

PROGRAM

Fifth International Conference

On

**Enhanced, Compact and Ultra-Compact Heat Exchangers:
Science, Engineering and Technology**

September 11-16, 2005

**The Westin Resort and Spa, 4090 Whistler Way
Whistler, British Columbia, Canada, V0N 1B4
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Conference Chair

Ramesh K. Shah

Rochester Institute of Technology
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Masaru Ishizuka

Toyama Prefectural University
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SUNDAY, SEPTEMBER 11, 2005

17:00 – 19:00 Registration
19:30 – 21:00 Dinner
21:00 – 22:00 Welcome Reception

MONDAY, SEPTEMBER 12, 2005

7:00 - 8:00 Breakfast

8:00 - 8:10 Welcome and Introduction

8:10 - 10:05 **Session 1: SINGLE-PHASE FLOW AND HEAT TRANSFER FUNDAMENTAL STUDIES – I**

Session Chair: Masaru Ishizuka, Toyama Prefectural University, Toyama, Japan

Keynote Lecture: Thermal Management in Solid Oxide Fuel Cell Systems, H. Yoshida and H. Iwai, Kyoto University, Kyoto, Japan

Air-Side Thermal Hydraulic Performance of an Offset-Strip Fin Array at Reynolds Numbers up to 120,000, G.J. Michna, A. M. Jacobi, R. L. Burton, University of Illinois at Urbana-Champaign, Urbana, IL, USA

Flow Pattern Control in Microchannels by Means of Wall Surface Patterning, K. Fushinobu, M. Nakata, M. Tokushige and K. Okazaki, Tokyo Institute of Technology, Tokyo, Japan

10:05 - 10:30 Coffee/Tea Break

10:30 - 12:30 **Session 2: SINGLE-PHASE FLOW AND HEAT TRANSFER FUNDAMENTAL STUDIES – II**

Session Chair: Ahmad Fakheri, Bradley University, Peoria, IL, USA

Keynote Lecture: Numerical Simulation and Experimental Study of Flow and Heat Transfer Characteristics of Shell Side Fluid in Shell-and-Tube Heat Exchangers, Y.L. He, W.Q. Tao, B. Deng, X. Li and Y. Wu, Xi'an Jiaotong University, Xi'an, Shaanxi, China

Thermal Conductivity of a Nano-Structured Material, K. Miyazaki¹, H. Tsukamoto¹, R.G. Yang¹, and G. Chen², ¹Kyushu Institute of Technology, Fukuoka, Japan, ²MIT, Cambridge, MA, USA

Natural Convection In Heat Exchangers – A New Incentive For More Compact Heat Exchangers, T. Aicher¹ and H. Martin², ¹Fraunhofer-Institut für Solare Energiesysteme ISE, Freiburg, Germany, ²Universität Karlsruhe (TH), Karlsruhe, Germany

Results of Experimental Research and Assessment of Rational Enhancement of Convective Heat Transfer in Rectangular Channels of Heat Exchange Finned Surfaces, V.Ya. Vassiliev, Astrakhan State Technical University, Astrakhan, Russia

12:30 - 13:30 Lunch

13:30 - 15:00 Networking/Informal Discussions/Free Time

15:00 – 15:30 Group Photo

15:30 – 16:00 Coffee/Tea Break

16:00 – 17:20 **Session 3: SINGLE-PHASE HEAT TRANSFER DESIGN DATA AND METHODS – I**
Session Chair: Hideo Yoshida, Kyoto University, Kyoto, Japan

Strouhal Numbers and Power Spectrums for Turbulent Fully-Developed Flows in Rectangular Ducts with Spatially-Periodic Interrupted-Plate Inserts, A. Lamoureux, L. Camargo and B. R. Baliga, McGill University, Montreal, Quebec, Canada

Vortex Heat Transfer Enhancement for Industrial Applications: Experimental and Numerical Study of Dimpled Wall in Rectangular Channel, Y. Chudnovsky¹, A. Kozlov¹, A. Maskinskaya², E. Sergievsky², ¹Gas Technology Institute, Des Plaines, Illinois, USA, ²Power Engineering Institute, Moscow, Russia

Enhancement of Heat Transfer in Compact Heat Exchangers with Oval Twisted Tubes, B.V. Dzyubenko and G.A. Dreitser, Moscow Aviation Institute, Moscow, Russia

17:20 – 17:40 Coffee/Tea Break

17:40 – 19:20 **Session 4: SINGLE-PHASE HEAT EXCHANGER DESIGN DATA AND METHODS – II**
Session Chair: Kazuyoshi Fushinobu, Tokyo Institute of Technology, Tokyo, Japan

