Modeling Of Biomass Char Gasification Combustion And

Effects of Transport and Chemical Kinetics
Sources, Recovery, and Applications
1st World Conference on Biomass for Energy and Industry
Biomass Gasification and Pyrolysis
Multiphase Reactor Engineering for Clean and Low-Carbon Energy Applications
A Kinetic Model of a Char-recirculation Biomass-gasification Reactor and a Study of the Kinetics of the Steam Gasification of Wood Charcoal
Kinetic Engineering Modeling of Co-current Moving Bed Gasification Reactors for Carbonaceous Materials
Engineering Fluid Dynamics
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Multiscale Simulation of Methane Assisted Fluidized Bed Biomass Gasification
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Solid Fuels Combustion and Gasification
Sustainable Bioenergy Production

Thermochemical Conversion Processes for Solid Fuels and Renewable Energies
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Fuel for Siege Economies
Thermal Energy
TMS 2015 Supplemental Proceedings
Practical Design and Theory
TMS 2016 145th Annual Meeting & Exhibition, Annual Meeting Supplemental Proceedings
Biomass Chars: Elaboration, Characterization and Applications Ⅱ
Entrained Flow Pyrolysis and Gasification of Selected Biomass - an Experimental and Modeling Study
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Biomass Gasification, Pyrolysis and Torrefaction
Modeling, Simulation and Optimization
Recent Advances and Future Challenges
Coal Pyrolysis
Biomass Gasification: Fundamentals, Experiments, and Simulation
Proceedings of the Conference Held in Sevilla, Spain, 5-9 June 2000
Renewable Energy Systems from Biomass
Modeling, Simulation, and Equipment Operations
Computational Modeling of Underground Coal Gasification

Network and Communication Technology Innovations for Web and IT Advancement
145th Annual Meeting and Exhibition
The Application of a Distributed Activation Energy Based Model to the Gasification and Combustion of Coal and Biomass Char Blends

DESHAWN MIDDLETON

Effects of Transport and Chemical Kinetics CRC Press
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. Sources, Recovery, and Applications CRC Press Technologies for the conversion of biomass to liquid fuels are important to develop because the demand for liquid fuels remains unchanged even with the necessity of limiting dependence on fossil fuels. Fluidized Bed Biomass Gasification (FBBG) is one such technology that can perform the initial step of converting raw biomass into syngas as an intermediate to liquid fuels. The char that is left in the reactor after devolatilization can be oxidized in order to maximize the amount of biomass carbon that is converted to gaseous carbon and generate heat to drive endothermic gasification reactions. This paper examines the rate of each of the three processes that occur during char conversion (external diffusion, chemical reactions, and intraparticle diffusion) to determine which process limits the rate of the reaction under a range of conditions. It was determined that at most FBBG operating points, the rate of char conversion will be limited by the rate of diffusion of oxygen through the particle's boundary layer and through its pores. Only at low reactor temperatures and small particle diameters will the reaction rate be purely kinetically limited. An overall rate expression accounting for all three processes has been formulated which can be implemented in more detailed reactor models. *1st World Conference on Biomass for Energy and Industry* IGI Global Biomass, as a renewable energy resource, can be utilized to generate chemicals, heat, and electricity. Compared with biomass combustion, biomass gasification is more eco-friendly because it generates less amount of green gas (CO2) and other polluting gases (NOx and SO2). This research is focused on biomass gasification using a circulating fluidized bed. In the gasifier, fully fluidized biomass particles react with water vapor and air to generate syngas (CO and H2). A comprehensive model, consisting of three modules, hydrodynamics, mass transfer and energy transfer modules, is built to simulate this process using ANSYS Fluent software and C programming language. In the hydrodynamic

s module, the k-epsilon turbulence equations are coupled with the fluctuating energy equation to simulate gas-particle interaction in the turbulent flows occurring in the riser. In the mass transfer and energy transfer modules, heat transfer and mass transfer in turbulent flows are simulated to solve for the profiles of temperature and species concentration in the gasifier. The impacts of thermal radiation, water gas shift reaction (WGS), equivalence ratio (ER), and char combustion product distribution coefficient are also investigated to gain deeper understanding of biomass gasification process.
Biomass Gasification and Pyrolysis CRC Press
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. *Multiphase Reactor Engineering for Clean and Low-Carbon Energy Applications* MDPI 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

A Kinetic Model of a Char-recirculation Biomass-gasification Reactor and a Study of the Kinetics of the Steam Gasification of Wood Charcoal John Wiley & Sons

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). 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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, CO_2/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. Kinetic Engineering Modeling of Co-current Moving Bed Gasification Reactors for Carbonaceous Materials Earthscan 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

Engineering Fluid Dynamics

Springer
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.

Clean Coal Technology and Sustainable Development John Wiley & Sons
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.

A Practical Guide to Splines CRC Press
This book is based on the author's experience with calculations involving polynomial splines, presenting those parts of the theory especially useful in calculations and stressing the representation of splines as weighted sums of B-splines. The B-spline theory is developed directly from the recurrence relations without recourse to divided differences. This reprint includes redrawn figures, and most formal statements are accompanied by proofs.

