

Nikolay Ivanov Kolev

# Multiphase Flow Dynamics

## 2

MECHANICAL  
INTERACTIONS

Fourth Edition



Springer

# Multiphase Flow Dynamics 2 Mechanical Interactions

**Nikolay Ivanov Kolev**



## **Multiphase Flow Dynamics 2 Mechanical Interactions:**

Multiphase Flow Dynamics 2 Nikolay Ivanov Kolev, 2012-02-05 Multi phase flows are part of our natural environment such as tornadoes typhoons air and water pollution and volcanic activities as well as part of industrial technology such as power plants combustion engines propulsion systems or chemical and biological industry The industrial use of multi phase systems requires analytical and numerical strategies for predicting their behavior In its fourth extended edition the successful monograph package Multiphase Flow Dynamics contains theory methods and practical experience for describing complex transient multi phase processes in arbitrary geometrical configurations providing a systematic presentation of the theory and practice of numerical multi phase fluid dynamics In the present second volume the methods for describing the mechanical interactions in multiphase dynamics are provided This fourth edition includes various updates extensions improvements and corrections The literature in the field of multiphase flows is numerous Therefore it is very important to have a comprehensive and systematic overview including useful numerical methods The volumes have the character of a handbook and accomplish this function excellently The models are described in detail and a great number of comprehensive examples and some cases useful for testing numerical solutions are included These two volumes are very useful for scientists and practicing engineers in the fields of technical thermodynamics chemical engineering fluid mechanics and for mathematicians with interest in technical problems Besides they can give a good overview of the dynamically developing complex field of knowledge to students This monograph is highly recommended BERND PLATZER ZAAM In the present second volume the methods for describing the mechanical interactions in multiphase dynamics are provided This fourth edition includes various updates extensions improvements and corrections The literature in the field of multiphase flows is numerous Therefore it is very important to have a comprehensive and systematic overview including useful numerical methods The volumes have the character of a handbook and accomplish this function excellently The models are described in detail and a great number of comprehensive examples and some cases useful for testing numerical solutions are included These two volumes are very useful for scientists and practicing engineers in the fields of technical thermodynamics chemical engineering fluid mechanics and for mathematicians with interest in technical problems Besides they can give a good overview of the dynamically developing complex field of

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technology step by step in their own engineering practice In many practical application gases are solved in liquids under given conditions released under other conditions and therefore affecting technical processes for good or for bad Useful information on the solubility of oxygen nitrogen hydrogen and carbon dioxide in water under large interval of pressures and temperatures is collected and appropriate mathematical approximation functions are provided In addition methods for the computation of the diffusion coefficients are described With this information solution and dissolution dynamics in multiphase fluid flows can be analyzed For this purpose the non equilibrium absorption and release on bubble droplet and film surfaces under different conditions is mathematically described A systematic set of internally consistent state equations for diesel fuel gas and liquid valid in broad range of changing pressure and temperature is provided This new second edition includes various updates extensions improvements and corrections

*Multiphase Flow Dynamics 5* Nikolay Ivanov Kolev, 2015-04-02

This Volume 5 of the successful book package *Multiphase Flow Dynamics* is devoted to nuclear thermal hydraulics which is a substantial part of nuclear reactor safety It provides knowledge and mathematical tools for adequate description of the process of transferring the fission heat released in materials due to nuclear reactions into its environment It step by step introduces into the heat release inside the fuel temperature fields in the fuels the simple boiling flow in a pipe described using ideas of different complexity like equilibrium non equilibrium homogeneity non homogeneity Then the simple three fluid boiling flow in a pipe is described by gradually involving the mechanisms like entrainment and deposition dynamic fragmentation collisions coalescence turbulence All heat transfer mechanisms are introduced gradually discussing their uncertainty Different techniques are introduced like boundary layer treatments or integral methods Comparisons with experimental data at each step demonstrate the success of the different ideas and models After an introduction of the design of the reactor pressure vessels for pressurized and boiling water reactors the accuracy of the modern methods is demonstrated using large number of experimental data sets for steady and transient flows in heated bundles Starting with single pipe boiling going through boiling in the rod bundles the analysis of complete vessel including the reactor is finally demonstrated Then a powerful method for nonlinear stability analysis of flow boiling and condensation is introduced Models

are presented and their accuracies are investigated for describing critical multiphase flow at different level of complexity Therefore the book presents a complete coverage of the modern Nuclear Thermal Hydrodynamics This present third edition includes various updates extensions improvements and corrections

