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International Conference, Bhopal, India, 23-25 February 2016
Waste Cooking Oil-to-biodiesel Conversion for Institutional Vehicular Applications
Biofuels and Bioenergy (BICE2016)
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Design and Economic Assessment of Biodiesel Production from Waste Cooking Oil
Status and Perspective

TAYLOR RIVERS

Waste and Biodiesel Elsevier
The recent issue of peak oil and environmental concerns has prompted deeper research into the area of alternative fuels, particularly biofuel. Two types of feedstock for biodiesel production was researched in this project, namely waste cooking oil (WCO) and Refined-Bleached-Deodorized (RBD) palm oil. The performance of the alkaline catalyst potassium hydroxide was investigated towards the methyl ester purity of the product produced using ultrasonic transesterification. The methanol oil molar ratio used in this research was 6:1. The best conditions for biodiesel production were determined in terms of reaction time and catalyst concentration. The range of catalyst concentration and reaction time studied were 0.75 to 1.75 weight percent and 20 to 50 minutes respectively. Catalyst concentration and reaction time played a significant role in the purity of the product produced. The results show that the best catalyst concentration to produce methyl ester of high purity is at 1.75 weight percent, while the best reaction time necessary is 50 minutes. The resulting conditions were then used to synthesize the final product that was then subjected to a combustion test to determine the quantity of carbon monoxide and carbon dioxide emitted. WCO biodiesel was found to have 19.1% lower carbon monoxide emissions than RBD palm oil biodiesel. In terms of the amount of carbon dioxide released, WCO biodiesel had emissions higher than that of RBD palm oil biodiesel by 2.3%. In conclusion, WCO biodiesel was found to be more environmentally friendly compared to RBD palm oil biodiesel upon combustion.
Processing and Uses John Wiley & Sons
Reviews recent advances in catalytic biodiesel synthesis, highlighting various nanocatalysts and nano(bio)catalysts developed for effective biodiesel production Nano- and Biocatalysts for Biodiesel Production delivers an essential reference for academic and industrial researchers in biomass valorization and biofuel industries. The book covers both nanocatalysts and biocatalysts, bridging the gap between homogenous and heterogenous catalysis. Readers will learn about the techno-economical and environmental aspects of biodiesel production using different feedstocks and catalysts. They will also discover how nano(bio)catalysts can be used as effective alternatives to conventional catalysts in biodiesel production due to their unique properties, including reusability, high activation energy and rate of reaction, easy recovery, and recyclability. Readers will benefit from the inclusion of:

Introductions to CaO nanocatalysts, zeolite nanocatalysts, titanium dioxide-based nanocatalysts and zinc-based in biodiesel production An exploration of carbon-based heterogeneous nanocatalysts for the production of biodiesel Practical discussions of bio-based nano catalysts for biodiesel production and the application of nanoporous materials as heterogeneous catalysts for biodiesel production An analysis of the techno-economical considerations of biodiesel production using different feedstocks Nano- and Biocatalysts for Biodiesel Production focuses on recent advances in the field and offers a complete and informative guide for academic researchers and industrial scientists working in the fields of biofuels and bioenergy, catalysis, biotechnology, bioengineering, nanotechnology, and materials science.

Biodiesel Fuels Based on Edible and Nonedible Feedstocks, Wastes, and Algae John Wiley & Sons

These conference proceedings provide a comprehensive overview of and in-depth technical information on all possible bioenergy resources (solid, liquid, and gaseous), including cutting-edge themes such as advanced fuels and biogas. The book includes current state-of-the-art topics ranging from feedstocks and cost-effective conversion processes to biofuels economic analysis and environmental policy, and features case studies and quizzes for each section derived from the implementation of actual hands-on biofuel projects to aid learning. It offers readers a starting point on this challenging and exciting path. The central concepts are defined and explained in the context of process applications under various topics. By focussing on the pertinent fundamental principles in the environment and energy sciences and by repeatedly emphasizing the importance of their correlation, it offers a strong foundation for future study and practice. Learning about fundamental properties and mechanisms on an ongoing basis is absolutely essential for long-term professional viability in a technically vibrant area such as nanotechnology. The book has been written for undergraduate and graduate students in chemical, energy and environment engineering. However, selected sections can provide the basis for courses in civil, mechanical or electrical engineering. It includes a self-contained presentation of the key concepts of energy resources, solar thermal and photovoltaic systems, nuclear energy, biomass conversion technology and agricultural-waste processing. Throughout it interweaves descriptive material on sustainable development, clean coal technology, green technology, solid-waste management and lifecycle assessments. It offers an introduction to these topics rather than comprehensive coverage of the themes and their in-depth fundamentals.

