Gasification for Low-grade Feedstock


Gasification for Low-grade Feedstock


Coal-typology, Chemistry, Physics, Constitution

Solid Fuels and Heavy Hydrocarbon Liquids: Thermal Characterization and Analysis

Most coveted energy forms nowadays are gas in nature and electricity due to their environmental cleanliness 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.

An Investigation of Synergistic Effect During Co-pyrolysis of Coal and Pine Sawdust at Moderate Temperatures

Gasification is the thermochemical process of converting carbonaceous material in the presence of an oxidant less than stoichiometric to form a gaseous product, known as synthesis gas or syngas, at high temperatures. The gas produced can have different uses depending on its quality. Among these uses are to drive internal combustion engines and gas turbines, direct burning, and synthesis of chemical components. This book provides a comprehensive overview of the various techniques and applications of syngas developed thus far to contribute to a better understanding of this important process of obtaining a renewable fuel, which is essential for the development of a sustainable economy.

Liquid Biofuels

Fuel Flexible Energy Generation

Solid fuels vary significantly with respect to the amount of CO2 directly produced per unit heating value. Elemental carbon is notably worse than other solid fuels in this regard, and since carbon (char) is an intermediate product of the combustion of almost all solid fuels, there is an opportunity to reduce specific CO2 emissions by reconfiguring processes to avoid char combustion wholly or in part. The primary goal of this one-year Innovative Concepts project is to make a fundamental thermodynamic assessment of three modes of solid fuel use: (1) combustion, (2) carbonization, and (3) oxidative pyrolysis, for a wide range of coal and alternative solid fuels. This period a large set of thermodynamic calculations were carried out to assess the potential of the three processes. The results show that the net carbon dioxide emissions and the relative ranking of the different processes depends greatly on the particular baseline fossil fuel being displaced by the new technology. As an example, in a baseline natural gas environment, it is thermodynamically more advantageous to carbonize biomass than to combust it, and even more advantageous to oxidatively pyrolyze the biomass.

Coal and Coal-related Compounds

Optimized operating conditions for complex systems can be attained by using advanced combinations of numerical and statistical methodologies. One of the most efficient and straightforward solutions relies on the application of statistical methods with an emphasis on the design of experiments (DoEs). Throughout the book, the design and analysis of experiments are conducted involving several approaches, namely, Taguchi, response surface methods, statistical correlations, or even fractional factorial and model-based evolutionary operation designs. This book not only
Energy Technology 2018

Pyrolysis is an irreversible thermochemical treatment process of materials at elevated temperatures in an inert atmosphere. It is basically a carbonisation process where an organic material is decomposed to produce a solid residue with high (or higher) carbon content and some volatile products. The decomposition reactions are accompanied in general with polymerisation and isomerisation reactions. The end products of pyrolysis can be controlled by optimizing pyrolysis parameters such as temperature and residence time. Pyrolysis is used heavily in the chemical industry to produce many forms of carbon and other chemicals from petroleum, coal, wood, oil shale, biomass or organic waste materials, and it is the basis of several methods for producing fuel from biomass. Pyrolysis also is the process of conversion of buried organic matter into fossil fuels.

Kinetics of Coal Gasification

The objectives of this study are to investigate thermal behavior of coal and biomass blends in inert gas environment at low heating rates and to develop a simplified kinetic model using model fitting techniques based on TGA experimental data. Differences in thermal behavior and reactivity in co-pyrolysis of Powder River Basin (PRB) sub-bituminous coal and pelletized southern yellow pine wood sawdust blends at low heating rates are observed. Coal/wood blends have higher reactivity compared to coal alone in the lower temperature due to the high volatile matter content of wood. As heating rates increase, weight loss rates increase. The experiment data obtained from TGA has a better fit with proposed two step first order reactions model compared single first order reaction model.

