

Advanced CFD modelling of pulverised biomass combustion

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ABSTRACT: In this paper, the development and application of a CFD model for pulverised biomass combustion is presented. As a first step, the Discrete Phase Model (DPM) of the commercial CFD software FLUENT, originally developed for the combustion of pulverised coal, was investigated regarding its capability to predict pulverised biomass combustion. Based on these investigations, a more detailed sub-model for the devolatilisation part of the combustion process, was included. Furthermore, the original DPM energy equation for a single particle was modified in order to account for the temperature-dependent specific heat capacity of a particle. This modification allows for a more accurate prediction of the temperature of a single particle (until the inert state of fly ash) along its trajectory. The validation of the modified DPM for thermally thin particles was performed with a 2 D numerical simulation of a pulverised wood flame in a vertical tube furnace. As a first engineering application, a 3D simulation of a wood dust-fired biomass underfeed stoker furnace was successfully performed. During operation it was observed, that a part of the fuel particles, which were apparently too small for fixed bed combustion, were entrained and burned out "on-the-fly". This effect seemed to be the reason for high temperatures and ash slagging at the upper wall of the primary combustion chamber. In order to investigate this phenomenon, the extended DPM was applied in combination with an earlier developed CFD model for biomass grate furnaces. With the simulations performed, the entrained fuel particles could be identified to be the reason for the slagging problems. The developed model showed to be a valuable design tool for pulverised biomass combustion furnaces, but further extensions of the model are necessary and ongoing in order to appropriately describe the particle combustion process.

INTRODUCTION

CFD analysis has been successfully applied for the design and optimisation of several biomass grate furnaces [10, 12]. Being interested in applying the same tool in a numerical study of pulverised biomass furnaces, the Discrete Phase Model (DPM) of the commercial CFD software FLUENT 6 was investigated regarding its capability to predict pulverised biomass combustion. The DPM, originally developed for the combustion of pulverised coal, is based on the assumption of thermally thin particles.

Advanced Cfd Modelling Of Pulverised Biomass Combustion

Zhe Xu



Advanced Cfd Modelling Of Pulverised Biomass Combustion:

The Handbook of Biomass Combustion and Co-firing Sjaak van Loo, Jaap Koppejan, 2012-05-16 This unique handbook presents both the theory and application of biomass combustion and co firing from basic principles to industrial combustion and environmental impact in a clear and comprehensive manner It offers a solid grounding on biomass combustion and advice on improving combustion systems Written by leading international academics and industrial experts and prepared under the auspices of the IEA Bioenergy Implementing Agreement the handbook is an essential resource for anyone interested in biomass combustion and co firing technologies varying from domestic woodstoves to utility scale power generation The book covers subjects including biomass fuel pre treatment and logistics modelling the combustion process and ash related issues as well as featuring an overview of the current R D needs regarding biomass combustion *From Crops and Wastes to Bioenergy* Electro Silva Lora, Manuel Garcia-Perez, Osvaldo José Venturini, 2025-03-13

From Crops and Wastes to Bioenergy Current Status and Challenges is a comprehensive volume on all aspects of biomass utilization for bioenergy from the fundamentals to the latest commercial and regulatory issues The book examines all aspects of biomass utilization from technologies and processes to products Sections examine the role of biomass in the energy transition land availability for bioenergy projects biomass logistics and supply chain and assesses the lifecycle of bioenergy systems Chapters are dedicated to each energy conversion route including thermochemical biochemical and chemical biofuels synthesis hydrogen from biomass biorefineries electricity generation and waste to energy Policy and regulatory issues are also considered Each chapter reviews the state of the art discusses disruptive technological approaches and concludes with specific recommendations on how to achieve commercial competitiveness Case studies provide examples of real world applications in each chapter Reviews the state of the art of the topic discussing disruptive technological approaches and concluding with specific recommendations on how to achieve commercial competitiveness Critically compares the various energy conversion routes including thermochemical biochemical chemical biofuel synthesis hydrogen from biomass biorefineries electricity generation and waste to energy Analyzes sustainability issues related to land availability biomass logistics and supply chain as well as the role of bioenergy in the energy transition lifecycle assessments and policies and regulatory issues

