

TENTATIVE CONFERENCE PROGRAM

**Fourth International Conference on
Compact Heat Exchangers and
Enhancement Technology for the Process
Industries**

**Fodele Beach Hotel
Crete, Greece**

September 28 – October 3, 2003

Conference Chair

Ramesh K. Shah

Rochester Institute of Technology
Rochester, New York, USA

Conference Co-Chairs

Alan W. Deakin

BP Chemicals
Sunbury, Middlesex, United Kingdom

Hiroshi Honda

Kyushu University
Fukuoka, Japan

Thomas M. Rudy

ExxonMobil Research and Engineering Company
Fairfax, Virginia, USA



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SUNDAY, SEPTEMBER 28, 2003

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

MONDAY, SEPTEMBER 29, 2003

- 7:00 - 8:00 Breakfast
8:00 - 8:15 Welcome and Introduction
8:15 - 10:00 **Session 1: SINGLE-PHASE FLOW AND HEAT TRANSFER FUNDAMENTAL STUDIES**
Session Chair: H. Honda, Kyushu University, Kasuga, Fukuoka, Japan.
- Keynote Lecture: Flow and Heat Transfer in Louvered and Offset-Strip Fin Arrays: The Effects of Vortex Shedding and Boundary-Layer Re-starting**
A.M. Jacobi, The University of Illinois, Urbana, IL, USA.
- Detailed Thermal and Flow Fields in a Rectangular Duct with Inclined Ribs**
X.F. Gao, L. Wang and B. Sundén, Lund Institute of Technology, Lund, Sweden.
- 3D Numerical Simulation on Laminar Heat Transfer and Fluid Flow Characteristics of Slitted Fin Surfaces: Investigation of Strip Location Effect**
Z.G. Qu, Y.L. He and W.Q. Tao, Xi'an Jiaotong University, Xi'an, China.
- 10:00 - 10:30 Coffee/Tea Break
10:30 - 12:30 **Session 2: SINGLE-PHASE FUNDAMENTAL AND AUGMENTATION STUDIES (cont'd)**
Session Chair: K. Suzuki
- Keynote Paper: Principle of Field Coordinated Enhancement of Single Phase Thermal Convection**
Z.Y. Guo¹, Z.X. Li¹, W.Q. Tao² and Y.L. He², ¹Tsinghua University, Beijing, China, ²Xi'an University, Xi'an, China.
- Experimental Study on Pressured Drop Through a Woven Screen Subjected to an Oscillating Flow**
Y.L. He and W.Q. Tao, Xi'an Jiaotong University, Xi'an, China.
- Visco-Elastic Fluid Flow Sweeping a Cavity between Rectangular Ribs**
H. Suzuki¹ and H. Usui², ¹Kobe University, Kobe, Japan, ²Kobe University, Kobe, Japan.
- Enhanced Heat Transfer Method "Breathing Effect" at Low Reynolds Number and Its Applications**
M. Fujii¹ and Y. Seshimo², ¹Kinki University, Wakayama, Japan, ²Mitsubishi Electric Corp., Wakayama, Japan.
- 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/Soft Drink Break

MONDAY, SEPTEMBER 29, 2003 (continued)

16:00 - 17:15 **Session 3: SINGLE-PHASE HEAT TRANSFER DESIGN DATA AND METHODS**
Session Chair: W. Q. Tao

Heat Transfer in Packed Beds from Pressure Drop - An Application of the L  v  que Analogy

H. Martin, Universit  t Karlsruhe (TH), Karlsruhe, Germany.

Heat Transfer Characteristics of Perforated Fin Heat Exchanger with Intense Turbulence

H. Yoshida, M. Saito, K. Tahara, and M. Kawasaki, Kyoto University, Kyoto, Japan.

Heat Transfer Performance of Each Row in Fin and Tube Heat Exchangers

M.K. Lee¹, T.J. Park¹, J.H. Jeong², Y.S. Lee³, Y.C. Kweon¹ and K.S. Chang¹, ¹Sunmoon University, Asan, Korea, ²Cheonan College of Foreign Studies, Cheonan, Korea, ³RRC-Advanced Climate Control Technology, Asan, Korea.

