Combustion Modelling Simulations Of Combustion And Mixture Formation For Use In The Study Of Gasoline Direct Injection Engines

Eventually, you will entirely discover a additional experience and finishing by spending more cash. yet when? reach you allow that you require to get those every needs considering having significantly cash? Why dont you try to acquire something basic in the beginning? Thats something that will guide you to comprehend even more nearly the globe, experience, some places, when history, amusement, and a lot more?

It is your utterly own become old to statute reviewing habit. in the middle of guides you could enjoy now is **Combustion Modelling Simulations Of Combustion And Mixture Formation For Use In The Study Of Gasoline Direct Injection Engines** below.

Mixture Formation in Internal Combustion Engines - Carsten Baumgarten 2006-09-28
A systematic control of mixture formation with modern high-pressure injection systems enables us to achieve considerable

improvements of the combustion pr- ess in terms of reduced fuel consumption and engine-out raw emissions. However, because of the growing number of free parameters due to more flexible injection systems, variable valve trains, the application of different combustion concepts within different regions of the engine map, etc., the prediction of spray and m- ture formation becomes increasingly complex. For this reason, the optimization of the in-cylinder processes using 3D computational fluid dynamics (CFD) becomes increasingly important. In these CFD codes, the detailed modeling of spray and mixture formation is a prerequisite for the correct calculation of the subsequent processes like ignition, combustion and formation of emissions. Although such simulation tools can be viewed as standard tools today, the predictive quality of the sub-models is c- stantly enhanced by a more accurate and detailed modeling of the relevant pr- esses, and by the inclusion of new important mechanisms and effects that come along with the development of new injection systems and have not been cons- ered so far. In this book the most widely used mathematical models for the simulation of spray and mixture formation in 3D CFD calculations are described and discussed. In order to give the reader an introduction into the complex processes, the book starts with a description of the fundamental mechanisms and categories of fuel - jection, spray break-up, and mixture formation in internal combustion engines.

Optimization Methods for the Mixture Formation and Combustion Process in Diesel Engines - Jost Weber 2008

Turbulent Combustion Modeling - Tarek Echekki 2010-12-25

Turbulent combustion sits at the interface of two important nonlinear, multiscale phenomena: chemistry and turbulence. Its study is extremely timely in view of the need to develop new combustion technologies in order to address challenges associated with climate change, energy source uncertainty, and air pollution. Despite the fact that modeling of turbulent combustion is a subject that has been researched for a number of years, its complexity implies that key issues are still eluding, and a theoretical description that is accurate enough to make turbulent combustion models rigorous and quantitative for industrial use is still lacking. In this book, prominent experts review most of the available approaches in modeling turbulent combustion, with particular focus on the exploding increase in computational resources that has allowed the simulation of increasingly detailed phenomena. The relevant algorithms are presented, the theoretical methods are explained, and various application examples are given. The book is intended for a relatively broad audience, including seasoned researchers and graduate students in engineering, applied mathematics and computational science, engine designers and computational fluid dynamics (CFD) practitioners, scientists at funding agencies, and anyone wishing to understand the state-of-the-art and the future directions of this scientifically challenging and practically important field.

Modelling Diesel Combustion - P. A. Lakshminarayanan 2010-03-03

Phenomenology of Diesel Combustion and Modeling Diesel is the most efficient combustion engine today and it plays an important role in transport of goods and passengers on land and on high seas. The emissions must be controlled as stipulated by the society without sacrificing the legendary fuel economy of the diesel engines. These important drivers caused innovations in diesel engineering like re-entrant combustion chambers in the piston, lower swirl support and high pressure injection, in turn reducing the ignition delay and hence the nitric oxides. The limits on emissions are being continually reduced. The- fore, the required accuracy of the models to predict the emissions and efficiency of the engines is high. The phenomenological combustion models based on physical and chemical description of the processes in the engine are practical to describe diesel engine combustion and to carry out parametric studies. This is because the injection process, which can be relatively well predicted, has the dominant effect on mixture formation and subsequent course of combustion. The need for improving these models by incorporating new developments in engine designs is explained in

Chapter 2. With “model based control programs” used in the Electronic Control Units of the engines, phenomenological models are assuming more importance now because the detailed CFD based models are too slow to be handled by the Electronic Control Units. Experimental work is necessary to develop the basic understanding of the pr- esses.

