Cfd Modelling Of Pulverized Coal Combustion In A Rotary

Oxy-fuel Combustion: Fundamentals, Theory and Practice provides a comprehensive review of various aspects of oxy-fuel combustion technology, including its concept, fundamental theory, pilot practice, large-scale feasibility studies and related practical issues, such as the commissioning and operation of an oxy-fuel combustion plant. Oxy-fuel combustion, as the most practical large-scale carbon capture power generation technology, has attracted significant attention in the past two decades. As significant progress has been achieved in worldwide demonstration and the oxy-combustion concept confirmed by Schwartze Pump, CUIDEN, Callide, Ponferrada and Yingcheng projects in the past five years, this book provides a timely addition for discussion and study. Covers oxy-fuel combustion technology Includes concepts, fundamentals, pilots and large-scale feasibility studies Considers related practical issues, such as the commissioning and operation of an oxy-fuel combustion plant Focuses on theories and methods closely related to engineering practice Issues in Energy Conversion, Transmission, and Systems: 2013 Edition is a ScholarlyEditions™ book that delivers timely, authoritative, and comprehensive information about Additional Research. The editors have built Issues in Energy Conversion, Transmission, and Systems: 2013 Edition on the vast information databases of ScholarlyNews.™ You can expect the information about Additional Research in this book to be deeper than what you can access anywhere else, as well as consistently reliable, authoritative, informed, and relevant. The content of Issues in Energy Conversion, Transmission, and Systems: 2013 Edition has been produced by the world’s leading scientists, engineers, analysts, research institutions, and companies. All of the content is from peer-reviewed sources, and all of it is written, assembled, and edited by the editors at ScholarlyEditions™ and available exclusively from us. You now have a source you can cite with authority, confidence, and credibility. More information is available at http://www.ScholarlyEditions.com/.

Rotary Kilns—rotating industrial drying ovens—are used for a wide variety of applications including processing raw minerals and feedstocks as well as heat-treating hazardous wastes. They are particularly critical in the manufacture of Portland cement. Their design and operation is critical to their efficient usage, which if done incorrectly can result in improperly treated materials and excessive, high fuel costs. This professional reference book will be the first comprehensive book in many years that treats all engineering aspects of rotary kilns, including a thorough grounding in the thermal and fluid principles involved in their operation, as well as how to properly design an engineering process that uses rotary kilns. This new edition contains an updated CFD section with inclusion of recent case studies and in line with recent developments covers pyrolysis processes, torrefaction of biomass, application of rotary kilns in C02 capture and information on using rotary kilns as incinerators for hydrocarbons. Provides essential information on fluid flow, granular flow, mixing and segregation, and aerodynamics during turbulent mixing and recirculation Gives guidance on which fuels to choose, including options such as natural gas versus coal-fired rotary kilns Covers principles of combustion and flame control, heat transfer and heating and material balances New edition contains information on pyrolysis processes with low temperatures and torrefaction of biomass. It also covers calcination of petcoke, how rotary kilns are used as incinerators for chlorinated hydrocarbons. Includes updated material on CFD simulation of kiln gas and solids flow with a selection of recent case studies.

The book provides highly specialized researchers and practitioners with a major contribution to mathematical models’ developments for energy systems. First, dynamic process simulation models based on mixture flow and two-fluid models are developed for combined-cycle power plants, pulverised coal-fired power plants, concentrated solar power plant and municipal waste incineration. Operation data, obtained from different power stations, are used to investigate the capability of dynamic models to predict the behaviour of real processes and to analyse the influence of modeling assumptions on simulation results. Then, a computational fluid dynamics (CFD) simulation programme, so-called DEMEST, is developed. Here, the fluid-solid, particle-particle and particle-wall interactions are modeled by tracking all individual particles. To this purpose, the deterministic Euler-Lagrange/Discrete Element Method (DEM) is applied and further improved. An emphasis is given to the determination of inter-phase values, such as volumetric void fraction, momentum and heat transfers, using a new procedure known as the offset-method and to the particle-grid method allowing the refinement of the grid resolution independently from particle size. Model validation is described in detail. Moreover, thermochemical reaction models for solid fuel combustion are developed based on quasi-single-phase, two-fluid and Euler-Lagrange/MP-PIC models. Measurements obtained from actual power plants are used for validation and comparison of the developed numerical models.

