

# Reactive Extraction

Yeah, reviewing a book **Reactive Extraction** could increase your near connections listings. This is just one of the solutions for you to be successful. As understood, execution does not recommend that you have extraordinary points.

Comprehending as competently as conformity even more than new will meet the expense of each success. neighboring to, the notice as capably as keenness of this Reactive Extraction can be taken as without difficulty as picked to act.

*Reactive Extraction*

2020-10-17

## WHITEHEAD JAIDEN

### **Chiral Separation of Amino-alcohols and Amines by Fractional Reactive Extraction** Springer Science & Business Media

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.

### **Reactive Solvent Extraction of Amino Acids** John Wiley & Sons

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.

### **Process Intensification Technologies for Biodiesel Production** Walter de Gruyter GmbH & Co KG

A single-step, extractive reaction for extraction of lipids such as biodiesel components, omega-3 fatty acids, or other triglycerides from microbial cells was examined. Conventional methods for lipid extraction use toxic solvents, and require multiple steps and long processing times. When the goal is to produce fatty acid methyl esters or FAMES, the extracted lipids are subjected to a separate transesterification reaction with simple alcohols in the presence of an acid or base catalyst. A simplified, single-step reactive extraction method can be applied that combines the sequential extraction followed by transesterification using acidified alcohols - a process known as in situ transesterification. It was hypothesized that the in situ transesterification could be scaled-up for industrial processing by a systematic understanding of fundamental reaction parameters including temperature, catalyst concentration, and biomass/solvent ratios. The hypothesis was tested using a marine fungus, *Schizochytrium limacinum* SR21. Growth of SR21 resulted in biomass yields of 0.3g-biomass/g-glycerol and accumulated high amounts of palmitic acid (C16:0, 0.255g-FAME/g-biomass), docosahexaenoic acid (DHA, C22:6, 0.185g-FAME/g-biomass), myristic acid (C14:0) (0.017g-FAME/g-biomass), and pentadecanoic acid (C15:0, 0.012g-FAME/g-biomass). The bulk phase separation characteristics of the FAMES were evaluated at high biomass concentrations. Recyclability of the acidified methanol in the system was also tested. A significant finding was that automatic phase separation of the FAMES could be achieved. When FAME concentration reaches critical solubility, 22.7mg-FAME ml<sup>-1</sup> methanol, all remaining FAMES automatically phase separate. After FAME separation, the remaining methanol was recycled and used in subsequent in situ reactions. Upon recycling, greater than 85% of product extraction and recovery was achieved. The kinetics of the transesterification reaction was evaluated under

various acid and biomass/solvent conditions. Based on the fundamental reaction mechanism governing the in situ transesterification, a theoretic model was derived to predict the conversion of TAGs into FAMES. Kinetic parameters were estimated by fitting the experimental data and the resulting model. The model derived closely resembled the observations in this study. Through understanding of the fundamental reaction kinetics and limitations during processing, a new, reliable, and cost-effective system for large scale lipid production can be developed for microbial biomass including oleaginous algae, fungi, and yeast.

### **Process Intensification Technologies for Green Chemistry** Springer Science & Business Media

The MixAlco process, a proprietary technology owned by Texas A & M University, converts biomass (e.g., municipal solid waste, sewage sludge, paper, agricultural residues, and energy crops) into usable chemicals (e.g., acetic acid) and fuels (e.g., ethanol). Historically, calcium carbonate has been used as the buffer. Recently, it was found that using ammonium bicarbonate as the buffering agent enhances the fermentation conversion. In this case, fermentation broth contains ammonium salts (e.g., ammonium acetate, propionate, butyrate, pentanoate). Therefore, the downstream processing steps (including extraction, purification, esterification, and product separation) must be compatible with the ammonium carboxylate salts formed in the fermentation. This research focuses on converting fermentation broth carboxylate salts into their corresponding acids via "acid springing." Reactive extraction and thermal conversion (distillation) are crucial parts of the acid springing process. Because the components of the fermentation broth are over 80% ammonium acetate and 20% other ammonium carboxylate salts (ammonium propionate, butyrate, pentanoate, etc.), all the initial experiments in this study were performed using reagentgrade ammonium acetate to simplify the reaction. Later, actual fermentation broth was employed. The primary objective of this study was to provide the optimal operating conditions to make the downstream processing steps of the MixAlco process compatible with ammonium carboxylate salts formed in the fermentation. The optimal initial concentration for reactive extraction should be 150-200 g/L and the volume ratio of aqueous phase and extractant should be 1:1. The distribution coefficient reaches the maximum value when the concentration of TOA is 20% (vol %) in n-octanol. The batch distillation study shows that there are two reaction stages: (1) water leaves the system at 100-106 °C and (2) the acid-amine complex decomposes at 160-180 °C.