Turbulent Combustion - Norbert Peters 2000-08-15

The combustion of fossil fuels remains a key technology for the foreseeable future. It is therefore important that we understand the mechanisms of combustion and, in particular, the role of turbulence within this process. Combustion always takes place within a turbulent flow field for two reasons: turbulence increases the mixing process and enhances combustion, but at the same time combustion releases heat which generates flow instability through buoyancy, thus enhancing the transition to turbulence. The four chapters of this book present a thorough introduction to the field of turbulent combustion. After an overview of modeling approaches, the three remaining chapters consider the three distinct cases of premixed, non-premixed, and partially premixed combustion, respectively. This book will be of value to researchers and students of engineering and applied mathematics by demonstrating the current theories of turbulent combustion within a unified presentation of the field.

Combustion Engines

Development - Günter P. Merker 2011-09-24 Combustion Engines Development nowadays is based on simulation, not only of the transient reaction of vehicles or of the complete driveshaft, but also of the highly unsteady processes in the carburation process and the combustion chamber of an engine. Different physical and chemical approaches are described to show the potentials and limits of the models used for simulation.

Simulation of Combustion Processes in Lean H2-air Mixtures - Alexei Kotchourko 2005

Combustion - Jürgen Warnatz 2012-12-06 Combustion is an old technology, which at present provides about 90% of our worldwide energy support. Combustion research in the past used fluid mechanics with global heat release by chemical reactions described with thermodynamics, assuming infinitely fast reactions. This approach was useful for stationary combustion processes, but it is not sufficient for transient processes like ignition and quenching or for pollutant formation. Yet pollutant formation during combustion of fossil fuels is a central topic and will continue to be so in future. This book provides a detailed and rigorous treatment of the coupling of chemical reactions and fluid flow. Also, combustion-specific topics of chemistry and fluid mechanics are considered, and tools described for the simulation of combustion processes.

Mixture Fraction Combustion Model for Large Scale Fire Simulation - K. B.

McGrattan 2001

A Multi-dimensional Flamelet Model for Ignition in Multi-feed Combustion Systems - Eric Michael Doran 2011 This work develops a computational framework for modeling turbulent combustion in multi-feed systems that can be applied to internal combustion engines with multiple injections. In the first part of this work, the laminar flamelet equations are extended to two dimensions to enable the representation of a three-feed system that can be characterized by two mixture fractions. A coupling between the resulting equations and the turbulent flow field that enables the use of this method in unsteady simulations is then introduced. Models are developed to describe the scalar dissipation rates of each mixture fraction, which are the parameters that determine the influence of turbulent mixing on the flame structure. Furthermore, a new understanding of the function of the joint dissipation rate of both mixture fractions is discussed. Next, the extended flamelet equations are validated using Direct Numerical Simulations (DNS) of multi-stream ignition that employ detailed finite-rate chemistry. The results demonstrate that the ignition of the overall mixture is influenced by heat and mass transfer between the fuel streams and that this interaction is manifested as a front propagation in two-dimensional mixture fraction space. The flamelet model is shown to capture this behavior well and is therefore able to accurately describe the ignition process of each mixture. To provide closure between the flamelet chemistry and the turbulent flow field, information about the joint statistics of the two mixture fractions is required. An investigation of the joint probability density function (PDF) was carried out using DNS of two scalars mixing in stationary isotropic turbulence. It was found that available models for the joint PDF lack the ability to conserve all second-order moments necessary for an adequate description of the mixing field. A new five parameter bivariate beta distribution was therefore developed and shown to describe the joint PDF more accurately throughout the entire mixing time and for a wide range of initial conditions. Finally, the proposed model framework is applied in the simulation of a split-injection diesel engine and compared with experimental results. A range of operating points and different injection strategies are investigated. Comparisons with the experimental pressure traces show that the model is able to predict the ignition delay of each injection and the overall combustion process with good accuracy. These results indicate that the model is applicable to the range of regimes found in diesel combustion.