Harness State-of-the-Art Computational Modeling Tools Computational Modeling of Pulverized Coal Fired Boilers successfully establishes the use of computational modeling as an effective means to simulate and enhance boiler performance. This text factors in how computational flow models can provide a framework for developing a greater understanding of the underlying processes in PC boilers. It also provides a detailed account of the methodology of computational modeling of pulverized coal boilers, as well as an apt approach to modeling complex processes occurring in PC boilers in a manageable way. Connects Modeling with Real-Life Applications Restricted to the combustion side of the boiler (the authors assume some prior background of reaction engineering and numerical techniques), the book describes the individual aspects of combustion and heat recovery sections of PC boilers that can be used to further improve the design methodologies, optimize boiler performance, and solve practical boiler-related problems. The book provides guidelines on implementing the material in commercial CFD solvers, summarizes key points, and presents relevant case studies. It can also be used to model larger boilers based on conventional, super-critical, or ultra-super critical technologies as well as based on oxy-fuel technologies. Consisting of six chapters, this functional text: Provides a general introduction Explains the overall approach and methodology Explores kinetics of coal pyrolysis (devolatilization) and combustion and methods of its evaluation Presents computational flow modeling approach to simulate pulverized

coal fired boiler Covers modeling aspects from formulation of model equations to simulation methodology Determines typical results obtained with computational flow models Discusses the phenomenological models or reactor network models Includes practical applications of computational modeling Computational Modeling of Pulverized Coal Fired Boilers explores the potential of computational models for better engineering of pulverized coal boilers, providing an ideal resource for practicing engineers working in utility industries. It also benefits boiler design companies, industrial consultants, R & D laboratories, and engineering scientists/research students.

Computational Fluid Dynamics: A Practical Approach, Third Edition, is an introduction to CFD fundamentals and commercial CFD software to solve engineering problems. The book is designed for a wide variety of engineering students new to CFD, and for practicing engineers learning CFD for the first time. Combining an appropriate level of mathematical background, worked examples, computer screen shots, and step-by-step processes, this book walks the reader through modeling and computing, as well as interpreting CFD results. This new edition has been updated throughout, with new content and improved figures, examples and problems. Includes a new chapter on practical guidelines for mesh generation Provides full coverage of high-pressure fluid dynamics and the meshless approach to provide a broader overview of the application areas where CFD can be used Includes online resources with a new bonus chapter featuring detailed case studies and the latest developments in CFD

This book covers various technological aspects of sustainable energy ecosystems and processes that improve energy efficiency, and reduce and sequestrate carbon dioxide (CO2) and other greenhouse emissions. Papers emphasize the need for sustainable technologies in extractive metallurgy, materials processing and manufacturing industries with reduced energy consumption and CO2 emission. Industrial energy efficient technologies include innovative ore beneficiation, smelting technologies, recycling, and waste heat recovery. The book also contains contributions from all areas of non-nuclear and non-traditional energy sources, including renewable energy sources such as solar, wind, and biomass. Papers from the following symposia are presented in the book: Energy Technologies and Carbon Dioxide Management Recycling and Sustainability Update Magnetic Materials for Energy Applications V Sustainable Energy and Layered Double Hydroxides

This book is the result of a careful selection of contributors in the field of CFD. It is divided into three sections according to the purpose and approaches used in the development of the contributions. The first section describes the "high-performance computing" (HPC) tools and their impact on CFD modeling. The second section is dedicated to "CFD models for local and large-scale industrial phenomena." Two types of approaches are basically contained here: one concerns the adaptation from global to local scale, - e.g., the applications of CFD to study the climate changes and the adaptations to local scale. The second approach, very challenging, is the multiscale analysis. The third section is devoted to "CFD in numerical modeling approach for experimental cases." Its chapters emphasize on the numerical approach of the mathematical models associated to few experimental (industrial) cases. Here, the impact and the importance of the mathematical modeling in CFD are focused on. It is expected that the collection of these chapters will enrich the state of the art in the CFD domain and its applications in a lot of fields. This collection proves that CFD is a highly interdisciplinary research area, which lies at the interface of physics, engineering, applied mathematics, and computer science.