Feedstocks and Precursors for Catalysts BoD – Books on Demand

Waste and Biodiesel: Feedstocks and Precursors for Catalysts is a comprehensive reference on waste material utilization at various stages of the biodiesel production process. The book discusses the technologies for converting cooking oil and waste animal fats to biodiesel, along with the efficacy of municipal waste derived lipids in biodiesel production. The use of wastewater-grown microalgae feedstock, oleaginous fungi, bacteria and yeast produced using waste substrate are also discussed. The use of various catalysts is addressed, including CaO derived from

waste shell materials, fish and animal waste, inorganic waste materials like red mud and cement waste, and whole cell enzymes using waste substrate. Each chapter addresses the challenges of high production costs at a pilot and industrial scale, offering methods of cost reduction and waste remediation. This book is a valuable resource for researchers and industry professionals in environmental science, energy and renewable energy. Provides a comprehensive assessment of waste for biodiesel production, including novel feedstocks such as waste cooking oil, animal fats and municipal waste Discusses the synthesis of cost-effective catalysts from various waste materials such as animal bones, fish scales, shells, red mud and cement waste Presents multiple methods of cost reduction in biodiesel production, e.g., by utilizing waste as a nutrient source for oleaginous algae and fungi

Energy Crops and Waste Cooking Oil for Biodiesel Production CRC Press

Biodiesel popularly known as an alternative diesel fuel in developed countries mainly for transportation and agriculture industry. Now days, biodiesel became more important due to insufficient of petroleum fuel and the needs of environmental friendly energy sources. The high price of crude petroleum oil to has made biodiesel become more favorable in the market. Due to the high cost of raw material, waste cooking oil use as raw material instead of conventional method using vegetable oil. However, waste cooking oil contain high amount of free fatty acid and thus, single steps transesterification process with the aid of homogeneous catalyst were implemented in this experiment with sodium methoxide is use as homogeneous catalyst. Methanol was chosen as alcohol solvent because its price is more cheaper compare to others type of alcohol. In the transesterification process, the triglycerides will react with a methanol to form esters and a by product glycerol. In this experiment, Response surface methodology (RSM) was used to studies the effect of two variables which are reaction time (varied from 30 minutes to 90 minutes) and catalyst concentrations (0.5 wt.% to1.0 wt%). The oil to methanol ratio was fixed at 1:6 and temperature was fixed at 65oC. The sample of each experiment was analyzed using thin layer chromatography (TLC) and the yield of biodiesel was recorded. The optimal reaction condition to achieve highest methyl ester content was at reaction time 70.15 minutes and catalyst concerntration was at 1.50wt.% while the optimal reaction condition to achieve highest biodiesel yield was at reaction time 64.66 minutes with the catalyst concerntration of 0.92wt.%. -Author.

Waste and Biodiesel Springer Science & Business Media

Biodiesel Production: Technologies, Challenges, and Future Prospects provides in-depth information on fundamentals, approaches, technologies, source materials and associated socio-economic and political impacts of biodiesel production.