17:15 – 17:35 Coffee/Tea/Soft Drink Break

17:35 – 19:00 **Session 4: SINGLE-PHASE HEAT TRANSFER DESIGN DATA AND METHODS**
Session Chair: TBA

Air Side Thermal-Hydraulic Characteristics of Rectangular Finned-Tube Heat Exchangers with Elliptic Tubes

J.S. Leu¹, J.Y. Jang², S.L. Chen², and C.H. Tu², ¹Far East College, Tainan, Taiwan, ²National Cheng-Kung University, Tainan, Taiwan.

Modelling of Heat Transfer and Hydraulic Resistance of Turbulent Gas and Liquid Flow in Tubes with Circular Turbulizers

G.A. Dreitser and I.E. Lobanov, Moscow Aviation Institute (State Technical University), Russia.

Heat Transfer Enhancement in Short Rectangular Channels with Transverse Projections and Grooves

E.V. Dubrovsky¹ and V.Ya.Vasiliev², ¹Scientific and Research Institute for Tractors, Moscow, Russia, ²Astrakhan State Technical University, Astrakhan, Russia.

19:00 - 19:30 Social

19:30 - 20:30 Dinner

20:30 - 21:30 **Panel Discussion** –Concerns on the Use of CHEs in the Process Industries and Ways to Accelerate the Technology Development

Session Chair: A.W. Deakin, BP Chemicals, Sunbury, Middlesex, UK.

Panelists: TBA

TUESDAY, SEPTEMBER 30, 2003

7:00 - 8:00 Breakfast

8:00 - 10:00 **Session 5: SINGLE-PHASE HEAT EXCHANGER DEVELOPMENT & APPLICATION**
Session Chair: Z.Y. Guo

Keynote Paper: High Performance Recuperator for the Solid Oxide Fuel Cell – Micro Gas Turbine Hybrid System

K. Suzuki and H. Iwai, Kyoto University, Kyoto, Japan.

Compact Heat Exchangers for Fuel Cell Systems

R.K. Shah, Rochester Institute of Technology, Rochester, NY, USA.

Session 5: SINGLE-PHASE HEAT TRANSFER DESIGN DATA AND METHODS
(cont'd)

Generation of Longitudinal Vortices Using Surface Corrugations

J. Floryan, The University of Western Ontario, London, Ontario, Canada.

New Design Equations For Liquid/Solid Fluidized Bed Heat Exchangers

M. Aghajani^{1,4}, H. Müller-Steinhagen^{2,3} and M. Jamialahmadi⁴, ¹University of Surrey, Guildford, UK, ²University of Stuttgart, Stuttgart, Germany, ³DLR Institute for Technical Thermodynamics, Stuttgart, Germany, ⁴University of Petroleum Industry, Ahwaz, Iran.

10:00 - 10:30 Coffee/Tea Break

10:30- 12:30 **Session 6: POSTER PRESENTATIONS**
Session Chair: TBA

Heat Transfer Performance of a Wavy Channel and Related Turbulence Structure

K. Matsubara, H. Suto and M. Kobayashi, Niigata University, Niigata, Japan.

Heat Transfer Characteristics of Flows in Undulated Rectangular Duct for Micro Gas Turbine Recuperator

H. Iwai, K. Fuwa and K. Suzuki, Kyoto University, Kyoto, Japan.

Heat Transfer and Pressure Loss for Flows Inside Converging and Diverging Channels with Surface Concavity Shape Effects

R.S. Bunker¹, M. Gotovskii², M. Belen'kiy², B. Fokin², ¹General Electric Research Center, Niskayuna, NY, USA, ²Central Boiler and Turbine Institute, St. Petersburg, Russia.

