

Research Article

Opposing Mixed Convection Heat Transfer for Turbulent Single-Phase Flows

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Convection, wherein forced and natural convections are prominent, is known as mixed convection. Specifically, when a forced convection flow is downward, this flow is called opposing flow. The objectives of this study are to gain a comprehensive understanding of opposing flow mixed convection heat transfer and to establish the prediction methodology by evaluating existing correlations and models. Several heat transfer correlations have been reported related to single-phase opposing flow; however, these correlations are based on experiments conducted in various channel geometries, working fluids, and thermal flow parameter ranges. Because the definition of nondimensional parameters and their validated range confirmed by experiments differ for each correlation reported in previous studies, establishing a guideline for deciding which correlation should be selected based on its range of applicability and extrapolation performance is important. This study reviewed the existing heat transfer correlations for turbulent opposing flow mixed convection and the single-phase heat transfer correlations implemented in the thermal-hydraulic system codes. Furthermore, the authors evaluated the predictive performance of each correlation by comparing them with the experimental data obtained under various experimental conditions. The Jackson and Fewster, Churchill, and Swanson and Canton correlations can accurately predict all the experimental data. The effect of the difference in the thermal boundary conditions, i.e., uniform heat flux and uniform wall temperature, on the turbulent mixed convection heat transfer coefficient is not substantial. The authors confirmed that heat transfer correlations using the hydraulic-equivalent diameter as a characteristic length can be used for predictions regardless of channel-geometry differences. Furthermore, correlations described based on nondimensional dominant parameters can be used for predictions regardless of the differences in working fluids. The authors investigated the extrapolation performance of the mixed convection heat transfer correlations for a wide range of nondimensional parameters and observed that the Jackson and Fewster, Churchill, and Aicher and Martin correlations exhibit excellent extrapolation performance with respect to natural and forced convection flows, indicating that they can be applied beyond the parameter range validated experimentally.

1. Introduction

The rapid cooling of a reactor pressure vessel (RPV) wall embrittled owing to exposure to neutrons could propagate cracks, if they exist, in the wall because of induced thermal stresses. This event is called pressurized thermal shock

(PTS) and is one of the most severe loads that could act on a RPV wall. Loss of coolant accident (LOCA) in a pressurized water reactor (PWR) is the most important and commonly studied accident. During a LOCA, when the water inventory of the primary system decreases and water from the emergency core cooling system is supplied to the cold

Heat Transfer In Turbulent Mixed Convection

G. Bergeles, W. Rodi



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Heat Transfer in Turbulent Mixed Convection B. S. Petukhov, A. F. Poliakov, 1988 Broad coverage of buoyancy effects on convective heat transfer in duct flows Provides an immense quantity of experimental data deriving from active and excellent research in the USSR Acidic paper Annotation copyright Book News Inc Portland Or **Heat Transfer in Turbulent Mixed Convection** B. S. Petukhov, A. F. Poliakov, Brian Edward Launder, 1988-01-01 The monograph provides the first comprehensive account of buoyancy effects on convective heat transfer in duct flows It also makes available to a Western readership a vast quantity of Soviet experimental data not otherwise available The book will be valuable equally to the practicing engineer to assist in heat exchanger design and to the research worker concerned with how turbulent mixing is affected by buoyant forces *Heat Transfer in Turbulent Mixed Convection (translated from the Russian)*. Petukhov BS., 1988 **Convective Heat Transfer, Second Edition** Sadik Kakaç, Yaman Yener, 1994-12-16 Convective Heat Transfer presents an effective approach to teaching convective heat transfer The authors systematically develop the topics and present them from basic principles They emphasize physical insight problem solving and the derivation of basic equations To help students master the subject matter they discuss the implementations of the basic equations and the workings of examples in detail The material also includes carefully prepared problems at the end of each chapter In this Second Edition topics have been carefully chosen and the entire book has been reorganized for the best presentation of the subject matter New property tables are included and the authors dedicate an entire chapter to empirical correlations for a wide range of applications of single phase convection The book is excellent for helping students quickly develop a solid understanding of convective heat transfer Computation of Three Dimensional Turbulent Mixed Convection Boundary Layers Bahram Afshari, Stanford University. Thermosciences Division, 1989 Convective Heat Transfer, Third Edition Sadik Kakaç, Yaman Yener, Anchasa Pramuanjaroenkij, 2013-12-17 Intended for readers who have taken a basic heat transfer course and have a basic knowledge of thermodynamics heat transfer fluid mechanics and differential equations Convective Heat Transfer Third Edition provides an overview of phenomenological convective heat transfer This book combines applications of engineering with the basic concepts of convection It offers a clear and balanced presentation of essential topics using both traditional and numerical methods The text addresses emerging science and technology matters and highlights biomedical applications and energy technologies What's New in the Third Edition Includes updated chapters and two new chapters on heat transfer in microchannels and heat transfer with nanofluids Expands problem sets and introduces new correlations and solved examples Provides more coverage of numerical computer methods The third edition details the new research areas of heat transfer in microchannels and the enhancement of convective heat transfer with nanofluids The text includes the physical mechanisms of convective heat transfer phenomena exact or approximate solution methods and solutions under various conditions as well as the derivation of the basic equations of convective heat transfer and their solutions A complete solutions manual and