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 book presents the latest findings on the subject of combustion optimization based on computational intelligence. It covers a broad range of topics, including the modeling of coal combustion characteristics based on artificial neural networks and support vector machines. It also describes the optimization of combustion parameters using genetic algorithms or ant colony algorithms, an online coal optimization system, etc. Accordingly, the book offers a unique guide for researchers in the areas of combustion optimization, NOx emission control, energy and power engineering, and chemical engineering.

This book describes different approaches for solving industrial problems like product design, process optimization, quality enhancement, productivity improvement and cost minimization. Several optimization techniques are described. The book covers case studies on the applications of classical as well as evolutionary and swarm optimization tools for solving industrial issues. The content is very helpful for industry personnel, particularly engineers from the Operation, R&D and Quality Assurance sectors, and also the academic researchers of different engineering and/or business administration background.

The use of coal is required to help satisfy the world's energy needs. Yet coal is a difficult fossil fuel to consume efficiently and cleanly. We believe that its clean and efficient use can be increased through improved technology based on a thorough understanding of fundamental physical and chemical processes that occur during consumption. The principal objective of this book is to provide a current summary of this technology. The past technology for describing and analyzing coal furnaces and combus tors has relied largely on empirical inputs for the complex flow and chemical reactions that occur while more formally treating the heat-transfer effects. GrOWing concern over control of combustion-generated air pollutants revealed a lack of understanding of the relevant fundamental physical and chemical mechanisms. Recent technical advances in computer speed and storage capacity, and in numerical prediction of recirculating turbulent flows, two-phase flows, and flows with chemical reaction have opened new opportunities for describing and modeling such complex combustion systems in greater detail. We believe that most of the requisite component models to permit a more fundamental description of coal combustion processes are available. At the same time there is worldwide interest in the use of coal, and progress in modeling of coal reaction processes has been steady.

Bringing together the world's leading researchers and practitioners of computational mechanics, these new volumes meet and build on the eight key challenges for research and development in computational mechanics. Researchers have recently identified eight critical research tasks facing the field of computational mechanics. These tasks have come about because it appears possible to reach a new level of mathematical modelling and numerical solution that will lead to a much deeper understanding of nature and to great improvements in engineering design. The eight tasks are: The automatic solution of mathematical models Effective numerical schemes for fluid flows The development of an effective mesh-free numerical solution method The development of numerical procedures for multiphysics problems The development of numerical procedures for multiscale problems The modelling of uncertainties The analysis of complete life cycles of systems Education - teaching sound engineering and scientific judgement Readers of Computational Fluid and Solid Mechanics 2003 will be able to apply the combined experience of many of the world's leading researchers to their own research needs. Those in academic environments will

gain a better insight into the needs and constraints of the industries they are involved with; those in industry will gain a competitive advantage by gaining insight into the cutting edge research being carried out by colleagues in academia. Features Bridges the gap between academic researchers and practitioners in industry Outlines the eight main challenges facing Research and Design in Computational mechanics and offers new insights into the shifting the research agenda Provides a vision of how strong, basic and exciting education at university can be harmonized with life-long learning to obtain maximum value from the new powerful tools of analysis

Computational Modeling of Pulverized Coal Fired BoilersCRC Press

This volume provides unique views of combustion from many technical and international research perspectives. Combustion science is often considered from its negative environmental impact, where we find, instead, that energy release from fuels of all kinds have promoted human endeavor throughout history. This volume tries to capture some of these positive features by showing a range of work examining unusual fuels and controlling the pollution from them.

Supplying nearly 350 expertly-written articles on technologies that can maximize and enhance the research and production phases of current and emerging chemical manufacturing practices and techniques, this second edition provides gold standard articles on the methods, practices, products, and standards recently influencing the chemical industries. New material includes: design of key unit operations involved with chemical processes; design, unit operation, and integration of reactors and separation systems; process system peripherals such as pumps, valves, and controllers; analytical techniques and equipment; current industry practices; and pilot plant design and scale-up criteria.

