry is a valuablesource for practising engineers and chemists alike who are interested in applying intensified reactor and/or separator systems in a range of industries to achieve green chemistry principles.

Process Intensification Technologies for Green Chemistry is the heat and mass transfer intensification defined as a new paradigm of process engineering, or is it just a common and old idea, renamed and given a current taste? Where might intensification occur? How to achieve intensification? How the shape optimization of thermal and fluidic devices leads to intensified heat and mass transfers? To answer these questions, Heat & Mass Transfer Intensification and Shape Optimization: A Multi-scale Approach clarifies the definition of the intensification by highlighting the potential role of the multi-scale structures, the specific interfacial area, the distribution of driving force, the modes of energy supply and the temporal aspects of processes. A reflection on the methods of process intensification or heat and mass transfer enhancement in multi-scale structures is provided, including porous media, heat exchangers, fluid distributors, mixers and reactors. A multi-scale approach to achieve intensification and shape optimization is developed and clearly explained. Providing readers with a tool box of reflections, techniques, methods, supported by literature reviews, Heat & Mass Transfer Intensification and Shape Optimization: A Multi-scale Approach will be a key guide for students, a teaching aid for lecturers and a source of inspiration for future research subjects.

Process Intensification This book will provide researchers and graduate students with an overview of the recent developments and applications of process intensification in chemical engineering. It will also allow the readers to apply the available intensification techniques to their problems and specific problems. The content can be adopted as part of special courses on process intensification, design, optimization and modelling aimed at senior undergraduate and graduate students. This book will be a useful resource for researchers in process system engineering as well as for practitioners interested in applying process intensification approaches to real-life problems in chemical engineering and related areas.

Re-Engineering the Chemical Processing Plant In recent years the need for sustainable process design and alternative reaction routes to
reduce industry’s impact on the environment has gained vital importance. The book begins with a general overview of new trends in designing industrial chemical processes which are environmentally friendly and economically feasible. Specific examples written by experts from industry cover the possibilities of running industrial chemical processes in a sustainable manner and provide an up-to-date insight into the main concerns, e.g., the use of renewable raw materials, the use of alternative energy sources in chemical processes, the design of intrinsically safe processes, microreactor and integrated reaction/ separation technologies, process intensification, waste reduction, new catalytic routes and/or solvent and process optimization.

Current Trends and Future Developments on (Bio-) Membranes Process synthesis and process intensification are becoming state-of-the-art scientific fields that provide the methods and tools to improve process technologies in terms of high energy efficiency, low capital investment, low emissions, improved safety, and less hazardous byproducts to achieve sustainable products and processes. The book covers manufacturing processes from both fossil- and biomass-based feedstocks for graduate students.

Sustainable Process Integration and Intensification The use of alternative energy forms and transfer mechanisms is one of the key approaches of process intensification. In recent years, significant amounts of research have been carried out in developing chemical processing technologies enhanced by plasma, electric and magnetic fields, electromagnetic and ultra-sound waves and high gravity fields. Discussing the broad impact of alternative energy transfer technologies on reactions, separations and materials synthesis, this book reports on recent breakthrough results in various application areas. It provides a comprehensive overview of the current developments in the field. The book enables industrialists, academics and postgraduates in alternative-energy based processing to see the potential of alternative energies for green chemistry and sustainability of chemical manufacturing.

The Fundamentals of Process Intensification “The authors have provided all the elements required for complete understanding of the basic concepts in heat recovery and water minimization in chemical and related processes, and followed these with carefully selected and developed problems and solutions in order to ensure that the concepts delivered can be applied.” Simon Perry, The University of Manchester. This graduate textbook covers fundamentals of the key areas of Process Integration and Intensification for intra-process heat recovery (Heat Integration), inter-process heat recovery and cogeneration (Total Site) as well as water conservation. Step by step working sessions are illustrated for deeper understanding of the taught materials. The textbook also provides a wealth of pointers as well as further information for readers to acquire more extensive materials on the diverse industrial applications and the latest development trends in Process Integration and Intensification. It is addressed to graduate students as well as professionals to help the effectively application of Process Integration and Intensification in plant design and operation.

Special Distillation Processes 27th European Symposium on Computer Aided Process Engineering, Volume 40 contains the papers presented at the 27th European Society of Computer-Aided Process Engineering (ESCAPE) event held in Barcelona, October 1-5, 2017. It is a valuable resource for chemical engineers, chemical process engineers, researchers in industry and academia, students, and consultants for chemical industries. Presents findings and discussions from the 27th European Society of Computer-Aided Process Engineering (ESCAPE) event

Process Synthesis Process intensification aims for increasing efficiency and sustainability of (bio-)chemical production processes. This book presents strategies for improving fluid separation such as reactive distillation, reactive absorption and membrane assisted separations. The authors discuss computer simulation, model development, methodological approaches for synthesis and the design and scale-up of final industrial processes.

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