### **Design of Reactive Extraction Systems for Bioproduct Recovery** LAP Lambert Academic Publishing

Lactic acid is a fermentation-derived organic acid used in a wide range of industries, such as food processing and pharmaceuticals. Its market is expected to expand due to the worldwide concern for the environment, as it is an essential feedstock for biodegradable polymers. However, fermentation product is a very dilute, multicomponent aqueous solution. Subsequent separation, purification and concentration of organic acids is difficult because of high affinity of the acids for water.

Reactive extraction is a viable alternative to classical separation techniques. Amine extractants dissolved in organic diluents are suitable agents with reasonable ranges of viscosity and density of the solvent phase. The product is obtained in an organic phase after reactive extraction. The aim of this study is to obtain equilibrium data of back extraction of lactic acid into appropriate aqueous solutions from the organic phase. Aqueous solutions of NaCl, NaOH, Na<sub>2</sub>SO<sub>4</sub>, NaNO<sub>3</sub> and Na<sub>2</sub>CO<sub>3</sub> were examined as back extractant in various initial concentrations (0.005–0.3 M). The organic phase consists of tri-*n*-octylmethylammonium lactate (TOMA(La)) dissolved in either oleyl alcohol or octanol with initial concentrations between 0.1 and 0.3 M. According to results of the experiments, the level of back extraction generally increased with increasing initial salt concentration in aqueous phase and decreased with increasing initial TOMA(La) concentration in organic phase. For all salts investigated, considerable levels of back extraction were obtained. NaOH was considered as the most suitable back extractant among the salts investigated since it exhibits higher distribution coefficients, regenerates tri-*n*-octylmethylammonium hydroxide (TOMA(OH)) in the organic phase and has no adverse effect on fermentation medium when forward and backward extraction steps are coupled with the fermentation. The effect of diluent type of TOMA(La) was also investigated during the experiments and it was concluded that

**Aqueous, Aqueous Reactive Extraction of Phenolic Compounds with Coated Membrane Contactors** John Wiley & Sons

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.

**Reactive Extraction of Acetic Acid with Cyanex 923** CRC Press  
Lignocellulosic biomass is an abundant, inexpensive feedstock. It is mostly composed of cellulose (38–50% of the dry mass) and hemicellulose (23–32% of the dry mass). Cellulose and hemicellulose are polysaccharides that can be hydrolyzed to monosaccharides, mostly glucose and xylose. These sugars can eventually be fermented to many different products, such as ethanol and 2,3-butanediol. Fuel ethanol, which is currently produced from food-based sugars, can also be produced via fermentation of sugars derived from lignocellulosic biomass. The