Modeling Engine Spray and Combustion Processes

- Gunnar Stiesch
2013-06-29

The utilization of mathematical models to numerically describe the performance of internal combustion engines is of great significance in the development of new and improved engines. Today, such simulation models can already be viewed as standard tools, and their importance is likely to increase further as available com puter power is expected to increase and the predictive quality of the models is constantly enhanced. This book describes and discusses the most widely used mathematical models for in-cylinder spray and combustion processes, which are the most important subprocesses affecting engine fuel consumption and pollutant emissions. The relevant thermodynamic, fluid dynamic and chemical principles are summarized, and then the application of these principles to the in-cylinder processes is ex plained. Different modeling approaches for the each subprocesses are compared and discussed with respect to the governing model assumptions and simplifica tions. Conclusions are drawn as to which model approach is appropriate for a specific type of problem in the development process of an engine. Hence, this book may serve both as a graduate level textbook for combustion engineering stu dents and as a reference for professionals employed in the field of combustion en gine modeling. The research necessary for this book was carried out during my employment as a postdoctoral scientist at the Institute of Technical Combustion (ITV) at the Uni versity of Hannover, Germany and at the Engine Research Center (ERC) at the University of Wisconsin-Madison, USA.

MILD Combustion: Modelling Challenges,

Experimental Configurations and Diagnostic Tools - Alessandro Parente 2021-11-26

Simulation of the Diesel Engine Combustion Process Using the Stochastic Reactor Model - Michal Pasternak 2016
The present work is concerned with the simulation of combustion, emission formation and fuel effects in Diesel engines. The simulation process is built around a zero-dimensional (0D) direct injection stochastic reactor model (DI-SRM), which is based on a probability density function (PDF) approach. An emphasis is put on the modelling of mixing time to improve the representation of turbulence-chemistry interactions in the 0D DI-SRM. The mixing time model describes the intensity of mixing in the gas-phase for scalars such as enthalpy and species mass fraction. On a crank angle basis, it governs the composition of the gas mixture that is described by PDF distributions for the scalars. The derivation of the mixing time is based on an extended heat release analysis that has been fully automated using a genetic algorithm. The predictive nature of simulations is achieved through the parametrisation of the mixing time model with known engine operating parameters such as speed, load and fuel injection strategy. It is shown that crank angle dependency of the mixing time improves the modelling of local inhomogeneity in the gas-phase for species mass fraction and temperature. In combination with an

exact treatment of the non-linearity of reaction kinetics, it enables an accurate prediction of the rate of heat release, in-cylinder pressure and exhaust emissions, such as nitrogen oxides, unburned hydrocarbons and soot, from differently composed fuels. The method developed is particularly tailored for computationally efficient applications that focus on the details of reaction kinetics and the locality of combustion and emission formation in Diesel engines.

A Multi-dimensional Flamelet Model for Ignition in Multi-feed Combustion Systems - Eric Michael Doran 2011

This work develops a computational framework for modeling turbulent combustion in multi-feed systems that can be applied to internal combustion engines with multiple injections. In the first part of this work, the laminar flamelet equations are extended to two dimensions to enable the representation of a three-feed system that can be characterized by two mixture fractions. A coupling between the resulting equations and the turbulent flow field that enables the use of this method in unsteady simulations is then introduced. Models are developed to describe the scalar dissipation rates of each mixture fraction, which are the parameters that determine the influence of turbulent mixing on the flame structure. Furthermore, a new understanding of the function of the joint dissipation rate of both mixture fractions is discussed. Next, the extended flamelet equations are validated using Direct Numerical Simulations (DNS) of multi-stream ignition that employ detailed finite-rate chemistry. The results demonstrate that the ignition of the overall mixture is influenced by heat and mass transfer between the fuel streams and that this interaction is manifested as a front propagation in two-dimensional mixture fraction space. The flamelet model is shown to capture this behavior well and is therefore able to accurately describe the ignition process of each mixture. To provide closure between the flamelet chemistry and the turbulent flow field, information about the joint statistics of the two mixture fractions is required. An investigation of the joint probability density function (PDF) was carried out using DNS of two scalars mixing in stationary isotropic turbulence. It was found that available models for the joint PDF lack the ability to conserve all second-order moments necessary for an adequate description of the mixing field. A new five parameter bivariate beta distribution was therefore developed and shown to describe the joint PDF more accurately throughout the entire mixing time and for a wide range of initial conditions. Finally, the proposed model framework is applied in the simulation of a split-injection diesel engine and compared with experimental results. A range of operating points and different injection strategies are investigated. Comparisons with the experimental pressure traces show that the model is able to predict the ignition delay of each injection and the overall combustion process with good accuracy. These results indicate that the model is applicable to the range of regimes found in diesel combustion.

