

International Conference on Enhanced, Compact and Ultra- Compact Heat Exchangers: Science, Engineering and Technology 2005

**Whistler, BC, Canada
11-16 September 2005**

ISBN: 978-1-60560-996-6

Printed from e-media with permission by:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571



Some format issues inherent in the e-media version may also appear in this print version.

Copyright© (2005) by Engineering Conferences International
All rights reserved.

Printed by Curran Associates, Inc. (2009)

For permission requests, please contact Engineering Conferences International
at the address below.

Engineering Conferences International
32 Broadway, Suite 314
New York, NY 10004

Phone: (212) 514-6760
Fax: (212) 514-6030

info@engconfintl.org

Additional copies of this publication are available from:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571 USA
Phone: 845-758-0400
Fax: 845-758-2634
Email: curran@proceedings.com
Web: www.proceedings.com

TABLE OF CONTENTS

SINGLE-PHASE FLOW AND HEAT TRANSFER FUNDAMENTAL STUDIES

| | |
|--|----|
| Thermal Management in Solid Oxide Fuel Cell Systems..... | 1 |
| <i>Hideo Yoshida, Hiroshi Iwai</i> | |
| Air-side Thermal-hydraulic Performance of an Offset-strip Fin Array at Reynolds Numbers Up to 120 000..... | 8 |
| <i>Gregory J. Michna, Anthony M. Jacobi, Rodney L. Burton</i> | |
| Flow Pattern Control in Microchannels by Means of Wall Surface Patterning..... | 15 |
| <i>K. Fushinobu, M. Nakata, M. Tokushige, K. Okazaki</i> | |
| Numerical Simulation and Experimental Study of Flow and Heat Transfer Characteristics of Shell Side Fluid in Shell-and-Tube Heat Exchangers | 21 |
| <i>Y. L. He, W. Q. Tao, B. Deng, X. Li, Y. Wu</i> | |
| Thermal Conductivity of a Nano-Structured Material..... | 35 |
| <i>K. Miyazaki, H. Tsukamoto, R. G. Yang, G. Chen</i> | |
| Natural Convection in Heat Exchangers - a New Incentive for More Compact Heat Exchangers?..... | 40 |
| <i>Thomas Aicher, Holger Martin</i> | |

SINGLE-PHASE FLOW AND HEAT TRANSFER FUNDAMENTAL STUDIES

| | |
|---|-----|
| Strouhal Numbers and Power Spectrums for Turbulent Fully-developed Flows in Rectangular Ducts with Spatially-periodic Interrupted-plate Inserts..... | 46 |
| <i>Alexandre Lamoureux, Lorena Camargo, B. Rabi Baliga</i> | |
| Entrance and Wall Conduction Effects in Parallel Flow Heat Exchangers | 54 |
| <i>Ahmad Fakheri, Hussien Al-Bakhit</i> | |
| Design Considerations for Compact Ceramic Offset Strip -fin High Temperature Heat Exchangers..... | 61 |
| <i>Sundaresan Subramanian, Valery Ponyavin, Clayton Ray DeLosier, Yitung Chen, Anthony E. Hechanova</i> | |
| Experimental and 3D Numerical Study of Air Side Heat Transfer and Pressure Drop of Slotted Fin Surface..... | 69 |
| <i>W. Q. Tao, Z. G. Qu, Y. L. He</i> | |
| Optimal Shape Design of Counter-Flow Primary Surface Recuperators | 78 |
| <i>Kenichi Morimoto, Yuji Suzuki, Nobuhide Kasagi</i> | |
| A Study of Channel Optimization in Cooling Spreader on a Smaller and Transient Heat Source..... | 86 |
| <i>K. Yazawa, M. Ishizuka</i> | |
| Heat Transfer and Fluid Flow in a Constructal Heat Exchanger..... | 94 |
| <i>V. Arun Prasad Raja, Tanmay Basak, Sarit Kumar Das</i> | |
| Performance Evaluation of Wire Spring Fin for Compact Plate-fin Heat Exchangers | 101 |
| <i>H. Iwai, S. Kawakami, K. Suzuki, J. Tsuji, T. Abiko</i> | |

SINGLE-PHASE MICRO & MESO CHES AND CFD

| | |
|--|-----|
| Micro and Meso Scale Compact Heat Exchangers in Electronics Thermal Management-a Review | 109 |
| <i>Yogendra Joshi, Xiaojin Wei</i> | |
| Role of Numerical Modeling in Compact Heat Exchanger Analysis | 127 |
| <i>P. Nithiarasu</i> | |

PLATE HEAT EXCHANGERS

| | |
|--|-----|
| An Experimental Investigation of the Port to Channel Flow and Pressure Distribution of the Smaller and Larger Plate Package Heat Exchangers | 139 |
| <i>Prabhakara Rao Bobbili, Bengt Sunden, Sarit Kumar Das</i> | |
| Experimental Study on Port to Channel Flow Distribution of Plate Heat Exchangers | 147 |
| <i>Fantu A. Tereda, N. Srihari, Sarit K. Das, Bengt Sunden</i> | |
| A Novel Type of All-stainless Steel Plate Heat Exchanger | 154 |
| <i>Per Sjodin, Christian Wolfe, Bjorn Wilhelmsson</i> | |
| Development of a New Type Heat Exchanger for Natural Refrigerant CO₂ Heat Pump Water Heaters..... | 160 |
| <i>Kazushige Kasai, Yutaka Shibata</i> | |