fermentation of xylose is essential for the cost-effective bioconversion of lignocellulose to fuels and chemicals, but wild-type strains of *Saccharomyces cerevisiae* do not metabolize xylose because the metabolic pathways convert xylose to xylitol via an NADPH-linked xylose reductase. Fermentation of xylose to ethanol through xylulose does occur in organisms which possess an NADH-linked aldose reductase, indicating that a balanced supply of NADH and NADPH must be maintained to avoid xylitol production. Although *S. cerevisiae* does not convert xylose to ethanol, it does have the metabolic pathway for the conversion of xylulose, the ketose isomer of xylose, to ethanol. Conversion of xylose to xylulose in high yield and at low cost from biomass hydrolysate has the potential to bypass the barrier to ethanol production from C<sub>5</sub> and C<sub>6</sub> sugars with native yeast. 2,3-Butanediol (2,3-BD) is a key building block and a promising bulk chemical due to its extensive industrial applications in making polymers, plastics, and hydrocarbon fuels. For example, 2,3-BD can be readily converted to butenes, butadiene, and methyl ethyl ketone that are used in the production of hydrocarbon fuels. *Enterobacter cloacae* NRRL B-23289, isolated from decaying wood/corn soil samples by the USDA Agricultural Research Service (Peoria, IL), is a natural producer of 2,3-BD. Previous work at the USDA ARS has shown that this strain is more efficient in converting ketose than aldose sugars to 2,3-BD. Particularly interesting is that fermentation of fructose showed higher 2,3-BD yield within a much shorter period of time as compared to glucose. Converting aldoses to ketoses involves isomerization, typically conducted enzymatically. However, the isomerization does not have a favorable equilibrium with respect to ketose formation. We have previously developed a method of simultaneous isomerization and reactive extraction (SIRE) to produce the ketose isomer of xylose (xylulose) in high yield and purity. SIRE followed by back-extraction (BE) allows recovery of xylulose in nearly pure form. Although successfully implemented with low concentration xylose, SIRE has not been tested for high concentration sugars (C<sub>5</sub> and C<sub>6</sub> mixtures), which would be relevant for biomass hydrolysates. Optimization of SIRE-BE with high concentrations of both C<sub>5</sub> (xylose/xylulose) and C<sub>6</sub> (glucose/fructose) is one of the objectives of this dissertation. Using this innovative and optimized method to pretreat the aldose sugars (glucose and xylose) and produce large quantities of nearly pure, concentrated ketose sugars (fructose and xylulose), the production of 2,3-butanediol was investigated. Ketose sugar fermentation yielded more 2,3-butanediol and in a shorter time than the aldose fermentations. Using this method to produce large quantities of nearly pure, concentrated xylulose, the production of ethanol was also investigated. The native yeast produced 0.44–0.45 g ethanol/g xylulose in xylulose fermentation.

**Reactive Extraction of Penicillin G in Hollow Fiber and Hollow Fiber Fabric Modules** Springer Science & Business Media

A system for remediating groundwater contaminated with halogenated solvents, certain metals and other inorganic species based on catalytic reduction reactions within reactive well bores. The groundwater treatment uses dissolved hydrogen as a reducing agent in the presence of a metal catalyst, such as palladium, to reduce halogenated solvents (as well as other substituted organic compounds) to harmless species (e.g., ethane or methane) and immobilize certain metals to low valence states. The reactive wells function by removing water from a contaminated water-bearing zone, treating contaminants with a well bore using catalytic reduction, and then reinjecting the treated effluent into an adjacent water-bearing zone. This system offers the advantages of a compact design with a minimal surface footprint (surface facilities) and the destruction of a broad suite of

contaminants without generating secondary waste streams.

**Investigation of Methyl Acetate Production by Reactive Extraction** World Scientific

Lactic acid is widely used in the food, cosmetic, pharmaceutical, and chemical industries and has received increased attention for use as a monomer for the production of biodegradable poly(lactic acid). We select the reactive extraction for the recovery of the lactic acid because it is the cheapest method to recovery of lactic acid than the other processes where the mass transfer and reaction are carried out in one unit. In this case study there different parameters are used such as effect of diluents, effect of the initial concentration of lactic acid in aqueous phase, effect of the concentration of TBP in organic phase and effect of temperature and we studied the kinetic studies of the reaction of lactic acid with TBP dissolved in di ethyl ether

**Reactive Separation for Process Intensification and Sustainability** Walter de Gruyter GmbH & Co KG

This book presents the latest achievements of separation science and technology. It highlights the application of separation with regard to problems of current interest, such as the protection of the environment and the development of emerging technology, including chemical engineering, biotechnology, renewable energy sources and recycling of materials.

**Reactive Separation Processes** Routledge

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.

**Optimizing Simultaneous-isomerization-and-reactive-extraction (SIRE) Followed by Back-extraction (BE) Process for Efficient Fermentation of Ketose Sugars to Products**

The (bio)conversion of lignocellulosic biomass to biofuel and chemicals (such as ethanol and furans) requires both hexose and pentose sugars released to be fully utilized to make the process cost-effective. To better utilize these sugars, the aldose isomers of both hexose and pentose sugars can be isomerized into their more reactive ketose forms. However, the isomerization equilibrium of the both hexose and pentose sugars into the more reactive ketose isomers using the enzyme xylose isomerase (GXI) or other catalytic means predominantly favors the aldose sugars. While there are multiple options for overcoming this unfavorable equilibrium, product removal strategies are widely used to shift the aldose/ketose equilibrium toward ketose. One such method,