This introduction reviews why combustion and radiation are important, as well as the technical challenges posed by radiation. Emphasis is on interactions among turbulence, chemistry and radiation (turbulence-chemistry-radiation interactions – TCRI) in Reynolds-averaged and large-eddy simulations. Subsequent chapters cover: chemically reacting turbulent flows; radiation properties, Reynolds transport equation (RTE) solution methods, and TCRI; radiation effects in laminar flames; TCRI in turbulent flames; and high-pressure combustion systems. This Brief presents integrated approach that includes radiation at the outset, rather than as an afterthought. It stands as the most recent developments in physical modeling, numerical algorithms, and applications collected in one monograph.

This book is a printed edition of the Special Issue "Biomass for Energy Country Specific Show Case Studies" that was published in Energies

Bioenergy with Carbon Capture and Storage: Using Natural Resources for Sustainable Development presents the technologies associated with bioenergy and CCS and its applicability as an emissions reduction tool. The book explores existing climate policies and current carbon capture and storage technologies. Sections offer an overview of several routes to use biomass and produce bioenergy through processes with low or even negative CO2 emissions. Associated technology and the results of recent research studies to improve the sustainability of the processes are described, pointing out future trends and needs. This book can be used by bioenergy engineering researchers in industry and academia and by professionals and researchers in carbon capture and storage. Presents the most recent technologies in use and future trends in research and policy Examines the bioenergy production and biomass processing value chains, including biorefining, negative emission technologies and the use of microalgae Includes techno-economic analysis and sustainability assessment of the technologies discussed, as well as an overview of the latest research results

ABSTRACT The current work briefly reviews the formation mechanisms and reduction approaches of the pollutants SOx and NOx in coal combustion and focuses on the simulation of the lower-cost in-furnace measures ƒ{ the dry additive process (DAP) for SOx reduction and the reburning as well as the advanced reburning (hybrid reburning/SNCR) techniques for NOx reduction. In addition, the influence of sulfur compounds on NOx formation is investigated. The major workings include: Simulation of the dry additive desulfurization process (DAP): Different models ƒ{ shrinking core model (SCM), pore model (PM) and grain model (GM) ƒ{ are implemented to describe the gas-particle reaction. Relevant processes such as the sintering of the additive, the self-retention by coal ash, the thermal equilibrium of the sulfation reaction are accounted for and modeled. A comprehensive model for the DAP with calcium based additives is subsequently established and integrated into a combustion CFD (computational fluid dynamics) code AIOLOS, in both Eulerian and Lagrangian schemes. The model is verified with experiments on a test reactor. Mechanism reduction and simulation of reburning/SNCR Processes: A method for reduction of kinetic mechanisms is introduced. A program tool is developed for automatic reduction of detailed reaction mechanisms. Reduced mechanisms for reburning and hybrid reburning/SNCR processes are developed and implemented into the CFD code. CFD-calculations with the reduced mechanisms are performed and compared with experimental measurements to comprehensively evaluate the simulation approach. It is shown that the detailed simulation is capable of modeling the complex reburning and SNCR processes with acceptable computing time and achieves reasonable results in wide parameter ranges. Study of the influence of sulfur compounds on NOx formation: The effect of SO2 on NOx formation is experimentally investigated and analysed with kinetic mechanisms. It is indicated that the presence of SO2 inhabits the NOx formation and reduce the NOx emissions in normal air-rich combustion. Under air-staging conditions, SO2 addition has no obvious influence on the final NOx emissions.

This book focuses on pulverized coal particle devolatilization, ignition, alkali metal release behavior, and burnout temperature using several novel optic diagnostic methods on a Hencken multi-flat flame burner. Firstly, it presents a novel multi-filter technique to detect the CH* signal during coal ignition, which can be used to characterize the volatile release and reaction process. It then offers observations on the prevalent transition from heterogeneous ignition to hetero-homogeneous ignition due to ambient temperature based on visible light signal diagnostics. By utilizing the gap between the excitation energies of the gas and particle phases, a new low-intensity laser-induced breakdown spectroscopy (PS-LIBS) is developed to identify the presence of sodium in the particle or gas phase along the combustion process. For the first time, the in-situ verification of the gas phase Na release accompanying coal devolatilization is fulfilled when the ambient temperature is high enough. In fact, particle temperature plays a vital role in the coal burnout process and ash

particle formation. The last part of the book uses RGB color pyrometry and the CBK model to study the char particle temperature on a Hencken burner. It offers readers valuable information on the technique of coal ignition and combustion diagnostics as well as coal combustion characteristics.