Advanced Power Plant Materials, Design and Technology Dermot Roddy, 2010-05-24 Fossil fuel power plants account for the majority of worldwide power generation Increasing global energy demands coupled with issues of ageing and inefficient power plants have led to new power plant construction programmes As cheaper fossil fuel resources are exhausted and emissions criteria are tightened utilities are turning to power plants designed with performance in mind to satisfy requirements for improved capacity efficiency and environmental characteristics *Advanced power plant materials design and technology* provides a comprehensive reference on the state of the art of gas fired and coal fired power plants their major components and performance improvement options Part one critically reviews advanced power plant designs

which target both higher efficiency and flexible operation including reviews of combined cycle technology and materials performance issues Part two reviews major plant components for improved operation including advanced membrane technology for both hydrogen H₂ and carbon dioxide CO₂ separation as well as flue gas handling technologies for improved emissions control of sulphur oxides SO_x nitrogen oxides NO_x mercury ash and particulates The section concludes with coverage of high temperature sensors and monitoring and control technology that are essential to power plant operation and performance optimisation Part three begins with coverage of low rank coal upgrading and biomass resource utilisation for improved power plant fuel flexibility Routes to improve the environmental impact are also reviewed with chapters detailing the integration of underground coal gasification and the application of carbon dioxide CO₂ capture and storage Finally improved generation performance is reviewed with coverage of syngas and hydrogen H₂ production from fossil fuel feedstocks With its distinguished international team of contributors Advanced power plant materials design and technology is a standard reference for all power plant engineers and operators as well as to academics and researchers in this field Provides a comprehensive reference on the state of the art gas fired and coal fired power plants their major components and performance improvement options Examines major plant components for improved operation as well as flue gas handling technologies for improved emissions control Routes to improve environmental impact are discussed with chapters detailing the integration of underground coal gasification

CFD Modelling of Pulverised Coal and Biomass Combustion Katarzyna Stechly,2019 *Advanced Technologies, Systems, and Applications VIII* Naida Ademović,Jasmin Kevrić,Zlatan Akšamija,2023-08-31 This book presents proceedings of the 14th Days of Bosnian Herzegovinian American Academy of Arts and Sciences held in Tuzla BIH June 1 4 2023 Delve into the intellectual tapestry that emerged from this event as we unveil our highly anticipated Conference Proceedings Book This groundbreaking publication captures the essence of seven captivating technical sessions spanning from Civil Engineering through Power Electronics all the way to Data Sciences and Artificial Intelligence each exploring a distinct realm of innovation and discovery Uniting diverse disciplines this publication catalyzes interdisciplinary collaboration forging connections that transcend traditional boundaries Within these pages readers find a compendium of knowledge insights and research findings from leading researchers in their respective fields The editors would like to extend special gratitude to the chairs of all symposia for their dedicated work in the production of this volume

Heat Transfer VII Bengt Sundén,C. A. Brebbia,2002 Featuring contributions from the Seventh International Conference on Advanced Computational Methods In Heat Transfer HEAT TRANSFER this book presents new approaches to the numerical solutions of heat transfer problems Methods discussed include all well established and efficient numerical techniques such as finite differences finite volume finite elements and boundary elements whilst special attention is paid to complex thermal problems from engineering practice Advanced Computational Methods In Heat Transfer VII will be of interest to scientists and engineers who are actively involved in developing innovative approaches in the heat transfer field as

