Modeling Of Biomass Char Gasification Combustion And

This book includes selected peer-reviewed papers presented at the International Conference on Modeling, Simulation and Optimization, organized by National Institute of Technology, Silchar, Assam, India, during 3–5 August 2020. The book covers topics of modeling, simulation and optimization, including computational modeling and simulation, system modeling and simulation, device/VLSI modeling and simulation, control theory and applications, modeling and simulation of energy system and optimization. The book disseminates various models of diverse systems and includes solutions of emerging challenges of diverse scientific fields.

The overall objective of the current project was to investigate the high pressure gasification characteristics of a feed containing both coal and biomass. The two feed types differ in their ash contents and ash composition, particularly the alkali content. Gasification of a combined feed of coal and biomass has the potential for considerable synergies that might lead to a dramatic improvement in process economics and flexibility. The proposed study aimed to develop a detailed understanding of the chemistry, kinetics, and transport effects during high pressure gasification of coal-biomass blend feed. Specifically, we studied to develop: (a) an understanding of the catalytic effect of alkali and other inorganic species present in the biomass and coal, (b) an understanding of processing conditions under which synergistic effects of the blending of coal and biomass might be observed. This included the role of particle size, residence time, and proximity of the two feed types, (c) kinetics of high pressure gasification of individual feeds as well as the blends, and (d) development of mathematical models that incorporate kinetics and transport models to enable prediction of gasification rate at a given set of operating conditions, and (e) protocols to extend the results to other feed resources. The goal was to provide a fundamental understanding of the gasification process and guide in optimizing the configurations and design of the next generation of gasifiers. The approach undertaken was centered on two basic premises: (1) the gasification for small particles without internal mass transfer limitations can be treated as the sum of two processes in series (pyrolysis and char gasification), and (2) the reactivity of the char generated during pyrolysis not only depends on the pressure and temperature but is also affected by the heating rates. Thus low heating rates (10-50 °C/min) typical of PTGA fail to produce char that would typically be formed at high heating rates (~104 °C/sec), encountered in entrained flow gasifiers. The char morphology, also a function of the heating rate, would influence the transport rates during the char gasification phase. Thus, heating rate plays a critical role through which both, pyrolysis and char gasification, are interconnected. We utilized two complementary gasification experiments: PEFR (pressurized entrained flow gasifier) and PTGA (pressurized thermo-gravimetric analyzer). The PEFR allowed us to study gasification at pressures, temperatures, and heating rates relevant for coal-biomass gasifiers. The PTGA work was useful in understanding the basic chemistry of the evolution of various gaseous species during pyrolysis. These results helped improved our understanding of the chemistry and chemical changes during pyrolysis. The role alkali metals and other inorganics in char gasification using steam and/or CO2 was investigated. Finally, the mathematical models for char gasification without the transport effects were developed at commercial operating conditions.

"The importance of climate change and subsequently the necessity for sustainable energy production have been evident to researchers and experts in this field for the past decades. However, moving forward with increasing the industrialization of biofuels and replacing them with conventional fuels require persuading businesses with robust and vast research results on the benefits of biofuels. Implementing numerical modeling as preliminary tests for different biomass as well as analyzing the behavior of the system by changing the effective properties, provides a resourceful tool for experimentation and is financially beneficial. Gasification has become one of the most desirable thermochemical conversion processes in the clean energy production, specifically for the hydrogen gas, with the biomass being compatible with this conversion system as a feedstock. However, the complexity of this process and the high range of temperature limit the possible number of the experimental tests, leading to the lack of extensive experimental results in the literature for biomass gasification compared to the combustion process. As a result, computational modeling is an ¬attractive alternative to fill the gap of knowledge on this matter. This work consists of one extensive literature review on the numerical modeling of the gasification process and two numerical modeling that have the potential for better understanding of the gasification process in biomass feedstock. The first model provides effective thermal conductivity (ETC) of the wood-plastic composites (WPCs) by using a homogenization method implemented by a finite element method (FEM). The solid volume fraction and porosity is considered as parameters, and high-density polyethylene (HDPE) plastic and wood-char were the materials. The results showed improved ETC as the solid volume fraction increased and the polymer is added to the wood-char. The ETC is one of the most important properties that affect the thermal processes of gasification. Using the homogenization technique, we potentially can design the microstructure of feedstocks to optimize their performance when used in the gasification process. The second model is a 1D gasification model for a single particle in a downdraft gasifier. The 1D model considers reduction and oxidation reactions for char and provides temperature distribution along the radius and time. Temperature rapidly increases before reaching a steady state after 3000s. The temperature on the radiuses closer to the surface has a higher temperature compared to the core. The results were consistent with the analytical data and can be used to better understand the effect of porosity and thermal conductivity on temperature changes in feedstock during gasification"--

The book details sources of thermal energy, methods of capture, and applications. It describes the basics of thermal energy, including measuring thermal energy, laws of thermodynamics that govern its use and transformation, modes of thermal energy, conventional processes, devices and materials, and the methods by which it is transferred. It covers 8 sources of thermal energy: combustion, fusion (solar) fission (nuclear), geothermal, microwave, plasma, waste heat, and thermal energy storage. In each case, the methods of production and capture and its uses are described in detail. It also discusses novel processes and devices used to improve transfer and transformation processes.