An essential resource for understanding the potential role for biomass energy with carbon capture and storage in addressing climate change Biomass Energy with Carbon Capture and Storage (BECCS) offers a comprehensive review of the characteristics of BECCS technologies in relation to its various applications. The authors — a team of expert professionals — bring together in one volume the technical, scientific, social, economic and governance issues relating to the potential deployment of BECCS as a key approach to climate change mitigation. The text contains information on the current and future opportunities and constraints for biomass energy, explores the technologies involved in BECCS systems and the performance characteristics of a variety of technical systems. In addition, the text includes an examination of the role of BECCS in climate change mitigation, carbon accounting across the supply chain and policy frameworks. The authors also offer a review of the social and ethical aspects as well as the costs and economics of BECCS. This important text: Reveals the role BECCS could play in the transition to a low-carbon economy Discusses the wide variety of technical and non-technical constraints of BECCS Presents the basics of biomass energy systems Reviews the technical and engineering issues pertinent to BECCS Explores the societal implications of BECCS systems Written for academics and research professionals, Biomass Energy with Carbon Capture and Storage (BECCS) brings together in one volume the issues surrounding BECCS in an accessible and authoritative manner.

Computational fluid dynamics (CFD), which uses numerical analysis to predict and model complex flow behaviors and transport processes, has become a mainstream tool in engineering process research and development. Complex chemical processes often involve coupling between dynamics at vastly different length and time scales, as well as coupling of different physical models. The multiscale and multiphysics nature of those problems calls for delicate modeling approaches. This book showcases recent contributions in this field, from the development of modeling methodology to its application in supporting the design, development, and optimization of engineering processes.

Dust Explosion Dynamics focuses on the combustion science that governs the behavior of the three primary hazards of combustible dust: dust explosions, flash fires, and smoldering. It explores the use of fundamental principles to evaluate the magnitude of combustible dust hazards in a variety of settings. Models are developed to describe dust combustion phenomena using the principles of thermodynamics, transport phenomena, and chemical kinetics. Simple, tractable models are described first and compared with experimental data, followed by more sophisticated models to help with future challenges. Dr. Ogle introduces the reader to just enough combustion science so that they may read, interpret, and use the scientific literature published on combustible dusts. This introductory text is intended to be a practical guide to the application of combustible dust models, suitable for both students and experienced engineers. It will help you to describe the dynamics of explosions and fires involving dust and evaluate their consequences which in turn will help you prevent damage to property, injury and loss of life from combustible dust accidents. Demonstrates how the fundamental principles of combustion science can be applied to understand the ignition, propagation, and extinction of dust explosions Explores fundamental concepts through model-building and comparisons with empirical data Provides detailed examples to give a thorough insight into the hazards of combustible dust as well as an introduction to relevant scientific literature

Although many books have been written on computational fluid dynamics (CFD) and many written on combustion, most contain very limited coverage of the combination of CFD and industrial combustion. Furthermore, most of these books are written at an advanced academic level, emphasize theory over practice, and provide little help to engineers who need

This second edition Encyclopedia supplies nearly 350 gold standard articles on the methods, practices, products, and standards influencing the chemical industries. It offers expertly written articles on technologies at the forefront of the field to maximize and enhance the research and production phases of current and emerging chemical manufacturing practices and techniques. This collecting of information is of vital interest to chemical, polymer, electrical, mechanical, and civil engineers, as well as chemists and chemical researchers. A complete reconceptualization of the classic reference series the Encyclopedia of Chemical Processing and Design, whose first volume published in 1976, this resource offers extensive A-Z treatment of the subject in five simultaneously published volumes, with comprehensive indexing of all five volumes in the back matter of each tome. It includes material on the design of key unit operations involved with chemical processes; the design, unit operation, and integration of reactors and separation systems; process system peripherals such as pumps, valves, and controllers; analytical techniques and equipment; and pilot plant design and scale-up criteria. This reference contains well-researched sections on automation, equipment, design and simulation, reliability and maintenance, separations technologies, and energy and environmental issues. Authoritative contributions cover chemical processing equipment, engineered systems, and laboratory apparatus currently utilized in the field. It also presents expert overviews on key engineering science topics in property predictions, measurements and analysis, novel materials and devices, and emerging chemical fields. ALSO AVAILABLE ONLINE This Taylor & Francis encyclopedia is also available through online subscription, offering a variety of extra benefits for both researchers, students, and librarians, including: Citation tracking and alerts Active reference linking Saved searches and marked lists HTML and PDF format options Contact Taylor and Francis for more information or to inquire about subscription options and print/online combination packages. US: (Tel) 1.888.318.2367; (E-mail) e-reference@taylorandfrancis.com International: (Tel) +44 (0) 20 7017 6062; (E-mail) online.sales@tandf.co.uk