Biodiesel Production Springer

Project Report from the year 2017 in the subject Engineering - Industrial Engineering and Management, , language: English, abstract: The conventional approach of biodiesel production is transesterification, using oil and alcohol in the presence of a catalyst with glycerol as a by-product of the reaction. Product quality is dependent on the type and amount of catalyst, type of oil feedstock, alcohol-to-oil ratio, etc. In

terms of the best process, currently the alkali catalyzed process is the most profitable while the enzymatic based one is even more promising due to the lower consumption of energy and water; however it requires that the enzyme cost is reduced. The reason that biodiesel is not utilized widely around the world is due to the high cost of raw materials. To overcome this, one can use lower quality oils, such as Waste Cooking Oil (WCO). A lot of research has been carried out on the production of biodiesel from fresh vegetable and animal oil sources but the use of Waste Cooking Oil, such as palm oil, etc. has not been well documented. Then the aim of this current project is to analyze and optimize the conditions for biodiesel production from Waste Cooking Oil, by investigating interaction effects among process variables (temperature, oil-to-methanol molar ratio and catalyst loading) using SPC and other tools. Thus this project focuses on making biodiesel processes better and more efficient.

Technologies, Challenges, and Future Prospects John Wiley & Sons

This book offers the current state of knowledge in the field of biofuels, presented by selected research centers from around the world. Biogas from waste production process and areas of application of biomethane were characterized. Also, possibilities of applications of wastes from fruit bunch of oil palm tree and high biomass/bagasse from sorghum and Bermuda grass for second-generation bioethanol were presented. Processes and mechanisms of biodiesel production, including the review of catalytic transesterification process, and careful analysis of kinetics, including bioreactor system for algae breeding, were widely analyzed. Problem of emissivity of NOx from engines fueled by B20 fuel was characterized. The closing chapters deal with the assessment of the potential of biofuels in Turkey, the components of refinery systems for production of biodegradable plastics from biomass. Also, a chapter concerning the environmental conditions of synthesis gas production as a universal raw material for the production of alternative fuels was also added.

A Key Cosmetic Ingredient BoD – Books on Demand

"Transesterification is a process that converts triglycerides, like vegetable oil, into fatty acid methyl esters, commonly known as biodiesel. This conversion reaction requires the triglyceride feedstock, an alcohol, and an alkali-catalyst to produce the biodiesel. Biodiesel is a versatile biofuel that is renewable, biodegradable, and environmentally beneficial in the sense that combustion adds only biogenic carbon to the atmosphere. The main limitation of commercialization of biodiesel is cost. However, developing closed-loop systems that have an available triglyceride supply, such as waste cooking oil, as well as demand for diesel based fuels, can achieve substantial emissions reductions and energy avoidance, while simultaneously solving a waste disposal issue. Thus, an analysis of the development of a closed-loop waste cooking to biodiesel fuel production process is warranted. A waste-to-energy (WtE) system like this offers great potential to institutions. Thus, this analysis includes the development of a waste cooking oil to biodiesel fuel program utilizing the available waste cooking oil of a university, the production of the fuel, the internal use of the fuel, and subsequent analysis of the fuel characteristics, emissions, and the life cycle

environmental and energy impacts of the production process and ultimate use. The results show that the waste cooking oil derived biodiesel meets the required American Society for Testing and Materials (ASTM) standard specifically for biodiesel, ASTM D6751. The produced biodiesel was blended with commercially available fuel oil, which met the ASTM specification D396-13b. Therefore, a blend of these two ASTM compliant fuels also met the required ASTM standards. The ASTM standards require high quality fuel characteristics and ensure proper utilization and combustion. Biodiesel blended heating fuels were utilized in two distinct heating facilities, both showing comparable emissions to conventional fuel oil. Small (500 mL) and large (1L) volume biodiesel blends were utilized in a conventional residential furnace. Emissions data were obtained through the exhaust ducting with a combustion gas analyzer. The same fuel blends were utilized in a lab-scale burner apparatus without a heat exchanger, which enabled near-flame interrogation and visualization of the combustion process. The emissions of both heating facilities were comparable to the incumbent fuel oil. The life cycle assessment results demonstrate the benefits of increasing the approved blends of biodiesel heating fuels. Currently, most oil burners are only approved up to a B5 blend (5% biodiesel, 95% fuel oil). The results show higher blends achieve substantial life cycle reduction in global warming potential and cumulative energy demand, as well as an energy return on investment of above 4, indicating more energy is obtained from the fuel than required to produce it."--Abstract.