well in solving a variety of industrial problems Advances in Bioenergy Peter D. Lund, John A. Byrne, Goeran Berndes, Iacovos Vasalos, 2015-12-07 The increasing deployment of bioenergy frequently raises issues regarding the use of land and raw materials infrastructure and logistics In light of these sometimes conflicting interests Advances in Bioenergy provides an objective and wide ranging overview of the technology economics and policy of bioenergy Offering an authoritative multidisciplinary summary of the opportunities and challenges associated with bioenergy utilization with international researchers give up to date and detailed information on key issues for biomass production and conversion to energy Key features Discusses different bioenergy uses such as transportation fuels electricity and heat production Assesses emerging fields such as bio based chemicals and bio refineries Debates conditions for the mobilization of sustainable bioenergy supply chains and outlines governance systems to support this mobilization Dedicated chapters to sustainability governance and emerging tools such as certification systems and standards supporting growth of a sustainable bioenergy industry Considers the political environmental social and cultural context related to the demand for energy resources the impact of this demand on the world around us and the choices and behaviours of consumers This book will be a vital reference to engineers researchers and students that need an accessible overview of the bioenergy area It will also be of high value for politicians policymakers and industry leaders that need to stay up to date with the state of the art science and technology in this area *Chemical Abstracts*, 2002 Renewable Energy Technologies Farooq Sher, 2015-12-05 Renewable Energy Technologies is a comprehensive guide to the utilization and application of the different sources of renewable energy highlighting how these technologies can help to tackle environmental challenges and global warming and to support energy transition with enhanced reliability security and resilience Bioenergy solar energy wind energy hydrogen hydropower marine energy and geothermal energy are covered in various sections organized by energy type Throughout the book emerging technologies are discussed such as energy storage and artificial intelligence and pathways to the adoption of renewable energy are explored Supported by clear definitions of key terms and phrases chapter objectives and summaries study questions and case studies this book supports all those looking to gain a fundamental understanding of renewable energy and related emerging technologies including students postgraduate researchers faculty engineers industry professionals and policy makers Covers the fundamentals of bio solar wind hydrogen hydro ocean and geothermal energy Addresses key challenges such as storage large scale production environment and economic factors Considers integration with regulations policy climate objectives and sustainable development goals Offers a future oriented perspective highlighting emerging areas such as artificial intelligence Supports reader understanding through the use of chapter objectives summaries questions and case studies **Energy and Power Technology** Xin Wei Yu, Hong Bing Ji, Sheng Zhou Chen, Xiao Guo Liu, Qing Zhu Zeng, 2013-09-10 Selected peer reviewed papers from the 2013 International Conference on Advances in Energy and Environmental Science ICAEES 2013 July 30 31 2013 Guangzhou China *Combustion and*

Emissions Control II Institute of Energy, 1995 Combustion and Emissions Control II contains 37 papers presented at the Institute of Energy Second International Conference on Combustion and Emissions Control held in London UK 4 5 December 1995 Combustion and Emissions Control II features contributions on both fundamental and applied aspects of the science and technology of combustion and emissions control Topics covered include emissions control and clean up energy from waste and biofuels modelling for industry plant performance industrial burners and furnaces advanced power generation internal combustion engines Presenting some of the latest developments in the field Combustion and Emissions Control II is an invaluable reference tool on a subject of great environmental concern Published by The Institute of Energy and distributed by Elsevier Science *Government Reports Announcements & Index*, 1996 **Specific Programme for Research and Development, Including Demonstration, in the Field of Non-nuclear Energy, 1994-1998** European Commission. Directorate-General XII, Science, Research, and Development, 1997 Energy Conversion and Resources-- ..., 2007 *Proceedings of the 18th International Conference on Fluidized Bed Combustion--2005*, 2005 **Energy Research Abstracts**, 1995 Semiannual with semiannual and annual indexes References to all scientific and technical literature coming from DOE its laboratories energy centers and contractors Includes all works deriving from DOE other related government sponsored information and foreign nonnuclear information Arranged under 39 categories e g Biomedical sciences basic studies Biomedical sciences applied studies Health and safety and Fusion energy Entry gives bibliographical information and abstract Corporate author subject report number indexes *Current Awareness in Particle Technology*, 1994 Government Reports Annual Index, 1994 *Pulverised Biomass and Coal Co-firing Simulation Using Computational Fluid Dynamics* Kristofer Jon Larsen, 2012 Recent national and international emissions legislation in particular sulphur dioxide and the rapid depletion of fossil fuels are forcing power producing industries to look at various alternatives such as biomass and co firing techniques Biomass may be transported to the burners of a pulverised fuel PF boiler either mixed with the primary fuel in general coal or used in dedicated pipelines In both cases the transportation of biomass is different due to its composition size and shape to the transportation of coal This thesis investigates the computational modelling techniques for a biomass and biomass blend particle transportation arboreal and flour in a pipeline with a transverse elbow the three phase flow of a coal and biomass co fire blend in the primary air annulus of a swirl burner and the combustion of a coal and pelletised straw mixture in a full scale furnace using dedicated burners for the biomass injection The comparison of spherical and non spherical drag models under gravity as well as Saffman lift inter particle collision and randomised impulsive wall collision models has been investigated Good agreement was observed between the computational fluid dynamics CFD simulations and the experimental data using a non spherical drag model In both cases due to the dilute volume fraction and secondary air flow inter particle collisions and lift were insignificant In the annulus lateral regions of high particle concentration were predicted which are not observed physically Numerical simulations of a 300MWe tangentially fired