New Trends in Coal Conversion: Combustion, Gasification, Emissions, and Coking covers the latest advancements in coal utilization, including coal conversion processes and mitigation of environmental impacts, providing an up-to-date source of information for a cleaner and more environmentally friendly use of coal, with a particular emphasis on the two biggest users of coal—utilities and the steel industry. Coverage includes recent advances in combustion co-firing,

gasification, and on the minimization of trace element and CO2 emissions that is ideal for plant engineers, researchers, and quality control engineers in electric utilities and steelmaking. Other sections cover new advances in clean coal technologies for the steel industry, technological advances in conventional by-products, the heat-recovery/non-recovering cokemaking process, and the increasing use of low-quality coals in coking blends. Readers will learn how to make more effective use of coal resources, deliver higher productivity, save energy and reduce the environmental impact of their coal utilization. Provides the current state-of-the-art and ongoing activities within coal conversion processes, with an emphasis on emerging technologies for the reduction of CO2 and trace elements Discusses innovations in cokemaking for improved efficiency, energy savings and reduced environmental impact Include case studies and examples throughout the book

For more than two decades, Alstom Power Inc. (Alstom) has developed a range of low cost, infurnace technologies for NOx emissions control for the domestic U.S. pulverized coal fired boiler market. This includes Alstom's internally developed TFS 2000{trademark} firing system, and various enhancements to it developed in concert with the U.S. Department of Energy. As of the date of this report, more than 270 units representing approximately 80,000 MWe of domestic coal fired capacity have been retrofit with Alstom low NOx technology. Best of class emissions range from 0.18 lb/MMBtu for bituminous coal to 0.10 lb/MMBtu for subbituminous coal, with typical levels at 0.24 lb/MMBtu and 0.13 lb/MMBtu, respectively. Despite these gains, NOx emissions limits in the U.S. continue to ratchet down for new and existing boiler equipment. On March 10, 2005, the Environmental Protection Agency (EPA) announced the Clean Air Interstate Rule (CAIR). CAIR requires 25 Eastern states to reduce NOx emissions from the power generation sector by 1.7 million tons in 2009 and 2.0 million tons by 2015. Low cost solutions to meet such regulations, and in particular those that can avoid the need for a costly selective catalytic reduction system (SCR), provide a strong incentive to continue to improve low NOx firing system technology to meet current and anticipated NOx control regulations. The overall objective of the work is to develop an enhanced combustion, low NOx pulverized coal burner, which, when integrated with Alstom's state-of-the-art, globally air staged low NOx firing systems will provide a means to achieve: Less than 0.15 lb/MMBtu NOx emissions when firing a high volatile Eastern or Western bituminous coal, Less than 0.10 lb/MMBtu NOx emissions when firing a subbituminous coal, NOx reduction costs at least 25% lower than the costs of an SCR, Validation of the NOx control technology developed through large (15 MWt) pilot scale demonstration, and Documentation required for economic evaluation and commercial application. During the project performance period, Alstom performed computational fluid dynamics (CFD) modeling and large pilot scale combustion testing in its Industrial Scale Burner Facility (ISBF) at its U.S. Power Plant Laboratories facility in Windsor, Connecticut in support of these objectives. The NOx reduction approach was to optimize near-field combustion to ensure that minimum NOx emissions are achieved with minimal impact on unburned carbon in ash, slagging and fouling, corrosion, and flame stability/turn-down. Several iterations of CFD and combustion testing on a Midwest coal led to an optimized design, which was extensively combustion tested on a range of coals. The data from these tests were then used to validate system costs and benefits versus SCR. Three coals were evaluated during the bench-scale and large pilot-scale testing tasks. The three coals ranged from a very reactive subbituminous coal to a moderately reactive Western bituminous coal to a much less reactive Midwest bituminous coal. Bench-scale testing was comprised of standard ASTM properties evaluation, plus more detailed characterization of fuel properties through drop tube furnace testing and thermogravimetric analysis. Bench-scale characterization of the three test coals showed that both NOx emissions and combustion performance are a strong function of coal properties. The more reactive coals evolved more of their fuel bound nitrogen in the substoichiometric main burner zone than less reactive coal, resulting in the potential for lower NOx emissions. From a combustion point of view, the more reactive coals also showed lower carbon in ash and CO values than the less reactive coal at any given main burner zone stoichiometry. According to bench-scale results, the subbituminous coal was found to be the most amenable to both low NOx, and acceptably low combustibles in the flue gas, in an air staged low NOx system. The Midwest bituminous coal, by contrast, was predicted to be the most challenging of the three coals, with the Western bituminous coal predicted to behave in-between the subbituminous coal and the Midwest bituminous coal. CFD modeling was used to gain insight into the mechanisms governing nozzle tip performance with respect to NOx emissions. The CFD simulations were run as steady state, turbulent, non-reacting flow with heat transfer and focused on predicting the near field mixing and particle dispersion rates. CFD results were used to refine the proposed tip concepts before they were built, as well as to help identify and evaluate possible improvements to the tips for subsequent test weeks.