Simulation of Combustion and Mixture Formation for Gasoline Direct Injection Engine Application - Chen Huang 2011

Combustion Modeling and Air-to-fuel Ratio and Dual-fuel Ratio Control of an Internal Combustion Engine - Stephen Daniel Pace 2008

Modeling and Simulation of Turbulent Combustion - Santanu De 2017-12-12

This book presents a comprehensive review of state-of-the-art models for turbulent combustion, with special emphasis on the theory, development and applications of combustion models in practical combustion systems. It simplifies the complex multi-scale and nonlinear interaction between chemistry and turbulence to allow a broader audience to understand the modeling and numerical simulations of turbulent combustion, which remains at the forefront of research due to its industrial relevance. Further, the book provides a holistic view by covering a diverse range of basic and advanced topics—from the fundamentals of turbulence–chemistry interactions, role of high-performance computing in combustion simulations, and optimization and reduction techniques for chemical kinetics, to state-of-the-art modeling strategies for turbulent premixed and nonpremixed combustion and their applications in engineering contexts.

Simulation of a Hydrogen Internal Combustion Engine with Cryogenic Mixture Formation - Simon Ellgas 2008

Combustion Engines Development - Günter P. Merker 2011-09-28 Combustion Engines Development nowadays is based on simulation, not only of the transient reaction of vehicles or of the complete driveshaft, but also of the highly unsteady processes in the carburation process and the combustion chamber of an engine. Different physical and chemical approaches are described to show the potentials and limits of the models used for simulation.

CFD Study on Hydrogen Engine Mixture Formation and Combustion - Fushui Liu 2004

Simulation and Optimization of Internal Combustion Engines - Zhiyu Han 2021-12-28 Simulation and Optimization of Internal Combustion Engines provides the fundamentals and up-to-date progress in multidimensional simulation and optimization of internal combustion engines. While it is impossible to include all the models in a single book, this book intends to introduce the pioneer and/or the often-used models and the physics behind them providing readers with ready-to-use knowledge. Key issues, useful modeling methodology and techniques, as well as instructive results, are discussed through examples. Readers will understand the fundamentals of these examples and be inspired to explore new ideas and means for better solutions in their studies and work. Topics include combustion basis of IC engines, mathematical descriptions of reactive flow with sprays, engine in-cylinder turbulence, fuel sprays, combustions and pollutant emissions, optimization of direct-injection gasoline engines, and optimization of diesel and alternative fuel engines.

Mit alphabetischem Sachregister zu Band I bis IV. - 1888

Numerical Analysis of Mixture Formation and Combustion in a Hydrogen Direct-injection Internal Combustion Engine - Udo Gerke 2007

A Probability Density Function Time-scale Model for Combustion Using Large Eddy Simulation - Shrikanth Rao 2001

Engine Modeling and Simulation - Avinash Kumar Agarwal 2021-12-16 This book focuses on the simulation and modeling of internal combustion engines. The contents include various aspects of diesel and gasoline engine modeling and simulation such as spray, combustion, ignition, in-cylinder phenomena, emissions, exhaust heat recovery. It also explored engine models and analysis of cylinder bore piston stresses and temperature effects. This book includes recent literature and focuses on current modeling and simulation trends for internal combustion engines. Readers will gain knowledge about engine process simulation and modeling, helpful for the development of efficient and emission-free engines. A few chapters highlight the review of state-of-the-art models for spray, combustion, and emissions, focusing on the theory, models, and their applications from an engine point of view. This volume would be of interest to professionals, post-graduate students involved in alternative fuels, IC engines, engine modeling and simulation, and environmental research.