**Multiphase Flow Dynamics 3** Nikolay Ivanov Kolev, 2007-06-08 In order to allow the application of the theory from all the three volumes also to processes in combustion engines a systematic set of internally consistent state equations for diesel fuel gas and liquid valid in broad range of changing pressure and temperature are provided also in Volume 3 Erlangen October 2006 Nikolay Ivanov Kolev Table of contents 1 Some basics of the single phase boundary layer theory 1 1 1 Flow over plates velocity profiles shear forces heat transfer 1 1 1 1 Laminar flow over the one side of a plate 1 1 1 2 Turbulent flow parallel to plane 2 1 2 Steady state flow in pipes with circular cross sections 4 1 2 1 Hydraulic smooth wall surface 6 1 2 2 Transition region 14 1 2 3 Complete rough region 14 1 2 4 Heat transfer to fluid in a pipe 15 1 3 Transient flow in pipes with circular cross sections 21 Nomenclature 23 References 26 2 Introduction to turbulence of multi phase flows 29 2 1 Basic ideas 29 2 2 Isotropy 40 2 3 Scales eddy viscosity 41 2 3 1 Small scale turbulent motion 41 2 3 2 Large scale turbulent motion Kolmogorov Pandt expression 42 2 4 k- $\epsilon$  framework 44 Nomenclature 48 References 53 3 Sources for fine resolution outside the boundary layer 55 3 1 Bulk sources 55 3 1 1 Deformation of the velocity field 55 3 1 2 Blowing and suction

Introduction to Multiphase Flow George Yadigaroglu, Geoffrey F. Hewitt, 2017-08-19 This book is the maiden volume in a new series devoted to lectures delivered through the annual seminars Short Courses on Multiphase Flow held primarily at ETH Zurich continuously since 1984 The Zurich short courses presented by prominent specialists in the various topics covered have attracted a very large number of participants This series presents fully updated and when necessary re grouped lectures in a number of topical volumes The collection aims at giving a condensed critical and up to date view of basic knowledge on multiphase flows in relation to systems and phenomena encountered in industrial applications The present volume covers the background of Multiphase Flows MPF that introduces the reader to the particular nature and complexity of multiphase flows and to basic but critical aspects of MPFs including concepts and the definition of the quantities of interest an introduction to modelling strategies for MPFs flow regimes flow regime maps and transition criteria It also deals with the ubiquitous needs of the multiphase flow modeller namely pressure drop and phase distribution i.e the void fraction and the topology of the phases that determines the flow regimes

**Multiphase Flow Dynamics 1** Nikolay Ivanov Kolev, 2011-10-22 Multi phase flows are part of our natural environment such as tornadoes typhoons air and water pollution and volcanic activities as well as part of industrial technology such as power plants combustion engines propulsion systems or chemical and biological industry The industrial use of multi phase systems requires analytical and numerical strategies for predicting their behavior In its fourth extended edition the successful monograph package Multiphase Flow Dynamics contains theory methods and practical experience for describing complex transient multi phase processes in arbitrary geometrical configurations providing a systematic

presentation of the theory and practice of numerical multi phase fluid dynamics In the present first volume the local volume and time averaging is used to derive a complete set of conservation equations for three fluids each of them having multi components as constituents Large parts of the book are devoted on the design of successful numerical methods for solving the obtained system of partial differential equations Finally the analysis is repeated for boundary fitted curvilinear coordinate systems designing methods applicable for interconnected multi blocks This fourth edition includes various updates extensions improvements and corrections The literature in the field of multiphase flows is numerous Therefore it is very important to have a comprehensive and systematic overview including useful numerical methods The volumes have the character of a handbook and accomplish this function excellently The models are described in detail and a great number of comprehensive examples and some cases useful for testing numerical solutions are included These two volumes are very useful for scientists and practicing engineers in the fields of technical thermodynamics chemical engineering fluid mechanics and for mathematicians with interest in technical problems Besides they can give a good overview of the dynamically developing complex field of knowledge to students This monograph is highly recommended BERND PLATZER ZAAM In the present first volume the local volume and time averaging is used to derive a complete set of conservation equations for three fluids each of them having multi components as constituents Large parts of the book are devoted on the design of successful numerical methods for solving the obtained system of partial differential equations Finally the analysis is repeated for boundary fitted curvilinear coordinate systems designing methods applicable for interconnected multi blocks This fourth edition includes various updates extensions improvements and corrections The literature in the field of multiphase flows is numerous Therefore it is very important to have a comprehensive and systematic overview including useful numerical methods The volumes have the character of a handbook and accomplish this function excellently The models are described in detail and a great number of comprehensive examples and some cases useful for testing numerical solutions are included These two volumes are very useful for scientists and practicing engineers in the fields of technical thermodynamics chemical engineering fluid mechanics and for mathematicians with interest in technical problems Besides they can give a good overview of the dynamically developing complex field of knowledge to students This monograph is highly recommended BERND PLATZER ZAAM      Multiphase Flow Peter Vorobieff, C. A. Brebbia, 2018-04-18 The selected papers contained in this book present the latest research in one of the most challenging yet most universally applicable areas of technology Multiphase flows are found in all areas of technology and the range of related problems of interest is vast including many areas of science and engineering Recently multiphase fluid dynamics have generated a great deal of attention leading to many notable advances in experimental analytical and numerical studies It is perhaps however work on numerical solutions which is the most noticeable owing to the continuing improvements in computer software tools Progress in numerical methods has permitted the solution of many practical problems helping to improve our understanding of the physics involved