Create affordable solid fuel blends that will burn efficiently while reducing the carbon footprint. Solid Fuel Blending Handbook: Principles, Practices, and Problems describes a new generation of solid fuel blending processes. The book includes discussions on such topics as flame structure and combustion performance, boiler efficiency, capacity as influenced by flue gas volume and temperature, slagging and fouling, corrosion, and emissions. Attention is given to the major types of combustion systems including stokers, pulverized coal, cyclone, and fluidized bed boilers. Specific topics considered include chlorine in one or more coals, alkali metals (e.g., K, Na) and alkali earth elements, and related topics. Coals of consideration include Appalachian, Interior Province, and Western bituminous coals; Powder River Basin (PRB) and other subbituminous coals; Fort Union and Gulf Coast lignites, and many of the off-shore coals (e.g., Adaro coal, an Indonesian subbituminous coal with very low sulfur; other off-shore coals from Germany, Poland, Australia, South Africa, Columbia, and more). Interactions between fuels and the potential for blends to be different from the parent coals will be a critical focus of this of the book. One stop source to solid fuel types and blending processes Evaluate combustion systems and calculate their efficiency Recognize the interactions between fuels and their potential energy output Be aware of the Environmental Aspects of Fuel Blending

A three-step methodology was developed to provide reliable prediction of a coal's behaviour in a utility boiler: (1)

Extracting the combustion kinetic model parameters by combining experimental data from a pilot-scale test facility, Computational Fluid Dynamic (CFD) codes and an artificial neural network. While the combustion kinetic parameters used in the model code will not correspond to the combustion rate of a single particle of coal, these parameters do describe the combustion behaviour of a "macroscopic" sample of tested coal.(2) Validation of the combustion kinetic model parameters by comparing diverse experimental data with simulation results calculated with the same set of model parameters. (3) The model parameters are then used for simulations of full-scale boilers using the same CFD code. For operational engineering information needed by the utility operator, the authors apply the predicted results to EXPERT SYSTEM, a boiler supervision system developed by Israel Electric Corporation (IEC). Four different bituminous and sub-bituminous coals with known behaviour in IEC 550MW opposite-wall and 575MW tangential-fired boilers were used to show the adequacy of the methodology. The predictions are done with the CFD code, GLACIER, propriety of Reaction Engineering International (REI). Preconfigured GLACIER models of the test and full-scale furnaces were purchased from REI and validated by our group. This book includes a detailed description of the methodology, test furnace facility and an example of the experimental and predictive combustion results from the four coals used to test the methodology. In addition, two previously unknown coals are examined prior to their firing in the utility boilers and prediction of their behaviour and operational parameters in the two boilers carried out.

