



N. Meenakshi  
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# Reactive extraction of Levulinic acid

Reactive extraction of levulinic acid using tri-n- butyl  
phosphate and tri-n-octylamine in different diluents



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# Reactive Extraction

**Marek Ochowiak, Szymon  
Woziwodzki, Michał Doligalski, Piotr  
Tomasz Mitkowski**

## Reactive Extraction:

*Reactive Extraction* Hans-Jörg Bart, 2013-04-17 This booklet is designed to bridge the gap between handbooks and technical literature and aims at graduate students or experienced readers Commercial flow sheeting simulation software is increasingly available and is used in the early steps of process design in industry As to this more sophisticated and precise models based on activities instead of concentrations should be used After an introductory chapter there is in Chapter 2 an intensive discussion of reactive phase equilibria of ionic and non ionic solutes based on chemical potentials Chapter 3 introduces to multicomponent diffusion and mass transfer However the main focus is on the reactive mass transfer on rigid and mobile surfaces where the interfacial reaction molecular diffusion and adsorption layers are decisive The respective extraction of zinc with a cation exchanger and of acetic acid with an anion exchanger is discussed as case studies Since adsorption layers and surfactants have a major impact on liquid liquid extraction efficiency the final chapter reviews several techniques which make use of polymeric species in an extractive process A short review is also given on extraction apparatus and the hydrodynamics hydraulic design droplet population balances of columns Much of the booklet is based on the PhD works of C Czapla 2000 G Modes 2000 H Klocker 1996 T Kronberger 1995 M Marters 2000 M Roos 2000 M Traving 2000 and B Wachter 1996 who I wish to thank for their fruitful contributions

*Intensification of Biobased Processes* Andrzej Górak, Andrzej Stankiewicz, 2018-06-18 In recent years bioprocessing has increased in popularity and importance however bioprocessing still poses various important techno economic and environmental challenges such as product yields excessive energy consumption for separations in highly watery systems batch operation or the downstream processing bottlenecks in the production of biopharmaceutical products Many of those challenges can be addressed by application of different process intensification technologies discussed in the present book The first book dedicated entirely to this area Intensification of Biobased Processes provides a comprehensive overview of modern process intensification technologies used in bioprocessing The book focusses on four different categories of biobased products bio fuels and platform chemicals cosmeceuticals food products and polymers and advanced materials It will cover various intensification aspects of the processes concerned including bio reactor intensification intensification of separation recovery and formulation operations and process integration This is an invaluable source of information for researchers and industrialists working in chemical engineering biotechnology and process engineering

Mass Transfer A. P. SINHA, PARAMESWAR DE, 2012-05-09 This book introduces the fundamental principles of the mass transfer phenomenon and its diverse applications in process industry It covers the full spectrum of techniques for chemical separations and extraction Beginning with molecular diffusion in gases liquids and solids within a single phase the mechanism of inter phase mass transfer is explained with the help of several theories The separation operations are explained comprehensively in two distinct ways stage wise contact and continuous differential contact The primary design requirements of gas liquid equipment are discussed The book provides a detailed

discussion on all individual gas liquid liquid liquid solid gas and solid liquid separation processes The students are also exposed to the underlying principles of the membrane based separation processes The book is replete with real applications of separation processes and equipment Problems are worked out in each chapter Besides problems with answers short questions multiple choice questions with answers are given at the end of each chapter The text is intended for a course on mass transfer transport and separation processes prescribed for the undergraduate and postgraduate students of chemical engineering

*29th European Symposium on Computer Aided Chemical Engineering* Anton A. Kiss, Edwin Zondervan, Richard Lakerveld, Leyla Özkan, 2019-06-28 The 29th European Symposium on Computer Aided Process Engineering contains the papers presented at the 29th European Symposium of Computer Aided Process Engineering ESCAPE event held in Eindhoven The Netherlands from June 16 19 2019 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 29th European Symposium of Computer Aided Process Engineering ESCAPE event

Process Intensification Technologies for Green Chemistry Kamelia Boodhoo, Adam Harvey, 2013-01-03 The successful implementation of greener chemical processes relies not only on the development of more efficient catalysts for synthetic chemistry but also and as importantly on the development of reactor and separation 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 chemical industry Following an introduction to process intensification and the principles of green chemistry this book presents a number of intensified technologies which have been researched and developed including case studies to illustrate their application to green chemical processes Topics covered include Intensified reactor technologies spinning disc reactors microreactors monolith reactors oscillatory flow reactors cavitation reactors Combined reactor separator systems membrane reactors reactive distillation reactive extraction reactive absorption Membrane separations for green chemistry Industry relevance of process intensification including economics and environmental impact opportunities for energy saving and practical considerations for industrial implementation Process Intensification for Green Chemistry is a valuable resource 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