Biodiesel Production from Waste Cooking Oil in Continuous Reactive Distillation Column Catalyzed by Superacid Heteropolyacid Elsevier

"Biodiesel is a renewable, sustainable, clean-burning biogenic fuel that can serve as a substitute for conventional ultra-low sulfur diesel (ULSD). Biodiesel is comprised of mono-alkyl esters of long chain fatty acids and is produced via transesterification, whereby glycerin is separated from the fatty acid component of either an oil or fat. The full process yields the fatty acid methyl ester (biodiesel fuel) and glycerin, an economically valuable by-product. As part of a United States Environmental Protection Agency (EPA) Climate Showcase Communities Grant to Monroe County, New York and Rochester Institute of Technology (RIT), the Golisano Institute for Sustainability (GIS) was engaged to develop a closed-loop biodiesel production process system using the food service waste cooking oil stocks. Because the waste oil feedstock supply and fuel demand are internal within the institution, the system dynamics, economic feasibility, and environmental benefits versus the incumbent ultra-low sulfur diesel can be effectively quantified. Along with establishing quantitative metrics associated with quality of the fuel itself, the main goal of this part of a broader research program included utilizing the biodiesel fuel for campus vehicular applications. Ultimately, developing a robust waste-to-energy process within the system boundaries of the institution is the desired outcome, along with economic valuation, emissions testing, fuel quality metrics and standardization, life cycle assessment, and energy return on investment for the university's stakeholders. Through the execution of this project, two successful biodiesel batches were produced which met

American Society of Testing and Materials (ASTM) quality standards for vehicle use. Lower heating value (LHV) measurement demonstrated comparable embodied energy content to earlier published data. In addition, cloud point measurements were taken to understand the performance of the fuel in cold weather conditions, and these metrics were also consistent with published data for biodiesel fuels. Through direct measurements of exhaust gas composition, overall reductions in greenhouse gas emissions were observed in two test vehicles. However, consistent with published data, there is evidence that emissions of nitrous oxides (NOx) may be higher with a 20% biodiesel blend (B20), depending on the specific vehicle and the type of exhaust gas recirculation (EGR) valve technology employed. According to a life cycle assessment conducted on the closed-loop biodiesel production process, the cumulative energy demand (CED) was 752 MJ/100 km and the global warming potential (GWP) was 80.6 kg CO2-eq./100 km. Crude oil-based diesel contributes the most to the energy and environmental impact to the total combustion CED and GWP of a B20 fuel mixture, while the methanol component contributes the greatest energy and environmental impact to just the biodiesel component. The energy return on investment (EROI) was determined to vary depending on specific waste oil properties and processing conditions, with a value of 4.16 determined to be most representative of the developed conversion process. This demonstrates that waste cooking oil biodiesel production at RIT is net energy positive, and thus can reasonably contribute to the University's renewable energy and GHG emissions reduction goals. The closed-loop biodiesel process also presented a compelling economic case, with a total computed cost of $3.35/gallon (including a conservative estimate for production labor) well lower than the reported national prices of B100 at retail market."-Abstract.

Optimization of Biodiesel Production from Waste Cooking Oil Using a Membrane Reactor Biodiesel Production from Waste Cooking OilBiodiesel Production from Waste Cooking Oil.Design and Economic Assessment of Biodiesel Production from Waste Cooking OilBiodiesel Production from Waste Cooking Oil in Continuous Reactive Distillation Column Catalyzed by Superacid HeteropolyacidOptimization of Biodiesel Production from Waste Cooking Oil Using a Membrane ReactorBiodiesel Production from Waste Cooking Oil Via Single Steps Transesterification Process with the Aid of Sodium Methoxide as a CatalystBiodiesel popularly known as an alternative diesel fuel in developed countries mainly for transportation and agriculture industry. Now days, biodiesel became more important due to insufficient of petroleum fuel and the needs of environmental friendly energy sources. The high price of crude petroleum oil to has made biodiesel become more favorable in the market. Due to the high cost of raw material, waste cooking oil use as raw material instead of conventional method using vegetable oil. However, waste cooking oil contain high amount of free fatty acid and thus, single steps transesterification process with the aid of homogeneous catalyst were implemented in this experiment with sodium methoxide is use as homogeneous catalyst. Methanol was chosen as alcohol solvent because its price is more cheaper compare to others type of alcohol. In the