Co-pyrolysis and Co-combustion of Coal and Biomass

MINIMIZING NET CARBON DIOXIDE EMISSIONS BY OXIDATIVE CO-PYROLYSIS OF COAL

Product Distributions from Isothermal Co-pyrolysis of Coal and Biomass

Advances in Energy and Combustion

Coal Science

Skyrocketing energy costs have spurred renewed interest in coal gasification. Currently available information on this subject needs to be updated, however, and focused on specific coals and end products. For example, carbon capture and sequestration, previously given little attention, now has a prominent role in coal conversion processes. This book approaches coal gasification and related technologies from a process engineering point of view, with topics chosen to aid the process engineer who is interested in a complete, coal-to-products system. It provides a perspective for engineers and scientists who analyze and improve components of coal conversion processes. The first topic describes the nature and availability of coal. Next, the fundamentals of gasification are described, followed by a description of gasification technologies and gas cleaning processes. The conversion of syngas to electricity, fuels and chemicals is then discussed. Finally, process economics are covered. Emphasis is given to the selection of gasification technology based on the type of coal fed to the gasifier and desired end product: E.g., lower temperature gasifiers produce substantial quantities of methane, which is undesirable in an ammonia synthesis feed. This book also reviews gasification kinetics which is informed by recent papers and process design studies by the US Department of Energy and other groups, and also largely ignored by other gasification books. • Approaches coal gasification and related technologies from a process engineering point of view, providing a perspective for engineers and scientists who analyze and improve components of coal conversion processes • Describes the fundamentals of gasification, gasification technologies, and gas cleaning processes • Emphasizes the importance of the coal types fed to the gasifier and desired end products • Covers gasification kinetics, which was largely ignored by other gasification books Provides a perspective for engineers and scientists who analyze and improve components of the coal conversion processes Describes the fundamentals of gasification technologies, and gas cleaning processes Covers gasification kinetics, which was largely ignored by other gasification books

Biomass Gasification and Pyrolysis

This book provides state-of-the-art advances in several areas of importance in energy, combustion, power, propulsion, environment using fossil fuels and alternative fuels, and biofuels production and utilization. Availability of clean and sustainable energy is of greater importance now than ever before in all sectors of energy, power, mobility and propulsion. Written by internationally renowned experts, the latest fundamental and applied research innovations on cleaner energy production as well as utilization for a wide range of devices extending from micro scale energy conversion to hypersonic propulsion using hydrocarbon fuels are provided. The tailored technical tracks and contributions from the world renowned technical experts are portrayed in the respective field to highlight different but complementary views on fuels, combustion, power and propulsion and air toxins with special focus on current and future R&D needs and activities. The energy and environment sustainability require a multi-pronged approach involving development and utilization of new and renewable fuels, design of fuel-flexible combustion systems that can be easily operated with the new fuels, and develop novel and environmentally friendly technologies for improved utilization of all kinds of gas, liquid and solid fuels. This volume is a useful book for practicing engineers, research engineers and managers in industry and research labs, academic institutions, graduate students, and final year undergraduate students in Mechanical, Chemical, Aerospace, Energy and Environmental Engineering.

Paper
Pyrolysis of Biomass

This volume contains papers presented at the 8th International Conference on Coal Science, held in Oviedo, Spain, September 10-15, 1995. Volume I contains papers dealing with Fundamentals and General Aspects, Combustion and Gasification and Pyrolysis and Carbonization. Volume II covers papers discussing Liquefaction and Hydrolysis and Coal and the Environment. The scope of topics covered will give the reader a state-of-the-art impression of coal characterization and depolymerization, coal-derived carbons, coal carbonization and liquefaction, and the progress towards making coal an environmentally acceptable fuel during its combustion in electricity production. The use of modern physicochemical characterization techniques has advanced knowledge of coal composition and structure enormously in the last twenty years, and it is hoped that coal will enter into the next millennium as a clean and efficient fuel.

Research and Development Report

This book provides useful information about pyrolysis, which includes the pyrolysis of biomass and pyrolysis of fossil fuels and petrochemicals. Additionally, this book elucidates and illustrates further innovative pyrolysis processes such as catalytic pyrolysis, spray pyrolysis, and microwave-assisted pyrolysis. This book discusses the production of semiconductors and nanomaterials through the pyrolysis process.