With the steady stream of new web based information technologies being introduced to organizations, the need for network and communication technologies to provide an easy integration of knowledge and information sharing is essential. Network and Communication Technology Innovations for Web and IT Advancement presents studies on trends, developments, and methods on information technology advancements through network and communication technology. This collection brings together integrated approaches for communication technology and usage for web and IT advancements.

This PhD thesis presents the work carried out by kinetic modeling incorporated with particle simulation on selected plant based biomass during pyrolysis and gasification followed by an experimental investigation of those processes under entrained flow to satisfy the engineering requirement.Renewable energy sources are becoming a significant part of the primary energy share for

mitigating the CO2 emission along with addressing the issue of fossil fuel depletion. According to the lifecycle of biomass, it is CO2 neutral and can be a potential replacement for fossil fuels. Being a solid fuel, it can be consumed using the existing technology for solid fossil fuels, however, with modification. To modify any available technology, significant research effort is needed in both fundamental and engineering level to find out optimum reaction conditions. One appropriate technology for solid fuel conversion is entrained flow gasification which uses a high heating rate and low residence time to produce high energy gas. Non-conventional biomass (e.g. algae) along with woody biomass might be consumed by this technology. At the same time, fossil fuel (coal) can be potentially replaced by blending biomass with it.To model the inherent kinetics involved in the pyrolysis process, a new algorithm was proposed for higher order distributed activation energy model. The new algorithm was found to be versatile in estimating the intrinsic pyrolysis kinetics for different types of biomass (algae, sawdust, and coconut shell) along with predicting the pyrolysis behavior of the blends of one those biomass samples and coal. To link this fundamental development to the engineering application, entrained flow pyrolysis experiments on biomass were performed on biomass by varying different operating conditions. After that, a particle model was developed for this process to predict the conversion profile of the solid biomass particle using apparent kinetics which showed good agreement with the experimental data. A guideline was also generated on the basis of parametric study (particle size, temperature, gas velocity, residence time etc.) to design a laminar entrained flow reactor for pyrolysis. Further development of the particle model was achieved by incorporating the intrinsic kinetic parameters obtained by the newly developed algorithm. It was proposed that inclusion of pyrolysis heat of reaction would improve the prediction of the model if intrinsic kinetic parameters were to be used.At the same time, effect of operating parameters (temperature, particle size) and species variation on entrained flow pyrolysis was evaluated. The study was limited to the particle size ranges under 600 ?m (suitable particle size for entrained flow gasification) and up to a temperature of 1000 °C. Among all the parameters, particle size was found to be the most critical because of its influence on both residence time and heating rate. Also, temperature was found be very important for achieving full conversion in case of larger particle size. At 1000 °C, pyrolysis of all types of biomass under consideration reached completion. In case of a lower temperature (800 °C), some unconverted particles were observed for larger size (500-600 ?m). Tar production was minimized at 1000 °C for the smaller particle size (150-250 ?m). At a higher temperature, the gas yield was also increased considerably due to the increase in conversion efficiency. Morphological study on the char particles showed that sawdust experienced a molten phase during its pyrolysis and due to the gas release from inside, the smaller particles were converted into cenospheres where no morphology of the parent particle was visible. This resulted in highly reactive char with an extremely porous structure. However, this observation could not be generalized as algae and coconut shell char showed different morphological development.As the char obtained from the entrained flow pyrolysis process were different from fixed bed chars, they were studied for their reactivity and kinetics under CO2. Generally, gasification kinetics of most of the chars was predicted well by random pore model. Only the algal char obtained from rapid pyrolysis was different because of its low amount of gasifiable mass attached to the surface which did not show any porous structure, therefore, followed the volumetric reaction model. Along with the fixed bed chars, only coconut shell char from entrained flow reactor showed very low reactivity. This difference in the reactivity was attributed to the lack of mesopores along with the variation of indigenous alkali in the ash among the biomass species to a lesser extent.This low reactivity of coconut shell char resulted in the entrained flow gasification experiments which were performed by varying the temperature, particle size and also concentration of gasifying agent (CO2). The char from coconut shell did not show any significant increase in conversion due to the decrease in particle size whereas a steady linear increase was observed for temperature. In contrast, the sawdust char was highly reactive and reached its highest conversion (50%) at 1000 °C under 20% CO2 for a reactor length of 1.885 m. Remarkable increase in the conversion was observed with decrease in the particle size and increase of temperature. The increase in reactor length also showed positive effect on char conversion and gas production. These findings have important implications on the gasifier design and sample preparation meaning there will be no benefit of reduced particle size on conversion if the sample itself is less reactive in the first place. Also it was revealed that if raw biomass was gasified, these effects would have been indistinguishable because of the dominance of pyrolysis. No tar was observed during char gasification process at 1000 °C as most of it removed during the pyrolysis process.Along with the above studies, a new analytical technique (Synchrotron based Infrared spectrum) was used to study the pyrolysis process of biomass. The study delineated the evolution of functional groups from the surface of biomass along with the effect of heating rate during the process. This was a preliminary study which opened up new possibilities in energy research considering in situ gasification of biomass.