Entrance and Wall Conduction Effects in Parallel Flow Heat Exchangers, A. Fakhri¹, and H. Al-Bakhit², ¹Bradley University, Peoria, IL, USA, ²Caterpillar Inc., Mossville, IL, USA

Heat Transfer Investigation In Tubes With Spiral Knurling, Yu.A. Kuzma-Kichta¹, P.A. Savelyev², A.K. Dobrovolsky¹, S.A. Koryakin¹, ¹Moscow Power Engineering Institute (Technical University), Moscow, Russia, ²Riga's Technical University, Riga, Latvia

Design Considerations for Compact Ceramic Offset Strip-Fin, High Temperature Heat Exchangers, S. Subramanian, V. Ponyavin, C.R. DeLosier, Y. Chen, A.E. Hechanova, University of Nevada, Las Vegas, USA

Experimental and 3D Numerical Study of Air Side Heat Transfer and Pressure Drop of Slotted Fin Surface, W.Q. Tao, Z.G. Qu and Y.L. He, Xi'an Jiaotong University, Xi'an, Shaanxi, China

19:20 **Dinner on your own**

TUESDAY, SEPTEMBER 13, 2005

7:00 - 8:00 Breakfast

8:00 - 10:00 **Session 5: SINGLE-PHASE MICRO & MESO CHEs AND CFD**
Session Chair: Sarit Kumar Das, Indian Institute of Technology Madras, Chennai, India

Keynote Lecture: Micro and Meso Scale Compact Heat Exchangers in Electronics Thermal Management – Review, Y. Joshi and X. Wei, Georgia Institute of Technology, Atlanta, GA, USA

Keynote Lecture: Role of Computational Fluid Dynamics (CFD) Studies in the Design of Compact Heat Exchangers, P. Nithiarasu, School of Engineering Civil and Computational Engineering Centre, University of Wales Swansea, Swansea, UK

Simulation and Design Tool for Microchannel Heat Exchangers, ¹R.A. Schwentker, ¹V. Aute, ¹R. Radermacher, K. Mercer², ¹Department of Mechanical Engineering, University of Maryland, College Park, MD, USA, ²Modine Manufacturing Company, Racine, WI, USA

10:00 - 10:30 Coffee/Tea Break

10:30- 12:30 **Session 6: POSTER SESSION**

Session Co-Chairs: Borris V. Dzyubenko, Moscow Aviation Institute, Moscow, Russia, and Hans Müller-Steinhagen, University of Stuttgart, Stuttgart, Germany

The Manufacture of Micro Cross-Flow Heat Exchangers by Selective Laser Melting, S. Tsopanos, C. J. Sutcliffe, I. Owen, The University of Liverpool, Liverpool, UK

The Heat Transfer Analysis of the Application of Ceramics Machining with Laser-assisted Machining Method, C-P. Kuo, C-W. Chang, and S-H. Chen, National Chung Cheng University, Chia-Yi, Taiwan

Investigation of the Local Heat Transfer: the Unique Capabilities of the Gradient Heat Flux Sensors, S. Z. Sapozhnikov, V. Y. Mitiakov and A. V. Mitiakov, State Polytechnic University of St.-Petersburg, Saint Petersburg, Russia

Mesoscale Analysis of Thermal Flow of Magnetic Fluids, Y. Xuan¹, Q. Li¹ and Z. Yang², ¹Nanjing University of Science and Technology, Nanjing, China, ²China University of Mining and Technology, Xuzhou, China

Numerical Simulation for Conjugated Heat Transfer in Concentric Tube Recuperator with Longitudinal Fins, M. Liu, M. Yang, Z. Xu and M. Lu, University of Shanghai for Science and Technology, Shanghai, PR. China

Simulation of Formation Mechanisms and Transport of Longitudinal Vortices In 3D Boundary Layer, K. Khallaki, S. Russeil and B. Baudoin, École Des Mines De Douai, Douai, France

Fluid Flow and Heat Transfer Characteristics for Laminar Crossflow of Air over Staggered Tube Banks, R. Rahmani¹, A. Ramezanpour¹, H. Shirvani¹ and, I. Mirzaee², ¹APU-DACS, Chelmsford, UK, ²Urmia University, Urmia, Iran

A Numerical Study in Optimum Arrangement of Staggered Tube Bundle Turbulence Cross Flow in Compact Heat Exchangers, A. Ramezanpour¹, H. Shirvani¹, R. Rahmani¹, and, I. Mirzaee², ¹APU-DACS, Chelmsford, UK, ²Urmia University, Urmia, Iran

Optimization of a Shell and Tube Refrigerant Direct Expansion (DX) Evaporator Using Genetic Algorithms, M. Valiya-Naduvath, M. Yanik and J. Judge, York International Corporation, York, PA 17403, USA

Modelling Heat and Mass Transfer in the Gas-Dropwise Turbulent Jet Flows with Phase Changes, B.M. Galitseisky, V.Yu. Shustrova, Moscow Aviation Institute, Moscow, Russia.