Global Chemical Kinetics of Fossil Fuels

This book covers the origin and chemical structure of sedimentary organic matter, how that structure relates to appropriate chemical reaction models, how to obtain reaction data uncontaminated by heat and mass transfer, and how to convert that data into global kinetic models that extrapolate over wide temperature ranges. It also shows applications for in-situ and above-ground processing of oil shale, coal, and other heavy fossil fuels. It is essential reading for anyone who wants to develop and apply reliable chemical kinetic models for natural petroleum formation and fossil fuel processing and is designed for course use in petroleum systems modelling. Problem sets, examples and case studies are included to aid in teaching and learning. It presents original work and contains an extensive reanalysis of data from the literature.

MINIMIZING NET CO2 EMISSIONS BY OXIDATIVE CO-PYROLYSIS OF COAL

Coal Pyrolysis

This collection focuses on energy efficient technologies including innovative ore beneficiation, smelting technologies, recycling and waste heat recovery. The volume also covers various technological aspects of sustainable energy ecosystems, processes that improve energy efficiency, reduce thermal emissions, and reduce carbon dioxide and other greenhouse emissions. Papers addressing renewable energy resources for metals and materials production, waste heat recovery and other industrial energy efficient technologies, new concepts or devices for energy generation and conversion, energy efficiency improvement in process engineering, sustainability and life cycle assessment of energy systems, as well as the thermodynamics and modeling for sustainable metallurgical processes are included. This volume also includes topics on CO2 sequestration and reduction in greenhouse gas emissions from process engineering, sustainable technologies in extractive metallurgy, as well as the materials processing and manufacturing industries with reduced energy consumption and CO2 emission. Contributions from all areas of non-nuclear and non-traditional energy sources, such as solar, wind, and biomass are also included in this volume. Papers from the following symposia are presented in the book: Energy Technologies and CO2 Management, Advanced Materials for Energy Conversion and Storage, Deriving Value from Challenging Waste Streams: Recycling and Sustainability, Joint Session, Solar Cell Silicon Stored Renewable Energy in Coal

Feedstock Recycling and Pyrolysis of Waste Plastics

Coal is more abundant than petroleum and natural gas. Further, coal is not localized but can be used by many more countries than petroleum. Therefore, if we can establish coal utilization technology, coal will bring about a great contribution to human life and society. On the other hand, shortage of petroleum and natural gas are anticipated in the second half of the 21st century. To compensate, the use of coal is expected to gradually increase during the 21st century. In the future, the development of the coal utilization technology will become more and more important to insure the supply of liquid fuels for transportation and carbon sources for the manufacture of chemicals and plastic materials. In order to develop such technologies, the elucidation of the structure of coal is a fundamental area of study. Further, more efficient coal utilization technology must be established to meet environmental legislation. One of the key technologies for this purpose is catalysis. This volume provides detailed of the basic and practical aspects of the science and technology of coal utilization with and without catalysts. The actual structure of coal, the chemistry included in the reactivity of coal, the methods to elucidate the structure of coal and re-action mechanisms of coal conversion, the most important catalyst for converting coal to liquid and gas, the role of the catalysts in coal conversion, the problems in the process engineering, and how to meet environmental regulations are discussed in detail. The recent progress in studies on the structure and reactivity of coal made over the last century is summarized and reviewed with emphasis on both fundamental and applied aspects of the science and technology for coal processing in the presence and absence of catalysts. * This book highlights the issues faced in trying to discover more efficient coal utilization technology. * Provides detailed discussion on how to meet environmental regulations and legislation. * Fills the gap between both the scientific and practical sides of coal utilization with and without catalysts.

Microwave-assisted Pyrolysis and Co-pyrolysis of Coal and Oil Palm Shell with Coconut Shell Activated Carbon as Microwave Absorber

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.

Coal Conversion
Energy and Fuel Systems Integration explains how growing energy and fuel demands, paired with the need for environmental preservation, require different sources of energy and fuel to cooperate and integrate with each other rather than simply compete. Providing numerous examples of energy and fuel systems integration success stories, this book: Discu

Recent Advances in Pyrolysis

Provides the best description of coal gasification reactions available today, presenting a series of publications by the late James Lee Johnson that trace his work on the development of coal gasification kinetics. Puts gasification kinetics into perspective for reactor design by discussing gasification thermodynamics, fluidized beds, and the physical characteristics of coals and coal chars for estimating this gasification reactivity. An outstanding reference based on a chapter contributed by Dr. Johnson to CHEMISTRY OF COAL UTILIZATION SUPPLEMENTARY VOLUME 2 (edited by Martin A. Elliot).