Numerical Computation for the Natural Ventilation of Air from a Vertical Open Cylinder with a Magnetic Field

S. Nishida, M. Kaneda, T. Tagawa and H. Ozoe, Kyushu University, Kasuga, Japan.

PIV Visualizations of the Flow Structure Upstream of the Tubes in a Two-Row Plate-Fin-and-Tube Heat Exchanger

M. Nacer-bey, S. Russeil and B. Baudoin, Ecole des Mines de Douai, Douai, France.

Thermal Hydraulic Investigation of Metallic Foams for Compact and Multi-Functional Heat Exchanger

P. Tochon, S. Ferrouillat, A. Maréchal, and L. Rouillon, CEA-Greth, Grenoble, France.

Heat Transfer and Hydraulic Resistance in Compact Heat Exchangers with Helical Tubes in Longitudinal Flow

B.V. Dzyubenko and G.A. Dreitser, Moscow Aviation Institute (State Technical University), Moscow, Russia.

TUESDAY, SEPTEMBER 30, 2003 (continued)

Resonance Intensification of Heat Transfer in Oscillating Flows

B.M. Galitseyskiy, Moscow Aviation Institute, Moscow, Russia.

CFD Simulation on Natural Convection Circuit among Tube Bundle of Residual Heat Removal Exchanger

T.Z. Ming and W. Liu, Huazhong University of Science & Technology, Wuhan, China.

Thermal Efficiency of Compact Heat Exchangers Using Finned Pipes with Inclined Fins

I. Carvajal-Mariscal, F. Sanchez-Silva, E. Nuñez-Alfaro, M. Toledo Velazquez, National Polytechnic Institute, Upalm, Mexico.

Influence of Different Process Parameters on Vegetable Drying in Gas Fluidized Beds

D. Jež ek, B. Tripalo, M. Brnèæ, University of Zagreb, Zagreb, Croatia.

Improvement of Surface Wettability by Plasma Irradiation

Y. Takata, S. Hidaka, A. Yamashita and H. Yamamoto, Kyushu University, Fukuoka, Japan.

A Visual Study of Air-Water Two-Phase Flow in a Vertical Return Bend

I.Y. Chen¹, P.S. Huang¹, R. Hu² and C.C. Wang², ¹National Yunlin University of Science and Technology, Taiwan, ²Energy & Resources Laboratories, Industrial Technology Research Institute, Hsinchu, Taiwan.

Experimental Verification of a New Approach for Film Condensation Heat Transfer Enhancement of Ethylene Glycol Vapour

X.H. Ma, X.F. Chen, T. Bai and J.B. Chen, Dalian University of Technology, Dalian, China.

Heat Removal Augmentation in Steam Generating Channels With Swirled Flows

E.A. Boltenko, Electrogorsk Research and Engineering Center on NPP Safety, Moscow, Russia.

Nucleate Boiling Heat Transfer of Refrigerants R-134A and R-404A on Porous and Structured Surface Tubes

C.Y. Yang and C.F. Fan, National Central University, Taoyuan, Taiwan.

Studies Over Heat-Stressed State For Tunnel Type Turbine

A.V. Soudarev¹, A.A. Suryaninov¹, A.S. Molchanov¹, P. Avran², and L.Lelait², ¹Boyko Research – Engineering «Ceramic Heat Engines» Center (NIZ KTD)¹, St. Petersburg, Russia, ²European Institute for Energy Research (EIFER), Karlsruhe, Germany.

Efficiency Analysis of Energy Utilization in Heat-Mass Transfer Machines

V.T. Volov, Samara Scientific Center of the Russian Academy of Science, Samara, Russia.

Enhanced Performance of Vertical Thermosyphon Reboilers Through Tube Inserts,

B. Rumpf¹ and S. Scholl², ¹BASF AG, Ludwigshafen, Germany, and ²Technical University Braunschweig, Braunschweig, Germany.

Loss Measurements with Particle Image Velocimetry: Application to Processing Industries

G. F. Naterer and O. B. Adeyinka, University of Manitoba, Winnipeg, Manitoba, Canada

TUESDAY, SEPTEMBER 30, 2003 (continued)

12:30 - 13:30 Lunch

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

15:30 - 16:00 Coffee/Tea/Cola Break

16:00 - 17:20 **Session 7: SINGLE-PHASE HEAT EXCHANGER DEVELOPMENT & APPLICATION**

Session Chair: N. Kasagi

Performance Evaluation of Two Kinds of Heat Exchangers by Using Water Solutions with Flow Drag Reduction Surfactant

N. Haruki¹, H. Inaba¹, A. Horibe¹, N. Furumoto¹, M. Kawai¹, T. Nakata² and K. Sato²,
¹Okayama University, Okayama, Japan, ²Toho Chemical Industry Co., LTD, Yokohama, Japan.