A Multi-regime Combustion Model for Reactive Flow in Internal Combustion Engines - Varun Mittal 2012

With the ever-rising need for better fuel efficiency and lower emissions, the development of better engine technologies is essential. Developing these technologies requires a good understanding of the interaction between the various coupled multi-physics phenomena present in the engine. Detailed simulations of the engine can potentially provide this. Such simulations are becoming tractable now with the increase in available computational power. Since the combustion process is the primary controlling feature in these engines, an accurate combustion model is essential for enabling these simulations. This model must be efficient and valid across different combustion regimes, since modern engines might operate in hybrid modes. In this work, a framework for studying combustion in engines is developed. In the first part of this work, the focus is on the premixed regime which is dominant in Spark Ignited (SI) engines. The canonical flamelet model used extensively to study constant pressure premixed combustion is extended to variable pressure conditions that are observed in an engine cylinder. An extrapolation procedure is also developed for ensuring a consistent enthalpy and temperature under strong compression. This model is validated against direct numerical simulations with detailed chemistry under different turbulence conditions. The performance of the isobaric model is also evaluated in high turbulence conditions by comparing against detailed experiments of a piloted premixed jet burner with finite rate chemistry and different turbulence levels. In the second part of this work, the autoignition regime is studied, which is the dominant regime in Homogeneous Charge Compression Ignition (HCCI) engines. The Representative Interactive Flamelet (RIF) combustion model has previously been used to describe ignition, combustion, and pollutant formation in direct-injected Diesel engines. It has also been applied successfully for HCCI type combustion. In this work, the RIF model is validated against direct numerical simulation data to evaluate model performance under mixture stratification in Diesel, HCCI, and hybrid regimes. A wide range of thermal stratification and concurrent stratification cases is considered using the model. Since mixed modes are present in a modern engine, a multi-regime combustion model is required. A model is developed in this work by integrating the models for autoignition and premixed regimes.

This model is validated against direct numerical simulations with for cases both regimes are important. Finally, simulations of an actual engine are performed. First, the validity of the flow solution is tested by simulating flow bench configurations with no valve motion or reaction. Next, gas exchange simulations of a motored engine are performed. Last, simulation of mixture formation in an engine is performed.

Combustion - J. Warnatz 2006-09-23

This book provides a rigorous treatment of the coupling of chemical reactions and fluid flow. Combustion-specific topics of chemistry and fluid mechanics are considered and tools described for the simulation of combustion processes. This edition is completely restructured. Mathematical Formulae and derivations as well as the space-consuming reaction mechanisms have been replaced from the text to appendix. A new chapter discusses the impact of combustion processes on the atmosphere, the chapter on auto-ignition is extended to combustion in Otto- and Diesel-engines, and the chapters on heterogeneous combustion and on soot formation are heavily revised.

Cfd Simulation of Internal Combustion Engines - Abhijeet Vaidya 2010-07

Understanding highly complex nature of flow in an IC engine is essential to optimize its performance. However, the events like reciprocating motion of piston, motion of valves, turbulence generation, spray and mixing lead to a complex flow pattern. CFD is very useful in computing and understanding this complex flow pattern. In this book, all aspects of CFD technique to simulate the mixing of fuel with air in GDI engines are explained. The book covers the governing equations, numerical techniques for solving them, method of analysis of data (in the context of mixing processes) and programming techniques. The book will be useful for professionals who are performing CFD analysis using CFD softwares for thermal systems specifically reciprocating systems like engines, compressors and systems involving sprays, mixing etc. It is also useful for those who are developing CFD tools.

Numerical Simulation of Combustion and Unburnt Products in Dual-fuel Compression-ignition Engines with Multiple Injection - Arash Jamali 2015