*18th European Symposium on Computer Aided Process Engineering* Bertrand Braunschweig, Xavier Joulia, 2008-06-18 Plenary Lectures Topic 1 Off Line Systems Topic 2 On Line Systems Topic 3 Computational Numerical Solutions Strategies Topic 4 Integrated And Multiscale Modelling And Simulation Topic 5 Cape For The Users Topic 6 Cape And Society Topic 7 Cape In Education

**Separation Processes** Pradeep Kumar Mishra, Manoj Kumar Mondal, Pradeep Srivastava, 2009 Contributed articles presented at an International Conference on Separation Processes organized by

Institute of Chemical Engineering Technology Institute of Technology Banaras Hindu University in 2009      *Downstream Processing in Biotechnology* Venko N. Beschkov, Dragomir Yankov, 2021-06-21 The current book gives an excellent insight into downstream processing technology and explains how to establish a successful strategy for an efficient recovery isolation and purification of biosynthetic products In addition to the overview of purification steps and unit operations the authors provide practical information on capital and operating costs related to downstream processing      **Practical Aspects of Chemical Engineering** Marek Ochowiak, Szymon Woziwodzki, Michał Doligalski, Piotr Tomasz Mitkowski, 2018-02-07 This book focuses on Chemical Engineering and Processing covering interdisciplinary innovation technologies and sciences closely related to chemical engineering such as computer image analysis modelling and IT The book presents interdisciplinary aspects of chemical and biochemical engineering interconnected with process system engineering process safety and computer science      **Novel Water Treatment and Separation Methods** Bharat A. Bhanvase, Rajendra P. Ugwekar, Raju B. Mankar, 2017-09-18 Due to increasing demand for potable and irrigation water new scientific research is being conducted to deal with wastewater from a variety of sources *Novel Water Treatment and Separation Methods* Simulation of Chemical Processes presents a selection of research related to applications of chemical processes for wastewater treatment separation techniques and modeling and simulation of chemical processes Among the many topics are degradation of herbicide removal of anionic dye efficient sun light driven photocatalysis removal of copper and iron using green activated carbon defluoridation of drinking water removal of calcium and magnesium from wastewater using ion exchange resins degradation of vegetable oil refinery wastewater novel separation techniques including microwave assisted extraction and more The volume presents selected examples in wastewater treatment highlighting some recent examples of processes such as photocatalytic degradation emulsion liquid membrane novel photocatalyst for degradation of various pollutants and adsorption of heavy metals The book goes on to explore some novel separation techniques such as microwave assisted extraction anhydrous ethanol through molecular sieve dehydration batch extraction from leaves of *Syzygium cumini* known as jambul jambolan jamblang or jamun and reactive extraction These novel separation techniques have proved be advantageous over conventional methods The volume also looks at modeling and simulation of chemical processes including chapters on flow characteristics of novel solid liquid multistage circulating fluidized bed mathematical modeling and simulation of gasketed plate heat exchangers optimization of the adsorption capacity of prepared activated carbon and modeling of ethanol water separation by pervaporation along with topics on simulation using CHEMCAD software The diverse chapters share and encourage new ideas methods and applications in ongoing advances in this growing area of chemical engineering and technology It will be a valuable resource for researchers and faculty and industrialists as well as for students      **Dicarboxylic Acids—Advances in Research and Application: 2012 Edition** , 2012-12-26 *Dicarboxylic Acids Advances in Research and Application 2012 Edition* is a ScholarlyEditions eBook that delivers timely authoritative and

comprehensive information about Dicarboxylic Acids The editors have built Dicarboxylic Acids Advances in Research and Application 2012 Edition on the vast information databases of ScholarlyNews You can expect the information about Dicarboxylic Acids in this eBook to be deeper than what you can access anywhere else as well as consistently reliable authoritative informed and relevant The content of Dicarboxylic Acids Advances in Research and Application 2012 Edition has been produced by the world s leading scientists engineers analysts research institutions and companies All of the content is from peer reviewed sources and all of it is written assembled and edited by the editors at ScholarlyEditions and available exclusively from us You now have a source you can cite with authority confidence and credibility More information is available at <http://www.ScholarlyEditions.com>

Process Intensification David Reay, Colin Ramshaw, Adam Harvey, 2013-06-05 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 product quality speed to market and inherent safety with a reduced 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 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 Ramshaw pioneered PI at ICI and is widely credited as the father of the technology

Re-Engineering the Chemical Processing Plant Andrzej Stankiewicz, Jacob A. Moulijn, 2003-11-07 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 optimization of chemical and industrial plants This volume updates professionals 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