Embedded Solid-State Cooling Layer Configurations in Power Electronics, J. Dirker¹, J.D. van Wyk², and J.P. Meyer¹, ¹University of Pretoria, South Africa, ²Virginia Polytechnic Institute and State University, USA

Experimental Study on Enhancing Heat Transfer inside Tube with Longitudinal Vortex Generator, Z.L. Yang, Y. Li and C. Yang, South China University of Technology, Guangzhou, Guangdong, China

The Transient Conduction Model for Estimating the Thermal Performance of the Vapor Chambers, Y.S. Chen¹, K.H. Chien², T.C. Hung³ and B.S. Pei¹, ¹National Tsing Hua University, Hsinchu, Taiwan, ²Industrial Technology Research Institute, Taiwan, ³I-Shou University, Kaohsiung County, Taiwan

Effect of Corrugation Angle on the Hydrodynamic Behaviour of Power-Law Fluids during a Flow in Plate Heat Exchangers. C.S. Fernandes¹, R.P. Dias², J.M. Nóbrega¹, J.M. Maia¹, ¹University of Minho, Guimarães, Portugal, ² Polytechnic Institute of Bragança, Bragança, Portugal.

Effect of Corrugation Angle on the Thermal Behaviour of Power-Law Fluids during a Flow in Plate Heat Exchangers. C.S. Fernandes¹, R.P. Dias², J.M. Nóbrega¹, J.M. Maia¹, ¹University of Minho, Guimarães, Portugal, ² Polytechnic Institute of Bragança, Bragança, Portugal.

Compact Heat Exchangers for Hygienic and High Purity Water Applications, M.R. Nilsson, C. Wolfe, Alfa Laval, Lund, Sweden

Compact Heat Exchangers for High Temperatures, M.R. Nilsson, C. Wolfe, Alfa Laval, Lund, Sweden

Novel Plate Heat Exchanger Pattern Improves Heat Transfer Effectiveness, H. Kockum and L. Hallgren, Alfa Laval, Lund, Sweden.

Chimney Effect on Natural Air Cooling of Electronic Equipment under Inclination, M. Ishizuka, S. Nakagawa and Y. Kitamura, Toyama Prefectural University, Toyama, Japan

12:30 - 13:30 Lunch

13:30 - 15:30 Networking/Informal Discussions/Free Time

15:30 – 16:00 Coffee/Tea break

16:00 - 17:20 **Session 7: SINGLE-PHASE HEAT TRANSFER DESIGN DATA AND METHODS – III**
Session Chair: B. Rabi Baliga, McGill University, Montreal, Quebec, Canada

Design of Optimum Flow Field for Convection Heat Transfer Enhancement, J-A. Meng, Z-Y. Guo and Z-X. Li, Tsinghua University, Beijing, China

Optimal Shape Design of Counter-Flow Primary Surface Recuperators, K. Morimoto, Y. Suzuki, and N. Kasagi, The University of Tokyo, Tokyo, Japan

A Study of Channel Optimization in Cooling Spreader on a Smaller and Transient Heat Source, K. Yazawa¹ and M. Ishizuka², Sony Corporation, Tokyo, Japan¹, Toyama Prefectural University, Toyama, Japan²

17:20 – 17:40 Coffee/Tea Break

17:40 - 19:10 **Session 8: SINGLE-PHASE HEAT TRANSFER DESIGN DATA AND METHODS – IV**
Session Chair: Bengt Sundén, Lund Institute of Technology, Lund, Sweden

Numerical Studies on Mass and Thermodynamic Optimization of a Finned Channel with Conjugate Convection using Genetic Algorithms, K. Srivatsa, D. Rakshit and C. Balaji, Indian Institute of Technology-Madras, Chennai, India

Heat Transfer and Fluid Flow in a Constructal Heat Exchanger, V.A.P. Raja, T. Bassak and S. K. Das, Indian Institute of Technology Madras, Chennai, India

Performance Evaluation of Wire Spring Fin for Compact Plate-Fin Heat Exchangers, H. Iwai¹, S. Kawakami¹, K. Suzuki², J. Tsujii³ and T. Abiko³, ¹Kyoto University, Kyoto, Japan, ²Shibaura Institute of Technology, Saitama, Japan, ³Sumitomo Precision Products Co., LTD., Hyogo, Japan