The presented papers illustrate the close interaction between numerical modellers and researchers working to gradually resolve the many outstanding issues in our understanding of multiphase flow

*Fundamentals of Turbulent and Multiphase Combustion* Kenneth K. Kuo, Ragini Acharya, 2012-07-03 Detailed coverage of advanced combustion topics from the author of Principles of combustion Second Edition Turbulence turbulent combustion and multiphase reacting flows have become major research topics in recent decades due to their application across diverse fields including energy environment propulsion transportation industrial safety and nanotechnology Most of the knowledge accumulated from this research has never been published in book form until now Fundamentals of Turbulent and Multiphase Combustion presents up to date integrated coverage of the fundamentals of turbulence combustion and multiphase phenomena along with useful experimental techniques including non intrusive laser based measurement techniques providing a firm background in both contemporary and classical approaches Beginning with two full chapters on laminar premixed and non premixed flames this book takes a multiphase approach beginning with more common topics and moving on to higher level applications In addition Fundamentals of Turbulent and Multiphase Combustion Addresses seven basic topical areas in combustion and multiphase flows including laminar premixed and non premixed flames theory of turbulence turbulent premixed and non premixed flames and multiphase flows Covers spray atomization and combustion solid propellant combustion homogeneous propellants nitramines reacting boundary layer flows single energetic particle combustion and granular bed combustion Provides experimental setups and results whenever appropriate Supported with a large number of examples and problems as well as a solutions manual Fundamentals of Turbulent and Multiphase Combustion is an important resource for professional engineers and researchers as well as graduate students in mechanical chemical and aerospace engineering

*Multiphase Flow Dynamics: Thermal and mechanical interactions* Nikolay Ivanov Kolev, 2005

**Mathematical Modeling of Disperse Two-Phase Flows** Christophe Morel, 2015-07-17 This book develops the theoretical foundations of disperse two phase flows which are characterized by the existence of bubbles droplets or solid particles finely dispersed in a carrier fluid which can be a liquid or a gas Chapters clarify many difficult subjects including modeling of the interfacial area concentration Basic knowledge of the subjects treated in this book is essential to practitioners of Computational Fluid Dynamics for two phase flows in a variety of industrial and environmental settings The author provides a complete derivation of the basic equations followed by more advanced subjects like turbulence equations for the two phases continuous and disperse and multi size particulate flow modeling As well as theoretical material readers will discover chapters concerned with closure relations and numerical issues Many physical models are presented covering key subjects including heat and mass transfers between phases interfacial forces and fluid particles coalescence and breakup amongst others This book is highly suitable for students in the subject area but may also be a useful reference text for more advanced scientists and engineers

Mathematical Reviews , 2006

Advanced Computational Methods and Experiments in Heat Transfer XII B. Sundén, C.A. Brebbia, D.

Poljak,2012-06-27 Containing papers presented at the twelfth in a series of successful international conferences on Advanced Computational Methods and Experiments in Heat Transfer this book covers the latest developments in this important field Heat Transfer plays a major role in emerging application fields such as sustainable development and the reduction of greenhouse gases as well as micro and nano scale structures and bio engineering Typical applications include heat exchangers gas turbine cooling turbulent combustion and fires electronics cooling melting and solidification The nature of heat transfer problems is complex involving many different simultaneously occurring mechanisms e g heat conduction convection turbulence thermal radiation phase change Their complexity makes it imperative that we develop reliable and accurate computational methods to replace or complement expensive and time consuming experimental trial and error work Tremendous advances have been achieved during recent years due to improved numerical solutions of non linear partial differential equations and more powerful computers capable of performing efficient and rapid calculations Nevertheless to further progress it will also be necessary to develop theoretical and predictive computational procedures both basic and innovative and in applied research Accurate experimental investigations are needed to validate the numerical calculations The book includes such topics as Heat Transfer in Energy Producing Devices Heat Transfer Enhancement Heat Transfer Problems Natural and Forced Convection and Radiation Multiphase Flow Heat Transfer Modelling and Experiments