This book addresses the science and technology of the gasification process and the production of electricity, synthetic fuels and other useful chemicals. Pursuing a holistic approach, it covers the fundamentals of gasification and its various applications. In addition to discussing recent advances and outlining future directions, it covers advanced topics such as underground coal gasification and chemical looping combustion, and describes the state-of-the-art experimental techniques, modeling and numerical simulations, environmentally friendly approaches, and technological challenges involved. Written in an easy-to-understand format with a comprehensive glossary and bibliography, the book offers an ideal reference guide to coal and biomass gasification for beginners, engineers and researchers involved in designing or operating gasification plants.

This unique textbook equips students with the theoretical and practical tools needed to model, design, and build efficient and clean low-carbon energy systems. Students are introduced to thermodynamics principles including chemical and electrochemical thermodynamics, moving onto applications in real-world energy systems, demonstrating the connection between fundamental concepts and theoretical analysis, modelling, application, and design. Topics gradually increase in complexity, nurturing student confidence as they build towards the use of advanced concepts and models for low to zero carbon energy conversion systems. The textbook covers conventional and emerging renewable energy conversion systems, including efficient fuel cells, carbon capture cycles, biomass utilisation, geothermal and solar thermal systems, hydrogen and low-carbon fuels. Featuring numerous worked examples, over 100 multi-component homework problems, and online instructor resources including lecture slides, solutions, and sample term projects, this textbook is the perfect teaching resource for an advanced undergraduate and graduate-level course in energy conversion engineering.

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Biomass, Biofuels, Biochemicals: Biofuels: Alternative Feedstocks and Conversion Processes for the Production of Liquid and Gaseous Biofuels, Second Edition, provides general information, basic data and knowledge on one of the most promising renewable energy sources—liquid and gaseous biofuels—and their production and application. The book delineates green technologies for abating environmental

crisis and enabling the transformation into a sustainable future. It provides date-based scientific information on the most advanced and innovative technology on biofuels, as well as the process scale-up and commercialization of various liquid and gaseous biofuels, detailing the functional mechanisms involved, various operational configurations, influencing factors and integration strategies. All chapters have been updated, with new chapters covering topics of current interest, including sustainability and biohydrogen. Presents a holistic view of biofuels in research, operation, scale-up and application Widens the scope of the existing technologies, providing state-of-the-art information and knowledge Provides strategic integrations of various bioprocesses that are essential in establishing a circular biorefinery Contains interdisciplinary knowledge on the environment, molecular biology, engineering, biotechnology, microbiology and economic aspects Integrates various subjects, including biotechnology, bioengineering, molecular biology, environmental science, sustainability science and chemical engineering

The 1st World Conference and Technology Exhibition on Biomass for Energy and Industry, held in Sevilla in June 2000, brought together for the first time the traditional European Conference on Biomass for Energy and Industry and the Biomass Conference of the Americas, thus creating the largest and most outstanding event in the worldwide biomass sector. The conference elaborated innovative global strategies, projects and efficient practice rules for energy and the environment at a key stage in the industry's development. New concepts and projects were highlighted to increase the social and political awareness for a change in worldwide resource consumption and to promote economically, socially and environmentally sustainable development for the next millennium. In 2 volumes, the Proceedings include some 470 papers essential to an understanding of current thinking, practice, research and global developments in the biomass sector - a vital reference source for researchers, manufacturers, and policy makers involved or interested in the use of biomass for energy and industry.