furnace co firing bituminous coal and pelletised straw have been performed and compared to experimental data Bituminous coal was co fired with pelletised straw Good agreement was obtained between the CFD predictions and the experimental data so that the trends of furnace temperature NOx emissions and carbon burnout reduction as biomass load is increased were observed Quantitative prediction of unburnt carbon UBC and NOx require a more detailed picture of the processes within the furnace at higher temperatures than that currently provided by experimental data *Thermal Engineering ,2004*

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Table of Contents Advanced Cfd Modelling Of Pulverised Biomass Combustion

1. Understanding the eBook Advanced Cfd Modelling Of Pulverised Biomass Combustion
 - The Rise of Digital Reading Advanced Cfd Modelling Of Pulverised Biomass Combustion
 - Advantages of eBooks Over Traditional Books
2. Identifying Advanced Cfd Modelling Of Pulverised Biomass Combustion
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Advanced Cfd Modelling Of Pulverised Biomass Combustion
 - User-Friendly Interface
4. Exploring eBook Recommendations from Advanced Cfd Modelling Of Pulverised Biomass Combustion
 - Personalized Recommendations

- Advanced Cfd Modelling Of Pulverised Biomass Combustion User Reviews and Ratings
- Advanced Cfd Modelling Of Pulverised Biomass Combustion and Bestseller Lists
- 5. Accessing Advanced Cfd Modelling Of Pulverised Biomass Combustion Free and Paid eBooks
 - Advanced Cfd Modelling Of Pulverised Biomass Combustion Public Domain eBooks
 - Advanced Cfd Modelling Of Pulverised Biomass Combustion eBook Subscription Services
 - Advanced Cfd Modelling Of Pulverised Biomass Combustion Budget-Friendly Options
- 6. Navigating Advanced Cfd Modelling Of Pulverised Biomass Combustion eBook Formats
 - ePub, PDF, MOBI, and More
 - Advanced Cfd Modelling Of Pulverised Biomass Combustion Compatibility with Devices
 - Advanced Cfd Modelling Of Pulverised Biomass Combustion Enhanced eBook Features
- 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Advanced Cfd Modelling Of Pulverised Biomass Combustion
 - Highlighting and Note-Taking Advanced Cfd Modelling Of Pulverised Biomass Combustion
 - Interactive Elements Advanced Cfd Modelling Of Pulverised Biomass Combustion
- 8. Staying Engaged with Advanced Cfd Modelling Of Pulverised Biomass Combustion
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Advanced Cfd Modelling Of Pulverised Biomass Combustion
- 9. Balancing eBooks and Physical Books Advanced Cfd Modelling Of Pulverised Biomass Combustion
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Advanced Cfd Modelling Of Pulverised Biomass Combustion
- 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
- 11. Cultivating a Reading Routine Advanced Cfd Modelling Of Pulverised Biomass Combustion
 - Setting Reading Goals Advanced Cfd Modelling Of Pulverised Biomass Combustion
 - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Advanced Cfd Modelling Of Pulverised Biomass Combustion
 - Fact-Checking eBook Content of Advanced Cfd Modelling Of Pulverised Biomass Combustion

- Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
- 14. Embracing eBook Trends
 - Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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