Fuel Processing and Energy Utilization

With the development of societies fossil energy is no longer the only energy resource, and increasing attention had been paid to alternative energy. Biomass is considered to be one of the alternatives due to efficiency and low cost. This book presents biomass pyrolysis behavior for three main components: Cellulose, Hemicellulose and Lignin, and discusses the influence of mineral salts, zeolite catalysts and metal oxide on their pyrolysis.

Chemistry and Technology of Coal (Khimiya i Tekhnologiya Uglya)

Fuel Flexible Energy Generation: Solid, Liquid and Gaseous Fuels provides updated information on flexible fuel energy generation, the process by which one or more fuels can be combusted in the same boiler or turbine to generate power. By adapting or building boilers and turbines to accept multiple fuel sources, they can be co-fired with biomass and waste derived fuels, allowing a reduction in carbon output, thus providing cleaner energy. Fuel flexibility is becoming more important in a world of diminishing fossil fuel stocks. Many countries are investing in the development of more efficient fuel flexible boilers and turbines, and their use is becoming more prevalent in industry as well. This book provides comprehensive coverage of flexible fuel energy generation across all potential fuel types, and was written by a selection of experts in the field who discuss the types of fuels which can be used in fuel flexible energy generation, from solid fuels to biomass fuels, the preparation of fuels to be used in fuel flexible operations, that includes their handling and transport, and combustion and conversion technologies with chapters ranging from large-scale coal gasification to technology options and plant design issues. Focuses on fuel flexibility across all potential fuel types Includes thorough treatment of the technology being developed to allow for fuel flexibility Written by leading experts in the field Provides an essential text for R&D managers in firms which produce boilers or turbines, those who work in the fuel industry, and academics working in engineering departments on energy generation

Gasification

Interactions During Co-pyrolysis of Direct Coal Liquefaction Residue with Lignite and the Kinetic Analysis

Co-pyrolysis of Low Rank Coals and Biomass

Compiled by a well-known expert in the field, Liquid Biofuels provides a profound knowledge to researchers about biofuel technologies, selection of raw materials, conversion of various biomass to biofuel pathways, selection of suitable methods of conversion, design of equipment, selection of operating parameters, determination of chemical kinetics, reaction mechanism, preparation of bio-catalyst: its application in bio-fuel industry and characterization techniques, use of nanotechnology in the production of biofuels from the root level to its application and many other exclusive topics for conducting research in this area. Written with the objective of offering both theoretical concepts and practical applications of those concepts, Liquid Biofuels can be both a first-time learning experience for the student facing these issues in a classroom and a valuable reference work for the veteran engineer or scientist. The description of the detailed characterization methodologies along with the precautions required during analysis are extremely important, as are the detailed description about the ultrasound assisted biodiesel production techniques, aviation biofuels and its characterization techniques, advance in alkali biofuel techniques, pre-treatment of biomass for biofuel production, preparation and characterization of bio-catalyst, and various methods of optimization. The book offers a comparative study between the various liquid biofuels obtained from different methods of production and its engine performance and emission analysis so that one can get the utmost idea to find the better biofuel as an alternative fuel. Since the book covers almost all the field of liquid biofuel production techniques, it will provide advanced knowledge to the researcher for practical applications across the energy sector. A valuable reference for engineers, scientists, chemists, and students, this volume is applicable to many different fields, across many different industries, at all levels. It is a must-have for any library.

Coal Gasification and Its Applications

Coupling in the Co-pyrolysis of Coal Model Compounds

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)

Energy and Fuel Systems Integration

Pyrolysis is a recycling technique converting plastic waste into fuels, monomers, or other valuable materials by thermal and catalytic cracking processes. It allows the treatment of mixed, unwashed plastic wastes. For many years research has been carried out on thermally converting waste
plastics into useful hydrocarbons liquids such as crude oil and diesel fuel. Recently the technology has matured to the point where commercial plants are now available. Pyrolysis recycling of mixed waste plastics into generator and transportation fuels is seen as the answer for recovering value from unwashed, mixed plastics and achieving their desired diversion from landfill. This book provides an overview of the science and technology of pyrolysis of waste plastics. It describes the types of plastics that are suitable for pyrolysis recycling, the mechanism of pyrolytic degradation of various plastics, characterization of the pyrolysis products and details of commercially mature pyrolysis technologies. This book also covers co-pyrolysis technology, including: waste plastic/waste oil, waste plastics/coal, and waste plastics/rubber.