simultaneous-isomerization and reactive-extraction (SIRE), uses a two-phase system to improve the ketose yield during isomerization. In SIRE, the isomerization occurs in the aqueous phase and the sugar complexation occurs with a lipophilic boronic acid complexing agent (CA) confined to the organic phase. This approach enables reuse of the immobilized GXI and the complexing agent/organic phase. It also enables the concentration of the sugars as they are stripped by back-extraction (BE) from the organic phase. The goal of this dissertation research was to develop mathematical models to predict the results of SIRE-BE of biomass sugars glucose and xylose. These models were validated with experimental data and were used to predict the outcome of the SIRE-BE process under a variety of operating conditions. Experimental data was collected for sugar isomerization, reactive-extraction, and back-extraction to determine appropriate model parameters. Kinetic parameters for the isomerization of aldose to ketose sugars were determined using experimental data fit to Michaelis-Menten reversible, enzyme-catalyzed reaction models. The theoretical model for the mixed sugar reactive-extraction process was derived as part of this dissertation. Equilibrium constants for the reactive-extraction of sugar isomers were determined from experimental data collected under several reactive-extraction conditions. The model was used to predict the composition of the resulting aqueous and organic phases at equilibrium and was implemented in MatLab. Parameters determined from the fits of isomerization and reactive-extraction models to experimental data were used in a comprehensive mathematical model that included both transient isomerization and pseudo-steady state reactive-extraction of aldose and ketose sugars to simulate SIRE. By optimizing the results for SIRE-BE for the pentose sugar isomerization (xylose to xylulose), a xylulose-rich aqueous sugar stream can be produced and converted into a wide variety of platform chemicals. One example is the dehydration of xylulose into furfural; furfural can be used as a precursor for fuels, fuel additives, and biobased-materials. Using existing experimental data for this dehydration reaction, a robust mathematical model of the reaction kinetics was developed to predict rates of xylulose consumption and furfural production under a range of temperature conditions.

*Reactive Extraction*

Economic needs as well as ecological demands are major driving forces in improving chemical processes and plants. To meet these goals processes have to be intensified in order to get products of higher quality, to increase yield by reducing or even suppressing by-products and to minimize energy consumption. A preferred principle for such intensifications is process - tegration, especially integration of reaction and separation operations. Scientific research in this field has been boosted by certain extremely successful examples like the Eastman-Kodak process for methyl acetate or the MTBE process which are milestones for this method. In 2002 the German Research Foundation defined process integration as one of the major - search topics for the next decade. In 1998 the Department of Biochemical- and Chemical Engineering at the University of Dortmund decided to pool its activities for concerted - forts in process integration and to form a joint research cluster. Our interest was to find out the general challenges as well as obstacles of integrated processes and to work out methods for their design and valuation. Soon it became clear that theoretical work only cannot give reasonable answers.

*Reactive Extraction of Formic Acid with Cyanex 923*

This book summarizes the available information in six known areas of reactive separation: reaction/distillation, reaction/extraction, reaction/absorption, reaction/adsorption, reaction/membrane, and reaction/crystallization.

#### Reactive Extraction of Microalgae for Biodiesel Production

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).

#### Reactive Extraction of Oxygenates with Aqueous Salt Solutions

This book describes, analyses and discusses the main principles, phenomena and design strategies of reactive separation processes with an emphasis on the intensification as a basis of the sustainability. Different reactive separation processes are explained in detail to show the phenomena and with the purpose of understanding when their use allows advantages based on the output results. Case examples are analysed and the perspective of these processes in the future is discussed. The overall sustainability of reactive separation processes in the industry is also explained separately.

#### Direct Conversion of Carboxylate Salts to Carboxylic Acids Via

#### Reactive Extraction

Separation and purification processes play a critical role in biorefineries and their optimal selection, design and operation to maximise product yields and improve overall process efficiency. Separations and purifications are necessary for upstream processes as well as in maximising and improving product recovery in downstream processes. These processes account for a significant fraction of the total capital and operating costs and also are highly energy intensive. Consequently, a better understanding of separation and purification processes, current and possible alternative and novel advanced methods is essential for achieving the overall techno-economic feasibility and commercial success of sustainable biorefineries. 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, 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 a series of detailed case studies including cellulosic bioethanol production, extraction of algae oil from microalgae, and production of biopolymers. Separation and Purification Technologies 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 bioenergy.

#### **Extractant Design for the Separation of Enantiomers by Reactive Extraction**

#### Reactive Extraction of Rapeseed for Biodiesel Production."

#### **Reactive Extraction of Rapeseed for Biodiesel Production**