19:10 - 20:00 Social

20:00 - 21:00 Dinner

WEDNESDAY, SEPTEMBER 14, 2005

7:00 - 8:00 Breakfast

8:00 - 10:00 **Session 9: PLATE HEAT EXCHANGERS**

Session Chair: Vishwas V. Wadekar, HTFS, Hyprotech UK Ltd , Harwell, Oxfordshire, UK

An Experimental Investigation of the Port to Channel Flow and Pressure Distribution of the Smaller and Larger Plate Package Heat Exchangers, B. P. Rao¹, B. Sundén¹ and S. K. Das², ¹Lund Institute of Technology, Lund, Sweden, ²Indian Institute of Technology Madras, Chennai, India.

Experimental Study on Port to Channel Flow Distribution of Plate Heat Exchangers, F. A. Tereda¹, N. Srihari¹, S. K. Das¹ and B. Sundén², ¹ Indian Institute of Technology Madras, Chennai, India., ²Lund Institute of Technology, Lund, Sweden

A Novel Type of All-Stainless Steel Plate Heat Exchanger, P. Sjödin¹, C. Wolfe¹, B. Wilhelmsson², ¹Alfa Laval Tumba AB, Tumba, Sweden, ²Alfa Laval Lund AB, Lund, Sweden

Development of a New Type Heat Exchanger for Natural Refrigerant CO₂ Heat Pump Water Heaters, K. Kasai, and Y. Shibata, Daikin Air-Conditioning R&D Lab. Ltd., Osaka, Japan.

10:00 - 10:30 Coffee/Tea Break

10:30- 12:30 **Session 10: SINGLE-PHASE HEAT EXCHANGER DEVELOPMENT AND APPLICATIONS**

Session Chair: Y. Takata, Kyushu University, Fukuoka, Japan

Keynote Lecture: High Temperature Heat Exchangers, B. Sundén, Lund Institute of Technology, Lund, Sweden

High Temperature Compact Heat Exchangers: Performance of Advanced Metallic Recuperators for Power Plants, D. Aquaro and M. Pieve, University of Pisa, Pisa, Italy

Compact Heat Exchangers for Microturbines, R.K. Shah, Rochester Institute of Technology, Rochester, NY, USA

Study on Compact Heat Exchanger for Vehicular Gas Turbine Engine, S. Akama, Y. Himeji, A. Minami, and T. Yoshikawa, Japan Defense Agency, Tokyo, Japan

12:30 - 15:30 Lunch on your own & Networking/Informal Discussions/Free Time

15:30 – 16:00 Coffee/Tea break

16:00 – 17:35 **Session 11: PHASE-CHANGE HEAT EXCHANGER FUNDAMENTAL STUDIES – I**

Session Chair: Sang Yong Lee, KAIST, Daejeon, South Korea

Keynote Lecture: Developments in Falling Film Type (Downflow) Reboilers in the Air Separation Industry, V.S. Chakravarthy, R.J. Jibb, J.H. Royal, M.J. Lockett, Praxair, Inc., Tonawanda, NY, USA

An Experimental Study of Louver-Fin Flat-Tube Heat Exchanger Performance under Frosting Conditions, Y. Zhong, A. M. Jacobi, University of Illinois at Urbana-Champaign, Urbana, IL, USA

Experimental Study of Pool Boiling on Micro-Pin-Fin Array Heat Sink in Saturated FC-72, C.K. Yu and D.C. Lu, National Chiao Tung University, Hsinchu, Taiwan

17:35 – 17:50 Coffee/Tea Break

17:50 – 19:30 **Session 12: PHASE-CHANGE HEAT EXCHANGER FUNDAMENTAL STUDIES – II**
Session Chair: Tassos G. Karayiannis, London South Bank University, London, UK

Two-phase Flow Across Small Diameter U-type Junctions, I. Y. Chen¹, C. W. Tsai¹,
B. C. Yang², C.C. Wang², ¹National Yunlin University of Science and Technology, Yunlin
Taiwan, ²Industrial Technology Research Institute, Hsinchu Taiwan

**A Fundamental Study on High Heat Flux Cooling using Subcooled Flow Boiling
with Microbubble Emission**, K. Suzuki and R. Inagaki, Tokyo University of Science,
Chiba, Japan

Boiling from a Super-Water-Repellent Surface, Y. Takata, S. Hidaka and M. Kohno,
Kyushu University, Fukuoka, Japan