Statistical Approaches With Emphasis on Design of Experiments Applied to Chemical Processes

The first strand involves a critical overview of the design of experimental methods used for examining the thermal behaviour of solid fuels [pyrolysis, liquefaction and gasification], while the second will emphasise chemical structures and molecular mass distributions of coal derived tars, extracts and pitches, petroleum-derived asphaltenes, and biomass derived heavy hydrocarbon liquids. Two major, interdependent strands in the study of fossil and renewable fuel utilisation are focused on within this text: (i) Thermal characterisation of solid fuels including various ranks of coals, biomass and waste, and, (ii) The analytical characterisation of heavy hydrocarbon liquids, covering coal, petroleum and biomass derived heavy fractions. Two major, interdependent strands in the study of fossil and renewable fuel utilisation are focused on within this text: (i) Thermal characterisation of solid fuels including various ranks of coals, biomass and waste, and, (ii) The analytical characterisation of heavy hydrocarbon liquids, covering coal, petroleum and biomass derived heavy fractions.

Advances in Chemical Engineering and Advanced Materials IV

Pyrolysis and gasification of combined low rank coal and biomass feeds are the subject of much study in an effort to mitigate the production of greenhouse gases from integrated gasification combined cycle (IGCC) systems. While co-feeding has the potential to reduce the net carbon footprint of commercial gasification operations, the effects of co-feeding on kinetics and product distributions requires study to ensure the success of this strategy. Southern yellow pine was pyrolyzed in a semi-batch type drop tube reactor with either Powder River Basin sub-bituminous coal or Mississippi lignite at several temperatures and feed ratios. Product gas composition of expected primary constituents (CO, CO2, CH4, H2, H2O, and C2H4) was determined by in-situ mass spectrometry while minor gaseous constituents were determined using a GC-MS. Product distributions are fit to linear functions of temperature, and quadratic functions of biomass fraction, for use in computational co-pyrolysis simulations. The results are shown to yield significant nonlinearities, particularly at higher temperatures and for lower ranked coals. The co-pyrolysis product distributions evolve more tar, and less char, CH4, and C2H4, than an additive pyrolysis process would suggest. For lignite co-pyrolysis, CO and H2 production are also reduced. The data suggests that evolution of hydrogen from rapid pyrolysis of biomass prevents the crossinglinking of fragmented aromatic structures during coal pyrolysis to produce tar, rather than secondary char and light gases. Finally, it is shown that, for the two coal types tested, co-pyrolysis synergies are more significant as coal rank decreases, likely because the initial structure in these coals contains larger pores and smaller clusters of aromatic structures which are more readily retained as tar in rapid co-pyrolysis.

Pyrolysis

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.

Acta Montana

Progress in Thermochemical Biomass Conversion

KINETIC STUDY OF COAL AND BIOMASS CO-PYROLYSIS USING THERMOGRAVIMETRY.

This study presents a set of thermodynamic calculations on the optimal mode of solid fuel utilization considering a wide range of fuel types and processing technologies. The technologies include stand-alone combustion, biomass/coal cofiring, oxidative pyrolysis, and straight carbonization with no energy recovery but with elemental carbon storage. The results show that the thermodynamically optimal way to process solid fuels depends strongly on the specific fuels and technologies available, the local demand for heat or for electricity, and the local baseline energy-production method. Burning renewable fuels reduces anthropogenic CO2 emissions as widely recognized. In certain cases, however, other processing methods are equally or more effective, including the simple carbonization or oxidative pyrolysis of biomass fuels.

Coal and Biomass Gasification

This book provides different aspects on fuel processing and refinery for energy generation. Most updated research findings along with case studies, real scenario examples, and extensive analyses of original research work and literature reviews is included in this book.

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