Biorefineries and Chemical Processes Jhuma Sadhukhan, Kok Siew Ng, Elias Martinez Hernandez, 2014-08-25 As the range of feedstocks process technologies and products expand biorefineries will become increasingly complex manufacturing systems Biorefineries and Chemical Processes Design Integration and Sustainability Analysis presents process modelling and integration and whole system life cycle analysis tools for the synthesis design operation and sustainable development of biorefinery and chemical processes Topics covered include Introduction An introduction to the concept and development of biorefineries Tools Included here are the methods for detailed economic and

environmental impact analyses combined economic value and environmental impact analysis life cycle assessment LCA multi criteria analysis heat integration and utility system design mathematical programming based optimization and genetic algorithms Process synthesis and design Focuses on modern unit operations and innovative process flowsheets Discusses thermochemical and biochemical processing of biomass production of chemicals and polymers from biomass and processes for carbon dioxide capture Biorefinery systems Presents biorefinery process synthesis using whole system analysis Discusses bio oil and algae biorefineries integrated fuel cells and renewables and heterogeneous catalytic reactors Companion website Four case studies additional exercises and examples are available online together with three supplementary chapters which address waste and emission minimization energy storage and control systems and the optimization and reuse of water This textbook is designed to bridge a gap between engineering design and sustainability assessment for advanced students and practicing process designers and engineers

**Valorization of Biomass to Value-Added Commodities** Michael O.

Daramola, Augustine O. Ayeni, 2020-04-21 This book presents the most up to date technologies for the transformation of biomass into valuable fuels chemicals materials and products It provides comprehensive coverage of the characterization and fractionation of various types of biomass and details the many challenges that are currently encountered during this process Divided into two sections this book discusses timely topics such as the characterization of biomass feedstock pretreatment and fractionation of biomass and describes the process for conversion of biomass to value added commodities The authors bring biomass transformational strategies that are yet to be explored to the forefront making this innovative book useful for graduate students and researchers in academia government and industry

**Carboxylic Acid Production** Gunnar

Lidén, 2018-04-13 This book is a printed edition of the Special Issue Carboxylic Acid Production that was published in Fermentation

**Bioprocess Engineering** Shijie Liu, 2016-08-29 Bioprocess Engineering Kinetics Sustainability and

Reactor Design Second Edition provides a comprehensive resource on bioprocess kinetics bioprocess systems sustainability and reaction engineering Author Dr Shijie Liu reviews the relevant fundamentals of chemical kinetics batch and continuous reactors biochemistry microbiology molecular biology reaction engineering and bioprocess systems engineering also introducing key principles that enable bioprocess engineers to engage in analysis optimization and design with consistent control over biological and chemical transformations The quantitative treatment of bioprocesses is the central theme in this book with more advanced techniques and applications being covered in depth This updated edition reflects advances that are transforming the field ranging from genetic sequencing to new techniques for producing proteins from recombinant DNA and from green chemistry to process stability and sustainability The book introduces techniques with broad applications including the conversion of renewable biomass the production of chemicals materials pharmaceuticals biologics and commodities medical applications such as tissue engineering and gene therapy and solving critical environmental problems Includes the mechanistic description of biotransformations and chemical transformations Provides quantitative descriptions of

bioprocesses Contains extensive illustrative drawings which make the understanding of the subject easy Includes bioprocess kinetics and reactor analysis Contains examples of the various process parameters their significance and their specific practical use Incorporates sustainability concepts into the various bioprocesses

### **Processing of Heavy Crude Oils**

Ramasamy Marappa Gounder, 2019 Unconventional heavy crude oils are replacing the conventional light crude oils slowly but steadily as a major energy source Heavy crude oils are cheaper and present an opportunity to the refiners to process them with higher profit margins However the unfavourable characteristics of heavy crude oils such as high viscosity low API gravity low H C ratio chemical complexity with high asphaltenes content high acidity high sulfur and increased level of metal and heteroatom impurities impede extraction pumping transportation and processing Very poor mobility of the heavy oils due to very high viscosities significantly affects production and transportation Techniques for viscosity reduction drag reduction and in situ upgrading of the crude oil to improve the flow characteristics in pipelines are presented in this book The heavier and complex molecules of asphaltenes with low H C ratios present many technological challenges during the refining of the crude oil such as heavy coking on catalysts Hydrogen addition and carbon removal are the two approaches used to improve the recovery of value added products such as gasoline and diesel In addition the heavy crude oil needs pre treatment to remove the high levels of impurities before the crude oil can be refined This book introduces the major challenges and some of the methods to overcome them

*The Fundamentals of Process Intensification* Andrzej Stankiewicz, Tom Van

Gerven, Georgios Stefanidis, 2019-06-13 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

### **Process Intensification Technologies for Biodiesel Production**

Anton Alexandru Kiss, 2014-03-15 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 reaction 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

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