transesterification process, the triglycerides will react with a methanol to form esters and a by product glycerol. In this experiment, Response surface methodology (RSM) was used to studies the effect of two variables which are reaction time (varied from 30 minutes to 90 minutes) and catalyst concentrations (0.5 wt.% to1.0 wt%). The oil to methanol ratio was fixed at 1:6 and temperature was fixed at 65oC. The sample of each experiment was analyzed using thin layer chromatography (TLC) and the yield of biodiesel was recorded. The optimal reaction condition to achieve highest methyl ester content was at reaction time 70.15 minutes and catalyst concerntration was at 1.50wt.% while the optimal reaction condition to achieve highest biodiesel yield was at reaction time 64.66 minutes with the catalyst concerntration of 0.92wt.%. - Author.Parametric Study of Biodiesel Production from Waste Cooking OilsBiodiesel ProductionTechnologies, Challenges, and Future ProspectsBiodiesel Production: Technologies, Challenges, and Future Prospects provides in-depth information on fundamentals, approaches, technologies, source materials and associated socio-economic and political impacts of biodiesel production.The Feasibility of Waste Cooking Oil As Biodiesel in Hong KongThis dissertation, "The Feasibility of Waste Cooking Oil as Biodiesel in Hong Kong" by Lai-ling, Li, □□□□, was obtained from The University of Hong Kong (Pokfulam, Hong Kong) and is being sold pursuant to Creative Commons: Attribution 3.0 Hong Kong License. The content of this dissertation has not been altered in any way. We have altered the formatting in order to facilitate the ease of printing and reading of the dissertation. All rights not granted by the above license are retained by the author. Abstract: With an alarming increase in dumping of municipal solid waste to landfill in Hong Kong, of which food waste dominated, it is now the best opportunity to promote the use of biodiesel produced from waste cooking oils. Biodiesel has its main advantages as renewability, biodegradability, non-toxicity, non-greenhouse effect contributor and safety. In this project, biodiesel was produced from waste cooking oils in laboratory. The feedstock used were home-used deep-frying canola oil, home-used pig oil, deep-fried oil obtained from a restaurant and fresh canola oil. Investigation and comparison were made between household waste cooking oil, restaurant cooking oil and fresh cooking oil in terms of quantity and quality by analysis on product density, cloud point, pour point and components by gas chromatography as well as mass spectrometry. Waste cooking Waste cooking oils should be used for biodiesel production because of its low price and sustainability. In comparison of biodiesel yield and quality produced from household waste cooking oil with restaurant waste cooking oil, household waste cooking oil was a better feedstock. In terms of technology and huge amount of waste cooking oil generated in Hong Kong, biodiesel production in mass way is feasible. Future investigation will be needed for collection of waste cooking oil from household level such as implementation of pilot-scaled collection and production scheme in large estates. Subjects: Biodiesel fuels - China - Hong KongBiofuelsStatus and Perspective Up-scale for the production of biodiesel from waste cooking oil (WCO) and Refined-Bleached-Deodorized (RBD)

under ultrasonic condition was studied. The effects of sodium hydroxide as a catalyst and time on the biodiesel conversion were investigated. Experiments have been performed to determine the optimum condition for this alkali-catalyzed transesterification process where the temperature is fixing at 40oC and the stirring rpm are 1000 rpm. The results showed that transesterification process under ultrasonic condition was proved to be time and energy saving. Gas Chromatography (GC) is used to study the formation of methyl ester of waste cooking oil and combustion test to study the combustion characteristic of biodiesel. The optimum experimental condition for catalyst concentration is 1 wt% sodium hydroxide (NaOH) and the reaction time is 40 minutes for WCO while 0.75 wt % sodium hydroxide (NaOH) and the reaction time is 30 minutes for RBD. The level of carbon dioxide (CO2) and carbon monoxide (CO) in biodiesel from WCO are low compare to the RBD and diesel fuel.