SINGLE-PHASE HEAT EXCHANGER DEVELOPMENT AND APPLICATIONS

| | |
|---|-----|
| High Temperature Heat Exchangers (HTHE)..... | 165 |
| <i>Bengt Sunden</i> | |
| High Temperature Compact Heat Exchangers: Performance of Advanced Metallic Recuperators for Power Plants | 178 |
| <i>D. Aquaro, M. Pieve</i> | |
| Compact Heat Exchangers for Microturbines..... | 187 |
| <i>R. K. Shah</i> | |
| Study on Compact Heat Exchanger for Vehicular Gas Turbine Engine | 198 |
| <i>S. Akama, Y. Himeji, A. Minami, T. Yoshikawa</i> | |

PHASE-CHANGE HEAT EXCHANGER FUNDAMENTAL STUDIES

| | |
|---|-----|
| Developments in Falling Film Type (downflow) Reboilers in the Air Separation Industry | 204 |
| <i>Vijayaraghavan S. Chakravarthy</i> | |
| An Experimental Study of Louver-fin Flat-tube Heat Exchanger Performance Under Frosting Conditions..... | 213 |
| <i>Yongfang Zhong, Anthony M. Jacobi</i> | |
| Two-phase Flow Across Small Diameter Split U-type Junctions | 221 |
| <i>I. Y. Chen, C. W. Tsai, B. C. Yang, C. C. Wang</i> | |
| A Fundamental Study on High Heat Flux Cooling using Subcooled Flow Boiling with Microbubble Emission | 228 |
| <i>Kiochi Suzuki, Ryuichiro Inagaki</i> | |
| Boiling from a Super-water-repellent Surface..... | 233 |
| <i>Y. Takata, S. Hidaka, M. Kohno</i> | |

| | |
|--|-----|
| A Rotating Shallow Cone Evaporator | 238 |
| <i>R. S. Jebson</i> | |
| The Use of Compact Heat Exchangers in Heat-integrated Distillation Columns..... | 244 |
| <i>J. A. Hugill, E. M. van Dorst</i> | |
| Heat Exchangers in Process Industry and Mini-and Microscale Heat Transfer..... | 252 |
| <i>Vishwas V. Wadekar</i> | |
| Gravity Effect on the Distribution of Refrigerant Flow in a Multi-circuited Condenser | 257 |
| <i>Jangho Lee, Moo Hwan Kim</i> | |
| Condensation from Gas-vapor Mixtures in Small Non-circular Tubes | 263 |
| <i>S. Krishnaswamy, H. S. Wang, J. W. Rose</i> | |
| Enhancement of Boiling on a Small Diameter Tube Due to Bubbles from Below..... | 269 |
| <i>Ebenezer Adom, Peter A. Kew, Keith Cornwell</i> | |

PHASE CHANGE HEAT EXCHANGER DEVELOPMENT AND APPLICATIONS

| | |
|---|-----|
| Aspects of Two-phase Flow Distribution at Header-channels Assembly | 277 |
| <i>Sang Yong Lee, Jun Kyoung Lee</i> | |
| Experimental Results with Novel Plasma Coated Tubes in Compact Tube Bundles..... | 291 |
| <i>D. Schafer, R. Tamme, H. Muller-Steinhagen, M. Muller</i> | |
| Frost Formation on Thermally Conductive Plastic Plain Plate | 297 |
| <i>Jang-Seok Lee, Sung Jhee, Jin-Koo Park, Jung-Soo Kim, Kwan-Soo Lee</i> | |
| Convective Flow Boiling of Refrigerant-oil Mixtures on an Enhanced Tube Bundle | 303 |
| <i>Nae-Hyun Kim, Tae-Ryong Shin, Eung-Ryul Lee</i> | |

FOULING IN HEAT EXCHANGERS

| | |
|---|-----|
| Effects of Heat Exchanger Flow Channel Variations on Pressure Drop and Effectiveness due to Manufacturing and Fouling..... | 310 |
| <i>Wei Shang, Robert W. Besant</i> | |
| Modified DLC-coatings for the Mitigation of Scaling on Heat Transfer Surfaces..... | 321 |
| <i>Wolfgang Augustin, Jiajie Zhang, Ingmar Bialuch, Timo Geddert, Stephan Scholl</i> | |

POSTER SESSION

| | |
|---|-----|
| The Manufacture of Micro Cross-flow Heat Exchangers by Selective Laser Melting..... | 330 |
| <i>S. Tsopanos, C. J. Sutcliffe, I. Owen</i> | |
| Simulation of Formation Mechanisms and Transport of Longitudinal Vortices in 3d Boundary Layer | 338 |
| <i>K. Khallaki, S. Russeil, B. Baudoin</i> | |
| Embedded Solid-state Cooling Layer Configurations in Power Electronics | 344 |
| <i>J. Dirker, J. D. van Wyk, J. P. Meyer</i> | |
| Effect of Corrugation Angle on the Hydrodynamic Behaviour of Power-law Fluids During a Flow in Plate Heat Exchangers | 351 |
| <i>Carla S. Fernandes, Ricardo P. Dias, J. M. Nobrega, Joao M. Maia</i> | |

| | |
|---|-----|
| Effect of Corrugation Angle on the Thermal Behaviour of Power-law Fluids During a Flow in Plate Heat Exchangers..... | 356 |
| <i>Carla S. Fernandes, Ricardo P. Dias, J. M. Nobrega, Joao M. Maia</i> | |

Author Index