Most coveted energy forms nowadays are gas in nature and electricity due to their environmental cleanness and convenience. Recently, gasification market trend is starting to switch to low-grade feedstock such as biomass, wastes, and low-rank coal that are still not properly utilized. In this sense, the most promising area of development in gasification field lies in low-grade feedstock that should be converted to more user-friendly gas or electricity form in utilization. This book tried to shed light on the works on gasification from many parts of the world and thus can feel the technology status and the areas of interest regarding gasification for low-grade feedstock.

Throughout the world many projects have been underway to investigate the conversion of renewable biomass into energy and synthetic fuels by thermo chemical methods such as combustion, pyrolysis, gasification and lique faction. While many of these represent prior art used during the early 20th century, the recent decade since the 1970s oil shock has immeasurably increased the knowledge base for such processes. Much of the new knowledge has been gained by persons who were not trained in classical wood chemistry and there have not yet been many attempts to synthesize the knowledge into a corpus of systematic information. To bring this about the International Energy Agency's Forestry Energy collaboration, the Gas Research Institute, the National Research Council of Canada and the US Department of Energy jointly sponsored a conference on the Fundamentals of Thermochemical Biomass Conversion in Estes Park, Colorado which was held on October 18-22, 1982. The Conference, which was structured around invited plenary papers and contributions from researchers, served as the basis for the papers in this volume which reflect the substantial conclusions of the Conference. During the planning for the Conference, it was realized by the editors in their capacity as Co-chairmen that a major problem in biomass research was the lack of reproducibility between reported experiments and their inter comparison on account of the heterogeneity of biomass materials. A well known wood chemist, George M.

Biomass gasification has received tremendous research attention all over the world because (a) biomass is abundant, diverse, renewable, and environmentally friendly, (b) the produced biogas/syngas is clean, versatile, efficient, and easily controllable, and (c) the system used is generally simple. This book aims to present up-to-date research on biomass gasification. The content of this book is divided to three parts or sections: the fundamentals of biomass gasification as presented in chapters 1 to 4, experimenting of biomass gasification as presented in chapters 5 and 6, and simulation of biomass gasification as presented in chapters 7 to 8. In chapter 1 (An introduction to biomass), biomass is introduced, and these mainly include biomass resources, biomass and energy, biomass and environment, benefits of biomass, etc. In chapter 2 (Biomass properties), the properties of biomass are introduced, and these include structural compositions (cellulose, hemicellulose, lignin, starch, extractives, proteins, etc.), physical properties (moisture content, particle size, bulk density, porosity, etc.), chemical properties (elemental compositions, chemical compositions, heating value, etc.) and the other properties (thermal conductivity, ignition temperature, specific heat, etc.). In chapter 3 (Biomass gasification technologies), biomass gasification technologies are classified and introduced according to the gasification agents used (air, oxygen, steam, hydrogen, supercritical water, carbon dioxide and the combination of the above gases), and some factors that have significant impacts on gasification technologies (or performances) are also discussed. Then the emerging gasification technologies (microwave gasification, solar gasification and plasma gasification) using new heat sources are also detailed, and the effects of heat source on biomass gasification are also discussed. In chapter 4 (Biomass gasifiers), the main gasifier structures are introduced, and these include fixed bed gasifiers (updraft and downdraft), fluidized bed gasifiers (bubbling fluidized bed, circulating fluidized bed and dual fluidized bed), entrained flow gasifiers (Koppers-Totzek (K-T) gasifier, shell gasifier and Gas Schwarze Pumpe (GSP) gasifier and Colin gasifier). The other gasifier structures are also presented, and these include solar gasifier, microwave gasifier and plasma gasifier, etc. In chapter 5 (High-temperature gasification of biomass), the effects of physical and chemical properties of biomass on high-temperature gasification are analyzed, and these mainly include high-temperature pyrolysis of biomass, thermal cracking of biomass tar, and high-temperature gasification of biomass char. In chapter 6 (Supercritical water gasification of biomass), the properties of SCW (supercritical water) are detailed and the effects of different operating parameters on CE (carbon conversion efficiency) and GE (gasification efficiency) are summarized. The operating parameters include feedstock characteristics, biomass concentration, gasification temperature, reactor pressure, residence time and catalyst types and concentration. In chapter 7 (Simulation of biomass gasification using thermodynamic equilibrium model), the two thermodynamic equilibrium models of stoichiometric thermodynamic equilibrium models and non-stoichiometric equilibrium models (using Gibbs free energy minimization approach) are initially introduced, and the simulation results obtained from biomass gasification using thermodynamic equilibrium models based on Aspen Plus are then presented. In chapter 8 (Simulation of biomass gasification using intrinsic reaction rate submodel), the numerical simulation of biomass gasification using the intrinsic reaction rate submodel was introduced. The kinetic model for char-gas reaction as well as the intrinsic kinetic data for various biomass materials are detailed. A CFD (computational fluid dynamic) model based on the intrinsic kinetics is developed for biomass entrained flow gasification, and the effects of operating conditions including gasification temperature, equivalence ratio, CO2/biomass mass ratio and average particle size on the gasification performances in a lab-scale entrained flow reactor are investigated. Multi-objective optimization of biomass gasification based on response surface method is then studied to improve the gasification performances. Hopefully, the content of this book can supply a helpful guide to the up-to-date research on the fundamentals, experimental, and simulation of biomass gasification.