**Thermo-Fluid Dynamics of Two-Phase Flow** Mamoru Ishii,Takashi Hibiki,2010-11-10 Thermo fluid Dynamics of Two Phase Flow Second Edition is focused on the fundamental physics of two phase flow The authors present the detailed theoretical foundation of multi phase flow thermo fluid dynamics as they apply to Nuclear reactor transient and accident analysis Energy systems Power generation systems Chemical reactors and process systems Space propulsion Transport processes This edition features updates on two phase flow formulation and constitutive equations and CFD simulation codes such as FLUENT and CFX new coverage of the lift force model which is of particular significance for those working in the field of computational fluid dynamics new equations and coverage of 1 dimensional drift flux models and a new chapter on porous media formulation

**Chemical Reactor Modeling** Hugo A. Jakobsen,2008-10-15 Chemical Reactor Modeling closes the gap between Chemical Reaction Engineering and Fluid Mechanics It presents the fundamentals of the single fluid and multi fluid models for the analysis of single and multiphase reactive flows in chemical reactors with a chemical reactor engineering rather than mathematical bias The book discusses numerical methods for solving the resulting equations as well as the interplay between physical and numerical modes It is organized in 12 chapters combining theoretical aspects and practical applications and covers some of the recent research in several areas of chemical reactor engineering This book contains a survey of the modern literature in the field of chemical reactor modeling The book is written by a Chemical Engineer for Chemical Process Engineers using the standard terminology of this community It is intended for researchers and engineers who want to develop their own codes or who are interested in a deeper insight into commercial CFD codes in

order to derive consistent extensions and to overcome black box practice It can also serve as a textbook and reference book for both students and practitioners

**Advances of Computational Fluid Dynamics in Nuclear Reactor Design and Safety Assessment** Jyeshtharaj Joshi, Arun K. Nayak, 2019-06-09 Advances of Computational Fluid Dynamics in Nuclear Reactor Design and Safety Assessment presents the latest computational fluid dynamic technologies It includes an evaluation of safety systems for reactors using CFD and their design the modeling of Severe Accident Phenomena Using CFD Model Development for Two phase Flows and Applications for Sodium and Molten Salt Reactor Designs Editors Joshi and Nayak have an invaluable wealth of experience that enables them to comment on the development of CFD models the technologies currently in practice and the future of CFD in nuclear reactors Readers will find a thematic discussion on each aspect of CFD applications for the design and safety assessment of Gen II to Gen IV reactor concepts that will help them develop cost reduction strategies for nuclear power plants Presents a thematic and comprehensive discussion on each aspect of CFD applications for the design and safety assessment of nuclear reactors Provides an historical review of the development of CFD models discusses state of the art concepts and takes an applied and analytic look toward the future Includes CFD tools and simulations to advise and guide the reader through enhancing cost effectiveness safety and performance optimization

**Safety Analysis for a Fuel Qualification Test with Supercritical Water** Raqué, Manuel, 2015-01-07

**Innovative Energetic Materials: Properties, Combustion Performance and Application** WeiQiang Pang, Luigi T. DeLuca, Alexander A. Gromov, Adam S. Cumming, 2020-07-04 This book focuses on the combustion performance and application of innovative energetic materials for solid and hybrid space rocket propulsion It provides a comprehensive overview of advanced technologies in the field of innovative energetic materials and combustion performance introduces methods of modeling and diagnosing the aggregation agglomeration of active energetic metal materials in solid propellants and investigates the potential applications of innovative energetic materials in solid and hybrid propulsion In addition it also provides step by step solutions for sample problems to help readers gain a good understanding of combustion performance and potential applications of innovative energetic materials in space propulsion This book serves as an excellent resource for researchers and engineers in the field of propellants explosives and pyrotechnics

*Theory of Periodic Conjugate Heat Transfer* Yuri B. Zudin, 2023-03-24 An original method of investigation of the conjugate conductive convective problem of periodic heat transfer is developed The novelty of the approach is that a particular conjugate problem is replaced by a general boundary value problem for the heat conduction equation in the solid Within the framework of the hyperbolic model of thermal conductivity the effect of self reinforcement of the degree of conjugation by increasing the period of oscillations is found The processes of hydrodynamics and heat exchange with periodic internal structure are considered periodic model of turbulent heat transfer hydrodynamic instability bubbles dynamics in liquid and model of evaporating meniscus The book is intended as a source and reference work for researchers and graduate students interested in the field of conjugate heat transfer

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