Contents

Preface xi
ISROMAC-3 Committees xiii

TURBINE COOLING HEAT TRANSFER

Heat Transfer Analysis in Rotating Gas Turbine Components: Experimental Techniques and Non-Intrusive Diagnostics
S. Wittig 3

Transient Heat Analysis of Stator in Air-Cooled Turbine Generators
Y. Takai and W.-J. Yang 25

Full Coverage Film Cooling on a Suction Surface of a Gas Turbine Blade
S. Kikkawa and K. Sakaguchi 41

Development and Structure of a Film-Cooling Jet in a Turbulent Boundary Layer with Heat Transfer
C. S. Subramanian, P. M. Ligrani, J. G. Green, W. Doner, and P. Kaisuwan 53

Mean Temperature Measurements of Jets with a Crossflow for Gas Turbine Film Cooling Application
K. A. Thole, A. K. Sinha, D. G. Bogard, and M. E. Crawford 69

Heat/Mass Transfer and Flow Characteristics of Pin Fin Cooling Channels in Turbine Blades
S. C. Lau and A. Saxena 87

Numerical Evaluation of Single Central Jet for Turbine Disk Cooling
M. R. Subbaraman, A. H. Hadid, and P. K. McConnaughey 107

Heat Transfer in a Five-Pass Irregular Channel With and Without Pin-Fins
Y. Zhang, W. Gu, and J. C. Han 121

ROTATING SURFACES

Film Condensation on a Rotating Cone
S.-L. Chen and K. M. Hwang 131

Prediction of Rotating Disc Flow and Heat Transfer in Gas Turbine Engines
J. W. Chew 145
Heat Transfer Between Rotating Cylinders
  G. J. Hwang, D. K. Lin, and L. T. Chen 161

Experimental Study on Unsteady Convection in Rotating Drums with Inner Surface Heating
  W.-J. Yang and G. Kawashima 177

Three-Dimensional Laminar Convection in a Concentric Circular Annulus with Inner Cylinder Rotation
  H. E. Moghadam, W. Aung, R. Reiss, L. Thigpen, F. K. Tsou, and Y. N. Jeng 189

Film Thinning Process on a Rotating Disk
  T. Ohara, Y. Matsumoto, and H. Ohashi 209

Airflow Study in a Cylindrical Enclosure Containing Multiple Corotating Disks
  H.-M. Tzeng and J. E. Fromm 225

Numerical Study of Three-Dimensional Flow and Heat Transfer Between a Fixed Outer Cylinder and a Rotating Inner Cylinder with Cavities
  T. Hayase, J. A. C. Humphrey, and R. Greif 239

Flows of a Gas in an Abruptly Rotating Cylinder
  J. S. Park and J. M. Hyun 255

CURVED DUCTS AND ROTATING CHANNELS

Visualization of Centrifugal Instability Phenomena in Parallel, Converging, and Diverging Curved Channels
  K. C. Cheng and M. Takuma 273

Developing Turbulent Flow in a Curved Duct with Strong Secondary Motion
  C. Ma, F. Shi, and Z. Xu 287

Effects of Turn Region Treatments on Pressure Loss Through Sharp 180-Degree Bends
  C. W. Plevich and D. E. Metzger 301

Heat Transfer in Rotating Coolant Channels
  B. Wang, J. Zheng, and X. Ding 313

Fluid Flow and Heat Transfer in an Axially Rotating Pipe: The Rotational Entrance
  B. Weigand and H. Beer 325
FLOW IN PUMPS

Examination of Inlet Surging in Centrifugal Pumps
   A. Engeda and M. Rautenberg  343

Passage-Averaged Finite Element Prediction of Turbulent Pump Flows
   D. Pelletier, A. Garon, and R. Camarero  355

Prerotational Swirl Control of Propeller Pumps by Use of Inlet Guide Vanes with Mechanical Flaps
   M. Radke, H. E. Siekmann, and U. Stark  371

Experimental Study of the Flow Diffusion in a Pump Turbine at Different Operating Points
   M. Ubaldi and P. Zunino  389

ANALYTICAL AND NUMERICAL METHODS

A Review of Predictive Efforts for Transport Phenomena in Axial Flow Compressors
   A. J. Wennerstrom  407

Prediction of Viscous Flows in Rotating Machinery Using Navier-Stokes Techniques
   R. L. Davis  419

Two-Dimensional Transonic Flow Around VKI Turbine Cascade
   J. H. Baek, H. T. Chung, and K. Kuwahara  441

Numerical Simulation of Flow and Heat Transfer Near the Leading Edge of a Blunt Body
   R. W. Johnson  451

The Boundary Element Analysis of Steady-State and Transient Temperature Fields of Turbine Rotors and Discs
   S. H. Huang and Z. Y. Ma  467

Three-Dimensional Flow Analysis of a Four-Stage Transonic Axial Compressor with Inlet Guide Vanes
   X.-C. Huang, W.-M. Cheng, and Y.-S. Li  481

DESIGN AND DESIGN METHODS

The Dynamic Transfer Matrix of a Pump and Its Use in Pumping System Design
   U. Bolleter, A. Stirnemann, J. Eberl, and T. McCloskey  493
Design and Test of a Low Specific Speed Mixed-Flow Fan
   X.-C. Huang, X.-Y. Ma, and Y.-S. Li  505

A Fast CAE/CAD-Procedure for the Optimum Design of Arbitrary Impellers
   R. Schilling, Ch. Watzelt, and H. Haas  519

An Innovative Turbine Design for the Open-Cycle Ocean Thermal Energy Conversion
   T. Schobeiri  535

A New Development Direction of Nozzle Cascade for High-Pressure Stages of High-Load Steam Turbine
   Z.-G. Zhang and D.-M. Zhou  555

MULTIPHASE FLOW AND CAVITATION

Particle Dynamics and Erosion in Radial Turbine Guide Vanes
   H. Eroglu and W. Tabakoff  567

LDV Measurements of Air-Solid Two-Phase Flow in a Duct
   F. Shi, C. Ma, and Z. Xu  583

The Influence of the Gap Flow at the Impeller Inlet on Cavitation and Part Load Recirculation in a Centrifugal Pump
   B. Stoffel and G. Ludwig  597

The Effects of Droplet Size on Behavior of Nonequilibrium Flow in LP Wet Steam Turbine Stages
   W.-S. Wang, B. Sun, and M.-Z. Yu  613

Sustained Oscillations of Pumped Two-Phase Flow in a Closed Loop
   R. T. Hartlen, S. L. Barreca, R. G. Ko, and J. H. Kim  621

GENERAL TOPICS

A Revised View of Boundary Layer Transition on Compressor Blading
   J. P. Gostelow  639

Calculation of Transitional Boundary Layers with a Two-Layer Model of Turbulence
   N. Fujisawa, W. Rodi, and B. Schönung  651

Spectral Analysis of Unsteady Surface Pressure on a Pusher Propeller
   S. Farokhi  665

Rotor/Stator Flow Coupling in Turbomachines
   Y.-T. Lee, C. W. Jiang, and T. Bein  681