The present science book "Application of Solar Energy" is edited by Professor R. D. Rugescu in the series on Solar Power and consists of 7 chapters that begin with the proof of the high thermal efficiency of the gravitational draught through concentrated solar heating. It continues with novel technologies of producing organic fuels through solar heating, new types of photovoltaic cells, long term use of thermal solar power plants, the efficiency of thermal storage and applications in Niger of the Solar power. The reader will be pleasantly impressed by the accompanying drawings and pictures that ease the text assimilation and makes it an attractive practice.

Bridging the gap between theory and application, this reference demonstrates the operational mechanisms, modeling, and simulation of

equipment for the combustion and gasification of solid fuels. Solid Fuels Combustion and Gasification: Modeling, Simulation, and Equipment Operation clearly illustrates procedures to improve and optimize the de

Besides being one of the best Clean Coal Technologies, fluidized beds are also proving to be the most practical option for biomass conversion. Although the technology is well established, the field lacks a comprehensive guide to the design and operating principles of fluidized bed boilers and gasifiers. With more than 30 years of research and industrial experience, Prabir Basu answers this pressing need with Combustion and Gasification in Fluidized Beds. This book is a versatile resource that explains how fluidized bed equipment works and how to use the basic principles of thermodynamics and fluid mechanics in design while providing insight into planning new projects, troubleshooting existing equipment, and appreciating the capabilities and limitations of the process. From hydrodynamics to construction and maintenance, the author covers all of the essential information needed to understand, design, operate, and maintain a complete fluidized bed system. It is a must for clean coal technology as well as for biomass power generation. Beginning with a general introduction to fossil or biofuel conversion choices, the book surveys hydrodynamics, fundamentals of gasification, combustion of solid fuels, pollution aspects including climate change mitigation, heat transfer in fluidized beds, the design and operation of bubbling and circulating fluidized bed boilers, and various supporting components such as distributor grates, feeding systems, and gas-solid separators.

There have been many developments in the science and technology of thermo chemical biomass conversion since the previous conference on Advances in Thermochemical Biomass Conversion in Interlaken, Switzerland, in 1992. This fourth conference again covers all aspects of thermal biomass conversion systems from fundamental research through applied research and development to demon stration and commercial applications to reflect the progress made in the last four years. All aspects of bioenergy systems are covered from pretreatment through to end-user applications with increased consideration paid to the environmental benefits and problems of implementing bio-energy systems. There was an excellent response with over 200 papers offered and over 180 delegates from 29 countries attending the conference. The programme was divided into five main areas covering pyrolysis, pretreatment, gasification, combustion and system studies and this division is reflected in the structure of these conference proceedings. Each main section was preceded by a state-of-the-art review to provide a focus for the ensuing presentations and an authoritative reference. All the papers included have been subject to a full peer review process. As with any international conference, an important aim was to exchange ideas and discuss problems with fellow researchers, as well as to hear about the latest research and development and applications. A workshop programme was included to encourage this interaction in areas of interest selected by participants. The resul tant workshop reports provide a summary of topical problems and opportunities.

Provides a comprehensive review on the brand-new development of several multiphase reactor techniques applied in energy-related processes Explains the fundamentals of multiphase reactors as well as the sophisticated applications Helps the reader to understand the key problems and solutions of clean coal conversion techniques Details the emerging processes for novel refining technology, clean coal conversion techniques, low-cost hydrogen productions and CO2 capture and storage Introduces current energy-related processes and links the basic principles of emerging processes to the features of multiphase reactors providing an overview of energy conversion in combination with multiphase reactor engineering Includes case studies of novel reactors to illustrate the special features of these reactors