A Rotating Shallow Cone Evaporator, R.S. Jebson, Massey University, New Zealand

19:30 - 20:00 Social

20:00 - 21:00 Dinner

THURSDAY, SEPTEMBER 15, 2005

7:00 - 8:00 Breakfast

8:00 - 15:30 Personal Time (Lunch at the hotel or box lunches)

15:30 - 16:00 Coffee/Tea Break

16:00 - 17:30 **Session 13: PHASE-CHANGE HEAT EXCHANGER FUNDAMENTAL STUDIES – III**
Session Chair: Stephan Scholl, Technical University of Braunschweig, Braunschweig, Germany

The Use of Compact Heat Exchangers in Heat-Integrated Distillation Columns, J.A. Hugill and E.M. van Dorst, Energy Research Centre of the Netherlands, Petten, The Netherlands.

Heat Exchangers in Process Industry and Mini-and Microscale Heat Transfer, V.V. Wadekar, HTFS, Aspen Technology Group, Milton Park, Oxfordshire, UK

Gravity Effect on the Distribution of Refrigerant Flow in a Multi-Circuited Condenser, J. Lee and M.H. Kim, Pohang University of Science and Technology, Pohang, South Korea;

17:30 – 17:50 Coffee/Tea Break

17:50 - 19:15 **Session 14: PHASE-CHANGE HEAT EXCHANGER FUNDAMENTAL STUDIES – IV**
Session Chair: Mahesh Valiya Naduvath, YORK International Corporation, York, PA, USA

Condensation from Gas-Vapour Mixtures in Small Non-Circular Tubes S. Krishnaswamy, H. S. Wang and J. W. Rose, Queen Mary, University of London, UK.

R134a Flow Boiling Heat Transfer in Small Diameter Tubes, X. Huo¹, Y.S. Tian², T.G. Karayiannis¹, South Bank University, London, UK, ²Aspentech Inc., Didcot, Oxfordshire, UK

Enhancement of Boiling on a Small Diameter Tube due to Bubbles from Below, E. Adom, P. A. Kew and K. Cornwell, Heriot Watt University, Edinburgh, UK

19:15 - 20:00 Social

20:00 - 21:30 **Conference Banquet**

FRIDAY, SEPTEMBER 16, 2005

7:00 - 8:00 Breakfast

8:00 – 10:15 **Session 15: PHASE-CHANGE HEAT EXCHANGER DEVELOPMENT AND APPLICATIONS**

Session Chair: Wen-Quan Tao, Xi'an Jiaotong University, Xi'an, Shaanxi, China

Keynote Lecture: Aspects of Two-Phase Flow Distribution at Header-Channels Assembly, S. Y. Lee and J. K. Lee, Korea Advanced Institute of Science and Technology, Science Town, Korea.

Experimental Results with Novel Plasma Coated Tubes in Compact Tube Bundles, D. Schäfer, R. Tamme, H. Müller-Steinhagen, M. Müller, German Aerospace and University of Stuttgart, Germany.

Frost Formation on Thermally Conductive Plastic Plain Plate, J-S. Lee¹, S. Jhee¹, J-K. Park¹, J-S. Kim² and K-S. Lee², ¹LG Electronics Inc, Seoul, Korea, ²Hanyang University, Seoul, Korea

Convective Flow Boiling of Refrigerant-Oil Mixtures on an Enhanced Tube Bundle, N-H. Kim, T-R. Shin and E-R. Lee, University of Incheon, Incheon, Korea

10:15 - 10:30 Coffee/Tea Break

10:30 - 11:45 **Session 16: FOULING IN HEAT EXCHANGERS**

Session Chair: Thomas M. Rudy, ExxonMobil Research Engineering, Fairfax, VA, USA

Effects of Heat Exchanger Flow Channel Variations on Pressure Drop and Effectiveness Due To Manufacturing and Fouling, W. Shang and R. W. Besant, University of Saskatchewan, Saskatoon, SK, Canada

Modified DLC-Coatings for the Mitigation of Scaling on Heat Transfer Surfaces W. Augustin¹, J. Zhang¹, I. Bialuch² and S. Scholl¹, ¹Technical University of Braunschweig, Germany, ²Fraunhofer Institute for Surface Engineering and Thin Films, Braunschweig, Germany.

Effect of Particle Ingestion on the Fouling Reduction and Heat Transfer Enhancement of a CFB Heat Exchanger, Y-D. Jun, K-B. Lee, S.Z. Islam, S-B.Ko and H-G. Kim, Kongju National University, Kongju, South Korea

11:45 - 12:00 Future Plans and Vote of Thanks

12:00 - 13:00 Lunch