Pulverized coal injection (PCI) into the blast furnace (BF) has been recognized as an effective way to decrease the coke and total energy consumption along with minimization of environmental impacts. However, increasing the amount of coal injected into the BF is currently limited by the lack of knowledge of some issues related to the process. It is therefore important to understand the complex physical and chemical phenomena in the PCI process. Due to the difficulty in attaining trus BF measurements, Computational fluid dynamics (CFD) modeling has been identified as a useful technology to provide such knowledge. CFD simulation is powerful for providing detailed information on flow properties and performing parametric studies for process design and optimization. In this project, comprehensive 3-D CFD models have been developed to simulate the PCI process under actual furnace conditions. These models provide raceway size and flow property distributions. The results have provided guidance for optimizing the PCI process.

"Mercury Emission and its Control in Chinese Coal-Fired Power Plants" focuses on investigating mercury emissions samplings and measurement in Chinese coal-fired power plants, mercury emission estimations and future trends, mercury speciation transformation during coal combustion, mercury control and mercury stability in byproducts. The book not only introduces mercury emissions from actual coal-fired power plants, but also presents studies on the mechanism of mercury emission and its control. This is a valuable reference for engineering thermal physicists, thermal engineers, and chemical engineers. Jinsong Zhou, Zhongyang Luo, and Mengxiang Fang are Professors in the College of Mechanical and Energy Engineering, Zhejiang University, China. Yanqun Zhu is Associate Professor in the College of Mechanical and Energy Engineering, Zhejiang University, China.

Energy Systems Engineering is one of the most exciting and fastest growing fields in engineering. Modeling and simulation plays a key role in Energy Systems Engineering because it is the primary basis on which energy system design, control, optimization, and analysis are based. This book contains a specially curated collection of recent research articles on the modeling and simulation of energy systems written by top experts around the world from universities and research labs, such as Massachusetts Institute of Technology, Yale University, Norwegian University of Science and Technology, National Energy Technology Laboratory of the US Department of Energy, University of Technology Sydney, McMaster University, Queens University, Purdue University, the University of Connecticut, Technical University of Denmark, the University of Toronto, Technische Universität Berlin, Texas A&M, the University of Pennsylvania, and many more. The key research themes covered include energy systems design, control systems, flexible operations, operational strategies, and systems analysis. The addressed areas of application include electric power generation, refrigeration cycles, natural gas liquefaction, shale gas treatment, concentrated solar power, waste-to-energy systems, micro-gas turbines, carbon dioxide capture systems, energy storage, petroleum refinery unit operations, Brayton cycles, to name but a few.

Thermofluid Modeling for Sustainable Energy Applications provides a collection of the most recent, cutting-edge developments in the application of fluid mechanics modeling to energy systems and energy efficient technology. Each chapter introduces relevant theories alongside detailed, real-life case studies that demonstrate the value of thermofluid modeling and simulation as an integral part of the engineering process. Research problems and modeling solutions across a range of energy efficiency scenarios are presented by experts, helping users build a sustainable engineering knowledge base. The text offers novel examples of the use of computation fluid dynamics in relation to hot topics, including passive air cooling and thermal storage. It is a valuable resource for academics, engineers, and students undertaking research in thermal engineering. Includes contributions from experts in energy efficiency modeling across a range of engineering fields Places thermofluid modeling and simulation at the center of engineering design and development, with theory supported by detailed, real-life case studies Features hot topics in energy and sustainability engineering, including thermal storage and passive air cooling Provides a valuable resource for academics, engineers, and students undertaking research in thermal engineering

Over the past few decades, exciting developments have taken place in the field of combustion technology. The present edited volume intends to cover recent developments and provide a broad perspective of the key challenges that characterize the field. The target audience for this book includes engineers involved in combustion system design, operational planning and maintenance. Manufacturers and combustion technology researchers will also benefit from the timely and accurate information provided in this work. The volume is organized into five main sections comprising 15 chapters overall: - Coal and Biofuel Combustion - Waste Combustion - Combustion and Biofuels in Reciprocating

Engines - Chemical Looping and Catalysis - Fundamental and Emerging Topics in Combustion Technology