## Contents

3.3 Turbulent Flow ......................................................... 41
  3.3.1 Parameters of the Turbulent Boundary Layer .............. 41
  3.3.2 Surface Heat Transfer: Experimental and Theoretical Data of Different Authors ................................. 45
  3.3.3 Effect of Approximation of the Radial Velocity Profile on Parameters of Momentum and Thermal Boundary Layers ........................................ 48
  3.3.4 Numerical Computation of Turbulent Flow and Heat Transfer for an Arbitrary Distribution of the Wall Temperature ........................................ 54

3.4 Generalized Analytical Solution for Laminar and Turbulent Regimes Based on the Novel Model for the Enthalpy Thickness ... 58

3.5 Inverse Problem of Restoration of the Wall Temperature Distribution at a Specified Arbitrary Power Law for the Nusselt Number ................................................................. 61
  3.5.1 Solution of the Problem ......................................... 61
  3.5.2 Limiting Case of the Solution .................................. 64
  3.5.3 Properties of the Solution for Temperature Head ........ 65
  3.5.4 Analysis of the Solution ......................................... 66

3.6 Theory of Local Modelling ......................................... 72
  3.6.1 Solution of the Problem ......................................... 72
  3.6.2 Other Interpretations ........................................... 74

4 Unsteady Laminar Heat Transfer of a Free Rotating Disk .......... 77
  4.1 Transient Experimental Technique for Measuring Heat Transfer over Rotating Disks ................................................. 77
  4.2 Self-Similar Navier–Stokes and Energy Equations ............... 79
  4.3 Exact Solution for Surface Heat Transfer of an Isothermal Rotating Disk ................................................................. 82

  4.4 Numerical Solution of an Unsteady Conjugate Problem of Hydrodynamics and Heat Transfer of an Initially Isothermal Disk 85
    4.4.1 Computational Domain and Grid ................................ 85
    4.4.2 Validation for Steady-State Fluid Flow and Heat Transfer ... 86
    4.4.3 Unsteady Fluid Flow and Heat Transfer ....................... 88

4.5 Unsteady Conjugate Laminar Heat Transfer of a Rotating Non-uniformly Heated Disk ............................................... 91
  4.5.1 Problem Statement ............................................... 91

  4.5.2 Self-Similar Solution of the Transient Laminar Convective Heat Transfer Problem ............................................... 92
  4.5.3 Solution of the Unsteady Two-Dimensional Problem of Heat Conduction in a Disk ............................................... 93
  4.5.4 Analysis of the Solutions for Unsteady Heat Conduction in a Disk ..................................................... 94
5 External Flow Imposed over a Rotating Disk

5.1 Rotation of a Disk in a Fluid Rotating as a Solid Body Without Imposed Radial Flow

5.1.1 Turbulent Flow

5.1.2 Laminar Flow

5.2 Accelerating Radial Flow Without Imposed External Rotation

5.2.1 Flow Impingement onto an Orthogonal Rotating Disk: Experimental and Computational Data of Different Authors

5.2.2 Turbulent Flow

5.2.3 Laminar Flow

5.3 Non-symmetric Flow over a Parallel Rotating Disk

6 Outward Underswirled and Overswirled Radial Flow Between Parallel Co-rotating Disks

6.1 Flow in the Ekman Layers

6.2 Radial Outflow Between Parallel Co-rotating Disks

6.2.1 Flow Structure, Experiments and Computations of Different Authors

6.2.2 Computation of the Radial Variation of the Swirl Parameter Using the Integral Method

6.2.3 Local Nusselt Numbers

6.2.4 Effect of the Radial Distribution of the Disk Surface Temperature

6.3 Effect of the Flow Overswirl

6.4 Aerodynamics and Heat Transfer in a Rotating-Disk Air Cleaner

7 Laminar Fluid Flow and Heat Transfer in a Gap Between a Disk and a Cone that Touches the Disk with Its Apex

7.1 General Characterization of the Problem

7.2 Navier–Stokes and Energy Equations in the Self-similar Form

7.3 Rotating Disk and/or Cone

7.3.1 Numerical Values of Parameters in the Computations

7.3.2 Cone Rotation at a Stationary Disk

7.3.3 Disk Rotation at a Stationary Cone

7.3.4 Co-rotating Disk and Cone

7.3.5 Counter-Rotating Disk and Cone

7.4 Radially Outward Swirling Flow in a Stationary Conical Diffuser

8 Heat and Mass Transfer of a Free Rotating Disk for the Prandtl and Schmidt Numbers Larger than Unity

8.1 Laminar Flow

xiii
8.2 Transitional and Turbulent Flows for the Prandtl or Schmidt Numbers Moderately Different from Unity ..................... 201
8.3 Transitional and Turbulent Flows at High Prandtl and Schmidt Numbers .................................................. 208
8.4 An Integral Method for Modelling Heat and Mass Transfer in Turbulent Flow for the Prandtl and Schmidt Numbers Larger than Unity .......................................................... 214
  8.4.1 Prandtl and Schmidt Numbers Moderately Different from Unity ................................................................. 214
  8.4.2 High Prandtl and Schmidt Numbers ................................. 217

References ................................................................. 225

Index ................................................................. 235
Convective Heat and Mass Transfer in Rotating Disk Systems
Shevchuk, I.V.
2009, XIX, 236 p. 116 illus., Hardcover
ISBN: 978-3-642-00717-0