Towards Low CO2 Power and Fuels Springer
This book is a printed edition of the Special Issue "Engineering Fluid Dynamics" that was

published in Energies *Multiscale Simulation of Methane Assisted Fluidized Bed Biomass Gasification* CRC Press Modeling the Gasification Process of Wood-char Biomass *Practical Design and Theory* John Wiley & Sons 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. *TMS 2016 Supplemental Proceedings* Modeling the Gasification

Process of Wood-char Biomass"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 homogenizatio n 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 homogenizatio n 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"-- Biomass Gasification: Fundamentals, Experiments, and SimulationBio mass gasification has received tremendous research attention all over the world because (a) biomass is abundant, diverse, renewable, and environmental ly 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.). 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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.A Kinetic Model of a Char-recirculation Biomass-gasification Reactor and a Study of the Kinetics of the Steam Gasification of Wood CharcoalA Thesis Presented to the Faculty of the Graduate School, Tennessee Technological UniversityProgress in Thermochemical Biomass Conversion 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.

Solid Fuels Combustion and Gasification

CRC Press

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.

Sustainable Bioenergy Production MDPI 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) *Thermochemical Conversion Processes for Solid Fuels and Renewable Energies* John

Wiley & Sons Owing to increasing concerns that climate change poses an urgent threat to the existence of human society, there is a need to develop cost-effective and scalable technologies to produce renewable, drop-in transportation fuels. Fluidized bed biomass gasification (FBBG) is one of the most promising options for the thermochemical conversion of lignocellulosic biomass to synthetic liquid fuels. When biomass is introduced into the high temperature bed (700-900 °C), it rapidly devolatilizes and subsequently reacts with steam, carbon dioxide, and oxygen to form syngas (hydrogen, carbon monoxide) as well as a complex assortment of light gases and condensable compounds known as tar. The main technical challenges facing FBBG technologies are incomplete char conversion and generation of polycyclic aromatic hydrocarbons (PAH's), which require expensive cleanup steps to avoid downstream operational issues. Existing approaches to optimize the performance of FBBG have examined the manipulation of operational parameters such as temperature, pressure, in-bed additives, steam to carbon ratio (SCR), and air fuel equivalence ratio (ER). However, the optimization of FBBG through experimental studies has proven difficult because the extremely complex, coupled, physical and chemical phenomena obscure the actual causal mechanisms. Prior modeling efforts are deficient in several key areas including gas-phase chemistry and char conversion processes, rendering them unable to conclusively determine operating conditions which achieve high cold gas efficiency and complete char/tar conversion. The first part of this work describes the development of a flexible, modular, robust, coupled reactor network model (CRNM) enabling the steady-state simulation of a variety of feedstocks over a wide-range of conditions. The CRNM consists of three independently validated and parameterized sub-models that consider i) particle devolatilization, ii) char conversion, and iii) hydrodynamics and homogeneous reaction kinetics. For each sub-module, the dominant physico-chemical processes and modeling assumptions are identified using characteristic time-scale analyses. The proposed char conversion model describes simultaneous and competing particle-scale processes including gasification, combustion, inhibition, intra/extra particle mass transfer, attrition, and elutriation both under transient and steady-state conditions. Bed hydrodynamics is described using the two-phase theory of fluidization resulting in a network of idealized reactors. This enables the efficient solution of comprehensive gas-phase kinetics mechanisms (327 species and 10933 reactions). The second part of this study validates the CRNM by comparing its results with data from lab-scale steam/air blown gasification experiments performed in collaboration with the National Renewable Energy Laboratory (NREL) and the MIT Chemical Engineering Practice School. The experimental results show that the composition of tar is highly sensitive to the addition of air/oxygen, which appears to accelerate the conversion of lighter PAH's into soot precursors at a fixed operating temperature. Experimental data and modeling results agree that the char reacts with very significant fraction of air/oxygen, improving its overall conversion drastically and reducing the steady state bed inventory of char. The validated model is used to carry out a constrained parametric analysis and optimization of the key operating variables, feed location, and fluidizing agent options. Standalone biomass gasification with steam and air tends to result in a syngas with low H2:CO ratio (/=1). The addition of steam improves the hydrogen content and reduces tars slightly; however, complete conversion of the methane and tar compounds (99%) is ultimately only possible if sufficient secondary air is injected into the freeboard to raise its temperature above 1300 °C. The modeling results demonstrate that methane and biomass act synergistically in the gasifier: the addition of methane acts to significantly improve the carbon yield and energy content of the syngas while the catalytic impact of minerals contained in the biomass act to promote the water-gas shift reaction in the bed region.

Development of Kinetics and Mathematical Models for High Pressure Gasification of Lignite-Switchgrass Blends

Springer 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

Fuel for Siege Economies

Cambridge University Press

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. *Thermal Energy* MDPI With the steady stream of new web based information technologies being introduced to organizations, the need for network and communicatio n 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.