Application of Taguchi Method in the Optimization of Biodiesel Production from Waste Cooking Oil Using MoO3/SiO2 Catalysts BoD – Books on Demand

This book aspires to be a comprehensive summary of current biofuels issues and thereby contribute to the understanding of this important topic. Readers will find themes including biofuels development efforts, their implications for the food industry, current and future biofuels crops, the successful Brazilian ethanol program, insights of the first, second, third and fourth biofuel generations, advanced biofuel production techniques, related waste treatment, emissions and environmental impacts, water consumption, produced allergens and toxins. Additionally, the biofuel policy discussion is expected to be continuing in the foreseeable future and the reading of the biofuels features dealt with in this book, are recommended for anyone interested in understanding this diverse and developing theme.

Nano- and Biocatalysts for Biodiesel Production GRIN Verlag

The edited volume presents the progress of first and second generation biofuel production technology in selected countries. Possibility of producing alternative fuels containing biocomponents and selected research methods of biofuels exploitation characteristics (also aviation fuels) was characterized. The book shows also some aspects of the environmental impact of the production and biofuels using, and describes perspectives of biofuel production technology development. It provides the review of biorefinery processes with a particular focus on pretreatment methods of selected primary and secondary raw materials. The discussion includes also a possibility of sustainable development of presented advanced biorefinery processes.

A Realistic Fuel Alternative for Diesel Engines GRIN Verlag

A comprehensive overview of current developments and applications in biofuels production Process Systems Engineering for Biofuels Development brings together the latest and most cutting-edge research on the production of biofuels. As the first book specifically devoted to process systems engineering for the production of biofuels, Process Systems Engineering for Biofuels Development covers theoretical, computational and experimental issues in biofuels process engineering. Written for researchers and postgraduate

students working on biomass conversion and sustainable process design, as well as industrial practitioners and engineers involved in process design, modeling and optimization, this book is an indispensable guide to the newest developments in areas including: Enzyme-catalyzed biodiesel production Process analysis of biodiesel production (including kinetic modeling, simulation and optimization) The use of ultrasonification in biodiesel production Thermochemical processes for biomass transformation to biofuels Production of alternative biofuels In addition to the comprehensive overview of the subject of biofuels found in the Introduction of the book, the authors of various chapters have provided extensive discussions of the production and separation of biofuels via novel applications and techniques.
Routledge
Waste and Biodiesel: Feedstocks and Precursors for Catalysts is a comprehensive reference on waste material utilization at various stages of the biodiesel production process. The book discusses the technologies for converting cooking oil and waste animal fats to biodiesel, along with the efficacy of municipal waste derived lipids in biodiesel production. The use of wastewater-grown microalgae feedstock, oleaginous fungi, bacteria and yeast produced using waste substrate are also discussed. The use of various catalysts is addressed, including CaO derived from waste shell materials, fish and animal waste, inorganic waste materials like red mud and cement waste, and whole cell enzymes using waste substrate. Each chapter addresses the challenges of high production costs at a pilot and industrial scale, offering methods of cost reduction and waste remediation. This book is a valuable resource for researchers and industry professionals in environmental science, energy and renewable energy. Provides a comprehensive assessment of waste for biodiesel production, including novel feedstocks such as waste cooking oil, animal fats and municipal waste Discusses the synthesis of cost-effective catalysts from various waste materials such as animal bones, fish scales, shells, red mud and cement waste Presents multiple methods of cost reduction in biodiesel production, e.g., by utilizing waste as a nutrient source for oleaginous algae and fungi
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Biodiesel Production from Waste Cooking Oil.
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Analysis and Optimization of a biodiesel production from WCO
This second volume of the Handbook of Biodiesel and Petrodiesel Fuels presents a representative sample of the population papers in the field of feedstock-specific biodiesel fuels. The research on feedstocks for biodiesel fuels has first focused on the edible oils as first-generation biodiesel fuels. However, the public concerns about the competition with foods based on these feedstocks and adverse impact on the ecological diversity and deforestation have resulted in the exploration of nonedible-oil-based biodiesel fuels as second-generation biodiesel fuels in the first instance. Due to the ecological and cost benefits of treating wastes, waste oil-based biodiesel fuels as third-