A comprehensive examination of the large number of possible pathways for converting biomass into fuels and power through thermochemical processes Bringing together a widely scattered body of information into a single volume, this book provides complete coverage of the many ways that thermochemical processes are used to transform biomass into fuels, chemicals and power. Fully revised and updated, this new edition highlights the substantial progress and recent developments that have been made in this rapidly growing field since publication of the first edition and incorporates up-to-date information in each chapter. Thermochemical Processing of Biomass: Conversion into Fuels, Chemicals and Power, 2nd Edition incorporates two new chapters covering: condensed phased reactions of thermal deconstruction of biomass and life cycle analysis of thermochemical processing systems. It offers a new introductory chapter that provides a more comprehensive overview of thermochemical technologies. The book also features fresh perspectives from new authors covering such evolving areas as solvent liquefaction and hybrid processing. Other chapters cover combustion, gasification, fast pyrolysis, upgrading of syngas and bio-oil to liquid transportation fuels, and the economics of thermochemically producing fuels and power, and more. Features contributions by a distinguished group of European and American researchers offering a broad and unified description of thermochemical processing options for biomass Combines an overview of the current status of thermochemical biomass conversion as well as engineering aspects to appeal to the broadest audience Edited by one of Biofuels Digest’s "Top 100 People" in bioenergy for six consecutive years Thermochemical Processing of Biomass: Conversion into Fuels, Chemicals and Power, 2nd Edition will appeal to all academic researchers, process chemists, and engineers working in the field of biomass conversion to fuels and chemicals. It is also an excellent book for graduate and advanced undergraduate students studying biomass, biofuels, renewable resources, and energy and power generation.

"This book introduces Higher Order Neural Networks (HONNs) to computer scientists and computer engineers as an open box neural networks tool when compared to traditional artificial neural networks"--Provided by publisher.

Biomass is the most widely used non-fossil fuel in the world. Biomass resources show a considerable potential in the long-term given the increasing proliferation of dedicated energy crops for biofuels. The second edition of Biomass Gasification and Pyrolysis is enhanced with new topics, such as torrefaction and cofiring, making it a versatile resource that not only explains the basic principles of energy conversion systems, but also provides valuable insight into the design of biomass conversion systems. This book will allow professionals, such as engineers, scientists, and operating personnel of biomass gasification, pyrolysis or torrefaction plants, to gain a better comprehension of the basics of biomass conversion. The author provides many worked out design problems, step-by-step design procedures and real data on commercially operating systems. With a dedicated focus on the design, analysis, and operational aspects of biomass gasification, pyrolysis, and torrefaction, Biomass Gasification, Pyrolysis and Torrefaction, Second Edition offers comprehensive coverage of biomass in its gas, liquid, and solid states in a single easy-to-access source. Contains new and updated step-by-step process flow diagrams, design data and conversion charts, and numerical examples with solutions Includes chapters dedicated to evolving torrefaction technologies, practicing option of biomass cofiring, and biomass conversion economics Expanded coverage of syngas and other Fischer-Tropsch alternatives Spotlights advanced processes such as supercritical water gasification and torrefaction of biomass. Provides available research results in an easy-to-use design methodology

The book deals with development of comprehensive computational models for simulating underground coal gasification (UCG). It starts with an introduction to the UCG process and process modelling inputs in the form of reaction kinetics, flow patterns, spalling rate, and transport coefficient that are elaborated with methods to generate the same are described with illustrations. All the known process models are reviewed, and relative merits and limitations of the modeling approaches are highlighted and compared. The book describes all the necessary steps required to determine the techno-economic feasibility of UCG process for a given coal reserve, through modeling and simulation.

This handbook is an edited version of the final report of the European Commission and IEA Bioenergy sponsored Pyrolysis Network that officially finished in 2004. It provides a companion volume to the first (ISBN 978-1-872691-07-7) and second (ISBN 978-1-872691-47-3) handbooks published in 1999 and 2002 respectively also available from CPL Press (www.cplpress.com). It is again intended that this will provide a useful guide both to newcomers to the subject area as well as those already involved in research, development and implementation. A significant feature of this third volume is the greater attention paid to wider issues concerning pyrolysis including environment, health and safety, norms and standards and marketability.

This book gathers the proceedings of the 8th International Symposium on Coal Combustion. The contributions reflect the latest research on coal quality and combustion, techniques for pulverized coal combustion and fluidized bed combustion, special issues regarding CO2 capture (CCS), industrial applications, etc. – aspects that are of great importance in promoting academic communications between related areas and the technical development of coal-related fields. The International Symposium on Coal Combustion (ISCC), sponsored and organized by Tsinghua University since 1987, has established itself as an important platform allowing scientists and engineers to exchange information and ideas on the science and technology of coal combustion and related issues, and to forge new partnerships in the growing Chinese market. Researchers in the fields of clean coal combustion, carbon dioxide capture and storage, coal chemical engineering, energy engineering, etc. will greatly benefit from this book. Guangxi Yue, professor of the Department of Thermal Engineering in Tsinghua University, Beijing, China, and a member of Chinese Academy of Engineering(CAE). Shuiqing Li, professor of the Department of Thermal Engineering in Tsinghua University, Beijing, China.