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Nuclear Safety, 1994 **Experimental and numerical studies on liquid metal cooled fast reactors** Songbai Cheng, Wenzhong Zhou, Long Gu, Hongli Chen, Di Yun, Koji Morita, Hidemasa Yamano, Shripad T. Revankar, 2023-03-03

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Rodi,2012-12-02 This book presents and discussses new developments in the area of turbulence modelling and measurements with particular emphasis on engineering related problems At present turbulence is one of the key issues in tackling engineering flow problems Powerful computers and numerical methods are now available for solving the flow equations but the simulation of turbulence effects which are nearly always important in practice is still in an unsatisfactory state and introduces considerable uncertainties in the accuracy of CFD calculations These and other aspects of turbulence modelling and measurements are dealt with in detail by experts in the field The resulting book is an up to date review of the most recent research in this exciting area **Heat Transfer** Naseem Uddin,2024-01-03 Heat Transfer A Systematic

Learning Approach presents valuable tools for understanding heat transfer mechanisms and provides a clear understanding of complex turbulent flows It gives a comprehensive introduction to topics of heat transfer including conduction convection thermal radiation and nanofluids Covering both traditional analytical models for canonical flows and modern turbulence modeling approaches for heat transfer the book discusses complex impinging jet flow phase change flows nanofluids and convective mass transfer flow The text includes numerous end of chapter problems to enhance student understanding and different solving approaches It offers the basic flow and energy analysis along with useful MAPLE code to facilitate the learning process The book is intended for senior undergraduate mechanical aerospace and chemical engineering students taking courses in heat transfer Instructors will be able to utilize a Solutions Manual Jupyter Notebook programmes and Figure Slides for their courses The eBook version includes the following enhancements Pop up glossary terms Hovering over a highlighted word will reveal the definition in a pop up bubble Video Videos are positioned appropriately within the text to enhance understanding and can be played paused and rewound using the integrated controls Quizzes Multiple choice quiz questions are provided at the end of each chapter to ensure that the reader has grasped key concepts **50 Years of CFD**

in Engineering Sciences Akshai Runchal,2020-03-09 Prof D Brian Spalding working with a small group of students and colleagues at Imperial College London in the mid to late 1960 s single handedly pioneered the use of Computational Fluid Dynamics CFD for engineering practice This book brings together advances in computational fluid dynamics in a collection of chapters authored by leading researchers many of them students or associates of Prof Spalding The book intends to capture the key developments in specific fields of activity that have been transformed by application of CFD in the last 50 years The focus is on review of the impact of CFD on these selected fields and of the novel applications that CFD has made possible

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Engineering Turbulence Modelling and Experiments Wolfgang Rodi, Ejup N. Ganić, 1990. This book brings together the experience of specialists on the modelling and measurements of turbulent flow. This multidisciplinary meeting was held to bring together workers in a wide range of engineering activities who employ common analytical and experimental methods in their estimation of structural response to turbulence. The results of the meeting are of world wide interest and will help to stimulate future research and analysis in this field.

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