

Preface

This book presents recent developments in my research on heat transfer of laminar forced convection and its film condensation. It is a monograph on advanced heat transfer, provided for university postgraduate students as textbook, students in self-study, researchers and professors as an academic reference book, and engineers and designers as a scientific handbook. A primary goal is to present a new similarity analysis method to replace the traditional Falkner-Skan type transformation for a deep investigation in this book. This method is so important that it becomes a theoretical basis of this book. A secondary goal is to report a system of research developments for heat and mass transfer of laminar forced convection and its two-phase film condensation, based on the present new similarity analysis method.

The book includes three parts: (1) theoretical foundation, including presentation of basic conservation equations for laminar convection, review of Falkner-Skan transformation for laminar forced convection boundary layer, and creation of the new similarity analysis method related to laminar forced convection and its two-phase film condensation; (2) laminar forced convection, including a system of complete similarity mathematical models based on the new similarity analysis method, rigorous numerical results of velocity and temperature fields, and advanced research results on heat transfer with ignoring variable physical properties or viscous thermal dissipation, considering viscous thermal dissipation, and considering coupled effect of variable physical properties; and (3) laminar forced film condensation, including a system of complete similarity mathematical models based on the new similarity analysis method, rigorous numerical results of velocity, temperature, and concentration fields, and advanced research achievements on condensate heat and mass transfer. In the research of this book, the following difficult issues have been resolved. They are (i) creating the new similarity analysis method, (ii) developing the system of complete similarity mathematical models, (iii) rigorously dealing with the variable physical properties, (iv) obtaining the reliable numerical results with satisfying whole interfacial physical matching conditions for the forced convection film condensation, (v) clarifying the effect of noncondensable gas on interfacial vapour saturation temperature as well as heat and mass transfer of the film condensation of vapour–gas mixture, (vi) clarifying the coupled effects of temperature-dependent physical properties on heat transfer of laminar forced convection, (vii) clarifying the coupled effect of concentration and temperature-dependent physical

properties on heat and mass transfer of forced convection film condensation, (viii) creating a series of reliable prediction equations on heat and mass transfer for practical application, etc. Having resolved all above difficult issues demonstrates the scientific contributions of this book to extensive research on heat and mass transfer of laminar forced convection and its film condensation.

Obviously, all above difficult issues resolved in this book are big challenges encountered in my recent research. While the most significant challenge is how to clarify heat and mass transfer and create the related reliable prediction equations with consideration of various complicated physical factors including the coupled effect of variable physical properties, in order to realize theoretically reliable and convenient prediction of heat and mass transfer. For this purpose, all related variable physical properties are based on the experimental data, and rigorously dealt with in the complete similarity mathematical models in the system of related investigations of this book. On this basis, the theoretical research results of this book have their reliable application values.

In this book, all flows are taken on a horizontal flat plate for a research systemization. However, the present new similarity analysis method is suitable for general type of laminar forced convection and its film condensation. The research of this book has a spread space.

Here, I am very sincerely grateful to Professor Liangcai Zhong, Northeastern University, China, who provided his great help for development of the related mathematical models and numerical calculation. This book involves his significant contribution. I am heartily thankful to Professor B.X. Wang, my supervisor of my Ph.D. study from 1988 to 1991 in Tsinghua University, China, whose profound knowledge of the speciality, strict style of investigation, encouragement, and support enabled me to develop the challenging research. My respective friend, Mr. Sam Gelman gave up his holiday during the period of New Year going through parts of the manuscript. I would like to offer my sincere gratitude to him for all his help, support, hints, and valuable improvements.

I am so thankful for my wife Shihua Sun's sustained moral encouragements, which gave me a long-term power to persist in completing this book and carrying out the significant research work before that.

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