This book is a printed edition of the Special Issue "Engineering Fluid Dynamics" that was published in Energies

The proceedings of the 20th International Conference on Fluidized Bed Combustion (FBC) collect 9 plenary lectures and 175 peer-reviewed technical papers presented in the conference held in Xi'an China in May 18-21,2009. The conference was the 20th conference in a series, covering the latest fundamental research results, as well as the application experience from pilot plants, demonstrations and industrial units regarding to the FBC science and technology. It was co-hosted by Tsinghua University, Southeast University, Zhejiang University, China Electricity Council and Chinese Machinery Industry Federation. A particular feature of the proceedings is the balance between the papers submitted by experts from industry and the papers submitted by academic researchers, aiming to bring academic knowledge to application as well as to define new areas for research. The authors of the proceedings are the most active researchers, technology developers, experienced and representative facility operators and manufacturers. They presented the latest research results, state-of-the-art development and projects, and the useful experience. The proceedings are divided into following sections: • CFB Boiler Technology, Operation and Design • Fundamental Research on Fluidization and Fluidized Combustion • C02 Capture and Chemical Looping • Gasification • Modeling and Simulation on FBC Technology • Environments and Pollutant Control • Sustainable Fuels The proceedings can be served as idea references for researchers, engineers, academia and graduate students, plant operators, boiler manufacturers, component suppliers, and technical managers who work on FBC fundamental research, technology development and industrial application.

Given the environmental concerns and declining availability of fossil fuels, as well as the growing population worldwide, it is essential to move toward a sustainable bioenergy-based economy. However, it is also imperative to address sustainability in the bioenergy industry in order to avoid depleting necessary biomass resources. Sustainable Bioenergy Production provides comprehensive knowledge and skills for the analysis and design of sustainable biomass production, bioenergy processing, and biorefinery systems for professionals in the bioenergy field. Focusing on topics vital to the sustainability of the bioenergy industry, this book is divided into four sections: Fundamentals of Engineering Analysis and Design of Bioenergy Production Systems, Sustainable Biomass Production and Supply Logistics, Sustainable Bioenergy Processing, and Sustainable Biorefinery Systems. Section I covers the fundamentals of genetic engineering, novel breeding, and cropping technologies applied in the development of energy crops. It discusses modern computational tools used in the design and analysis of bioenergy production systems and the life-cycle assessment for evaluating the environmental sustainability of biomass production and bioenergy processing technologies. Section II focuses on the technical and economic feasibility and environmental sustainability of various biomass feedstocks and emerging technologies to improve feedstock sustainability. Section III addresses the technical and economic feasibility and environmental sustainability of different bioenergy processing technologies and emerging technologies to improve the sustainability of each bioenergy process. Section IV discusses the design and analysis of biorefineries and different biorefinery systems, including lignocellulosic feedstock, whole-crop, and green biorefinery.

This book offers comprehensive coverage of the design, analysis, and operational aspects of biomass gasification, the key technology enabling the production of biofuels from all viable sources--some examples being sugar cane and switchgrass. This versatile resource not only explains the basic principles of energy conversion systems, but also provides valuable insight into the design of biomass gasifiers. The author provides many worked out design problems, step-by-step design procedures and real data on commercially operating systems. After fossil fuels, biomass is the most widely used fuel in the world. Biomass resources show a considerable potential in the long term if residues are properly handled and dedicated energy crops are grown. Includes step-by-step design procedures and case studies for Biomass Gasification Provides worked process flow diagrams for gasifier design. Covers integration with other technologies (e.g. gas turbine, engine, fuel cells)

Facilitates the process of learning and later mastering Aspen Plus® with step by step examples and succinct explanations Step-by-step textbook for identifying solutions to various process engineering problems via screenshots of the Aspen Plus® platforms in parallel with the related text Includes end-of-chapter problems and term project problems Includes online exam and quiz problems for instructors that are parametrized (i.e., adjustable) so that each student will have a standalone version Includes extra online material for students such as Aspen Plus®-related files that are used in the working tutorials throughout the entire textbook

It is widely believed that a large proportion of greenhouse gas emissions originated anthropogenically from the use of fossil fuels with additional contributions coming from manufactured materials, deforestation, soil erosion, and agriculture (including livestock). The global society actively supports measures to create a flexible and low-carbon energy economy to attenuate climate change and its devastating environmental consequences. In this Special Issue, the recent advancements in the next-generation thermochemical conversion processes for solid fuels and renewable energies (e.g., the operational flexibility of co-combustion of biomass and lignite, integrated solar combined cycle power plants, and advanced gasification systems such as the sorption-enhanced gasification and the chemical looping gasification) were shown.