generation biodiesel fuels have emerged. Furthermore, following a series of influential review papers, the research has focused on the algal oil-based biodiesel fuels in recent years. Since the cost of feedstocks in general constitutes 85% of the total biodiesel production costs, the research focused more on improving biomass and lipid productivity in these research fields. Furthermore, since water, CO2, and nutrients (primarily N and P) have been major ingredients for the algal biomass and lipid production, the research has also intensified in the use of wastewaters and flue gases for algal biomass production to reduce the ecological burdens and the production costs. Part 1 presents a representative sample of the population papers in the field of edible oil-based biodiesel fuels covering major research fronts. It covers soybean oil-based biodiesel fuels, palm oil-based biodiesel fuels, and rapeseed oil-based biodiesel fuels as case studies besides an overview paper. Part 2 presents a representative sample of the population papers in the field of nonedible oil-based biodiesel fuels covering major research fronts. It covers Jatropha oil-based biodiesel fuels, polanga oil-based biodiesel fuels, and moringa oil-based biodiesel fuels as case studies besides an overview paper. Part 3 presents a representative sample of the population papers in the field of waste oil-based biodiesel fuels covering major research fronts. It covers wastewater sludge-based biodiesel fuels, waste cooking oil-based biodiesel fuels, and microbial oil-based biodiesel fuels as case studies besides an overview paper. Part 4 presents a representative sample of the population papers in the field of algal oil-based biodiesel fuels covering major research fronts. It covers algal biomass production in general, algal biomass production in wastewaters, algal lipid production, hydrothermal liquefaction of algal biomass, algal lipid extraction, and algal biodiesel production besides an overview paper. This book will be useful to academics and professionals in the fields of Energy Fuels, Chemical Engineering, Physical Chemistry, Biotechnology and Applied Microbiology, Environmental Sciences, and Thermodynamics. Ozcan Konur is both a materials scientist and social scientist by training. He has published around 200 journal papers, book chapters, and conference papers. He has focused on the bioenergy and biofuels in recent years. In 2018, he edited ‘Bioenergy and Biofuels’, that brought together the work of over 30 experts in their respective field. He also edited ‘Handbook of Algal Science, Technology, and Medicine’ with a strong section on the algal biofuels in 2020.

Up-scale Study on Ultrasonically Assisted of Biodiesel Production from Waste Cooking Oil (WCO)

Energy technologies have attracted great attention due to the fast development of sustainable energy. Biodiesel technologies have been identified as the sustainable route through which overdependence on fossil fuels can be reduced. Biodiesel has played a key role in handling the growing challenge of a global climate change policy. Biodiesel is defined as the monoalkyl esters of vegetable oils or animal fats. Biodiesel is a cost-effective, renewable, and sustainable fuel that can be made from vegetable oils and animal fats. Compared to petroleum-based diesel, biodiesel would offer a non-toxicity, biodegradability, improved air quality and positive impact on the environment, energy security, safe-to-

handle, store and transport and so on. Biodiesels have been used as a replacement of petroleum diesel in transport vehicles, heavy-duty trucks, locomotives, heat oils, hydrogen production, electricity generators, agriculture, mining, construction, and forestry equipment. This book describes a comprehensive overview, covering a broad range of topics on biodiesel technologies and allied applications. Chapters cover history, properties, resources, fabrication methods, parameters, formulations, reactors, catalysis, transformations, analysis, in situ spectroscopies, key issues and applications of biodiesel technology. It also includes biodiesel methods, extraction strategies, biowaste utilization, oleochemical resources, non-edible feedstocks, heterogeneous catalysts, patents, and case-studies. Progress, challenges, future directions, and state-of-the-art biodiesel commercial technologies are discussed in detail. This book is an invaluable resource guide for professionals, faculty, students, chemical engineers, biotechnologists, and environmentalists in these research and development areas.