Natural gas substitution for diesel can result in significant reduction in pollutant emissions. Based on current fuel price projections, operating costs would be lower. With a high ignition temperature and relatively low reactivity, natural gas can enable promising approaches to combustion engine design. In particular, the combination of low reactivity natural gas and high reactivity diesel may allow for optimal operation as a reactivity-controlled compression ignition (RCCI) engine, which has potential for high efficiency and low emissions. In this computational study, a lean mixture of natural gas is ignited by direct injection of diesel fuel in a model of the heavyduty CAT3401 diesel engine. Dual-fuel combustion of natural gas-diesel (NGD) may provide a wider range of reactivity control than other dual-fuel combustion strategies such as gasoline-diesel dual fuel. Accurate and efficient combustion modeling can aid NGD dual-fuel engine control and optimization. In this study, multi-dimensional simulation was performed using a nite-volume computational code for fuel spray, combustion and emission processes. Adaptive mesh refinement (AMR) and multi-zone reaction modeling enables simulation in a reasonable time. The latter approach avoids expensive kinetic calculations in every computational cell, with considerable speedup. Two approaches to combustion modeling are used within the Reynolds averaged Navier-Stokes (RANS) framework. The first approach uses direct integration of the detailed chemistry and no turbulence-chemistry interaction modeling. The model produces encouraging agreement between the simulation and experimental data. For reasonable accuracy and computation cost, a minimum cell size of 0.2 millimeters is suggested for NGD dual-fuel engine combustion. In addition, the role of different chemical reaction mechanism on the NGD dual-fuel combustion is considered with this model. This work considers fundamental questions regarding combustion in NGD dual-fuel combustion, particularly about how and where fuels react, and the difference between combustion in the dual fuel mode and conventional diesel mode. The results show that in part-load working condition main part of CH_4 cannot burn and it has significant effect in high level of HC emission in NGD dual-fuel engine. The CFD results reveal that homogeneous mixture of CH_4 and air is too lean, and it cannot ignite in regions that any species from C_7H_{16} chemical mechanism does not exist. It is shown that multi-injection of diesel fuel with an early main injection can reduce HC emission significantly in the NGD dual-fuel engine. In addition, the results reveal that increasing the air fuel ratio by decreasing the air amount could be a promising idea for HC emission reduction in NGD dual-fuel engine, too.

Development of a Partially Premixed Combustion Model for a Diesel Engine Using Multiple Injection Strategies - Rene Thygesen 2012

In order to fulfil future emissions legislations, new combustion systems are to be investigated. One way of improving exhaust emissions is the application of multiple injection strategies and conventional or partially premixed combustion conditions to a Diesel engine. The application of numerical techniques as CFD supports and improves the quality of engine developments. Unfortunately, current spray and combustion models are not accurate enough to simulate multiple injection systems, being in this way a topic of research. The goal of this study was the development of a novel simulation method for the investigation of Diesel engines operated with multiple injection strategies and different combustion modes. The first part of this work focused in improving the spray modelling. The inform ation of 3D CFD simulations of the injector nozzle was introduced in the spray simulation as boundary conditions developing coupling subroutines for this issue. The atomisation modelling was also improved using validated presumed droplet size distributions. Moreover, to avoid the simulation of the injector nozzle for every investigated operating point, a novel interpolating tool was developed in order to create spray boundary conditions based on few 3D CFD simulations of the nozzle under certain initial and boundary conditions. The second part of this thesis dealt with the combustion modelling of Diesel engines. For this issue, a laminar flamelet approach called Representative Interactive Flamelet model (RIF) was selected and implemented. Afterwards, an extended combustion model based on RIF was developed in order to take into account multiple injection strategies. Finally, this new model was validated with a wide range of operating points: applying multiple injection strategies under conventional and partially premixed combustion conditions.

Combustion - Jürgen Warnatz 2012-12-06 Combustion is an old technology, which at present provides about 90% of our worldwide energy support. Combustion research in the past used fluid mechanics with global heat release by chemical reactions described with thermodynamics, assuming infinitely fast reactions. This approach was useful for stationary combustion processes, but it is not sufficient for transient processes like ignition and quenching or for pollutant formation. Yet pollutant formation during combustion of fossil fuels is a central topic and will continue to be so in future. This book provides a detailed and rigorous treatment of the coupling of chemical reactions and fluid flow. Also, combustion-specific topics of chemistry and fluid mechanics are considered, and tools described for the simulation of combustion processes. For the 2nd edition, the parts dealing with experiments, spray combustion, and soot were thoroughly revised.

Mixture Fraction Combustion Model for Fire Simulation Using CFD - J. E. Floyd 2001

Combustion Modeling in Reciprocating Engines - James N. Mattair 1980

1D and Multi-D Modeling Techniques for IC Engine Simulation - Angelo Onorati 2020-04-06

1D and Multi-D Modeling Techniques for IC Engine Simulation provides a description of the most significant and recent achievements in the field of 1D engine simulation models and coupled 1D-3D modeling techniques, including 0D combustion models, quasi-3D methods and some 3D model applications.