The TMS 2016 Annual Meeting Supplemental Proceedings is a collection of papers from the TMS 2016 Annual Meeting & Exhibition, held February 14-18 in Nashville, Tennessee, USA. The papers in this volume represent 21 symposia from the meeting. This volume, along with the other proceedings volumes published for the meeting, and archival journals, such as Metallurgical and Materials Transactions and Journal of Electronic Materials, represents the available written record of the 67 symposia held at TMS2016. This proceedings volume contains both edited and unedited papers; the unedited papers have not necessarily been reviewed by the symposium organizers and are presented “as is.” The opinions and statements expressed within the papers are those of the individual authors only, and no confirmations or endorsements are intended or implied.

New innovations are needed for the invention of more efficient, affordable, sustainable and renewable energy systems, as well as for the mitigation of climate change and global environmental issues. In response to a fast-growing interest in the realm of renewable energy, Renewable Energy Systems: Efficiency, Innovation and Sustainability identifies a need to synthesize relevant and up-to-date information in a single volume. This book describes a systems approach to renewable energy, including technological, political, economic, social and environmental viewpoints, as well as policies and benefits. This unique and concise text, encompassing all aspects of the field in a single source, focuses on truly promising innovative and affordable renewable energy systems. Key Features: Focuses on innovations in renewable energy systems that are affordable and sustainable Collates the most relevant and up-to-date information on renewable energy systems, in a single and unique volume Discusses lifecycle assessment, cost and availability of systems Emphasizes bio-related topics Provides a systems

approach to the renewable energy technologies and discusses technological, political, economic, social, and environmental viewpoints as well as policies

Gasification involves the conversion of carbon sources without combustion to syngas, which can be used as a fuel itself or further processed to synthetic fuels. The technology provides a potentially more efficient means of energy generation than direct combustion. This book provides an overview of gasification science and engineering and the production of synthetic fuels by gasification from a variety of feedstocks. Part one introduces gasification, reviewing the scientific basis of the process and gasification engineering. Part two then addresses gasification and synthentic fuel production processes. Finally, chapters in part three outline the different applications of gasification, with chapters on the conversion of different types of feedstock. Examines the design of gasifiers, the preparation of feedstocks, and the economic, environmental and policy issues related to gasification Reviews gasification processes for liquid fuel production Outlines the different applications of gasification technology

Biomass can be converted to energy, biofuels, and bioproducts via thermochemical conversion processes, such as combustion, pyrolysis, and gasification. Combustion technology is most widely applied on an industrial scale. However, biomass gasification and pyrolysis processes are still in the research and development stage. The major products from these processes are syngas, bio-oil, and char (called also biochar for agronomic application). Among these products, biomass chars have received increasing attention for different applications, such as gasification, co-combustion, catalysts or adsorbents precursors, soil amendment, carbon fuel cells, and supercapacitors. This Special Issue provides an overview of biomass char production methods (pyrolysis, hydrothermal carbonization, etc.), characterization techniques (e.g., scanning electronic microscopy, X-ray fluorescence, nitrogen adsorption, Raman spectroscopy, nuclear magnetic resonance spectroscopy, X-ray photoelectron spectroscopy, and temperature programmed desorption and mass spectrometry), their properties, and their suitable recovery processes.

This book is for chemical engineers, fuel technologists, agricultural engineers and chemists in the world-wide energy industry and in academic, research and government institutions. It provides a thorough review of, and entry to, the primary and review literature surrounding the subject. The authors are internationally recognised experts in their field and combine to provide both commercial relevance and academic rigour. Contributions are based on papers delivered to the Fifth International Conference sponsored by the IEA Bioenergy Agreement.

This book is the outcome of contributions by many experts in the field from different disciplines, various backgrounds, and diverse expertise. This book provides information on biomass volume calculation methods and biomass valorization for energy production. The chapters presented in this book include original research and review articles. I hope the research presented in this book will help to advance the use of biomass for bioenergy production and valorization. The key features of the book are: Providing information on biomass volume estimation using direct, nondestructive and remote sensing methods Biomass valorization for energy using thermochemical (gasification and pyrolysis) and biochemical (fermentation) conversion processes.