Modeling of End-Gas Autoignition for Knock Prediction in Gasoline Engines - Andreas Manz 2016-08-18

Downsizing of modern gasoline engines with direct injection is a key concept for achieving future CO22 emission targets. However, high power densities and optimum efficiency are limited by an uncontrolled autoignition of the unburned air-fuel mixture, the so-called spark knock phenomena. By a combination of three-dimensional Computational Fluid Dynamics (3D-CFD) and experiments incorporating optical diagnostics, this work presents an integral approach for predicting combustion and autoignition in Spark Ignition (SI) engines. The turbulent premixed combustion and flame front propagation in 3D-CFD is modeled with the G-equation combustion model, i.e. a laminar flamelet approach, in combination with the level set method. Autoignition in the unburned gas zone is modeled with the Shell model based on reduced chemical reactions using optimized reaction rate coefficients for different octane numbers (ON) as well as engine relevant pressures, temperatures and EGR rates. The basic functionality and sensitivities of improved sub-models, e.g. laminar flame speed, are proven in simplified test cases followed by adequate engine test cases. It is shown that the G-equation combustion model performs well even on unstructured grids with polyhedral cells and coarse grid resolution. The validation of the knock model with respect to temporal and spatial knock onset is done with fiber optical spark plug measurements and statistical evaluation of individual knocking cycles with a frequency based pressure analysis. The results show a good correlation with the Shell autoignition relevant species in the simulation. The combined model approach with G-equation and Shell autoignition in an active formulation enables a realistic representation of thin flame fronts and hence the thermodynamic conditions prior to knocking by taking into account the ignition chemistry in unburned gas, temperature fluctuations and self-acceleration effects due to pre-reactions. By the modeling approach and simulation methodology presented in this work the overall predictive capability for the virtual development of future knockproof SI engines is improved.

Recent Advances in Combustion Modelling - Bernard Larrouturou 1991
This volume gathers the contributions of six world experts to a course on combustion modelling. Therefore, a pedagogical effort has been made in writing up these texts, which cover state of the art advances in most aspects of combustion science. The book is aimed at students, researches and engineers, as was the course.

Modeling and Computer Simulation of Internal Combustion Engines - 1997

Combustion - Jerzy Chomiak 1990-01

Simulating Combustion - Günter P. Merker 2005-12-27
The numerical simulation of combustion processes in internal combustion engines, including also the formation of pollutants, has become increasingly important in the recent years, and today the simulation of

those processes has already become an indispensable tool when - veloping new combustion concepts. While pure thermodynamic models are well-established tools that are in use for the simulation of the transient behavior of complex systems for a long time, the phenomenological models have become more important in the recent years and have also been implemented in these simulation programs. In contrast to this, the thr- dimensional simulation of in-cylinder combustion, i. e. the detailed, integrated and continuous simulation of the process chain injection, mixture formation, ignition, heat release due to combustion and formation of pollutants, has been significantly improved, but there is still a number of challenging problems to solve, regarding for example the exact description of s- processes like the structure of turbulence during combustion as well as the appropriate choice of the numerical grid. While chapter 2 includes a short introduction of functionality and operating modes of internal combustion engines, the basics of kinetic reactions are presented in chapter 3. In chapter 4 the physical and chemical processes taking place in the combustion chamber are described. Ch- ter 5 is about phenomenological multi-zone models, and in chapter 6 the formation of poll- ants is described.

Introduction to Modeling and Control of Internal Combustion Engine Systems - Lino Guzzella 2009-12-21

Internal combustion engines (ICE) still have potential for substantial improvements, particularly with regard to fuel efficiency and environmental compatibility. In order to fully exploit the remaining margins, increasingly sophisticated control systems have to be applied. This book offers an introduction to cost-effective model-based control-system design for ICE. The primary emphasis is put on the ICE and its auxiliary devices. Mathematical models for these processes are developed and solutions for selected feedforward and feedback control-problems are presented. The discussions concerning pollutant emissions and fuel economy of ICE in automotive applications constantly intensified since the first edition of this book was published. Concerns about the air quality, the limited resources of fossil fuels and the detrimental effects of greenhouse gases exceedingly spurred the interest of both the industry and academia in further improvements. The most important changes and additions included in this second edition are: restructured and slightly extended section on superchargers, short subsection on rotational oscillations and their treatment on engine test-benches, complete section on modeling, detection, and control of engine knock, improved physical and chemical model for the three-way catalytic converter, new methodology for the design of an air-to-fuel ratio controller, short introduction to thermodynamic engine-cycle calculation and corresponding control-oriented aspects.