A Heat and Mass Transfer Analysis of Cross-Flow Air-to-Air Total Heat Exchangers Made of Moisture-Permeable Paper

Y.C. Lee, M.S. Jeng, C.Y. Huang, J.C. Perng and C.H. Lan, Energy & Resources Laboratories, Industrial Technology Research Institute, Hsinchu, Taiwan.

Semicircular Heat Exchangers

W.R. Da Veiga¹ and J.P. Meyer², ¹Rand Afrikaans University, Auckland Park, South Africa, ²University of Pretoria, Pretoria, South Africa.

17:20 – 17:40 Coffee/Tea/Soft Drink Break

17:40 - 19:00 **Session 8: SINGLE-PHASE HEAT EXCHANGER DEVELOPMENT & APPLICATION**

Session Chair: M. Ishizuka

Optimal Design and Assessment of High Performance Micro Bare-Tube Heat Exchangers

N. Kasagi¹, Y. Suzuki¹, N. Shikazono¹ and T. Oku², ¹The University of Tokyo, Tokyo, Japan, ²Nissan Motor Co., Ltd., Atsugi, Japan.

Experimental and Theoretical Investigations of a Pilot Compact Heat Exchanger for Heat Recovery at the Hamburger Aluminium Werk GmbH

J. Eiden¹, C.N. Ranong, J. Hapke¹ and E. Sturm², ¹Technical University of Hamburg, Hamburg, Germany, ²Hamburger Aluminium Werk GmbH, Hamburg, Germany.

Flexible Heat Exchange Solutions Fit for Lifetime Operation of Oil & Gas Production Facilities

E. Sellman, Alfa Laval Inc, Houston, TX, USA.

19:00 - 20:00 Social

20:00 - 21:00 Dinner

WEDNESDAY, OCTOBER 1, 2003

7:00 - 8:00 Breakfast

8:00 - 10:00 **Session 9: PHASE-CHANGE HEAT TRANSFER FUNDAMENTAL STUDIES**
Session Chair: V.V. Wadekar, HTFS, Hyprotech UK Ltd, Harwell, UK.

Keynote Paper: Flow Patterns during Condensation in Smooth and Micro-Fin Tubes

J. P. Meyer and L. Liebenberg, University of Pretoria, Pretoria, South Africa.

Heat and Mass Transfer on Teflon Coated Tubes Used for Latent Heat Recovery

J.H. Lee, K.G. Cho, T.J. Kim, H.D. Kim, and M.H. Kim, Pohang University of Science and Technology, Pohang, Korea.

Subcooled Flow Boiling of Water in Narrow Vertical Channels

J. Shuai, R. Kulenovic and M. Gröll, Universität Stuttgart, Stuttgart, Germany.

Visualizations of Pool Boiling of Propane/Iso-Butane Mixtures on an Enhanced Tube

Y. Chen, M. Gröll, R. Mertz, R. Kulenovic, University of Stuttgart, Stuttgart, Germany.

10:00 - 10:30 Coffee/Tea Break

10:30- 12:30 **Session 10: PHASE-CHANGE HEAT TRANSFER FUNDAMENTAL STUDIES**
Session Chair: TBA

Branching of Two-Phase Flow from a Vertical Header to Horizontal Parallel Channels

J.K. Lee and S.Y. Lee, Korea Advanced Institute of Science and Technology, Science Town, Daejeon, Korea.

Flow and Heat Transfer Characteristics of a Natural Circulation Cooling System for Electronic Components

H. Honda and J.J. Wei, Institute of Advanced Material Study, Kyushu University, Kasuga, Japan.

Enhanced Condensation of CFC113 on a Horizontal Wire-Wrapped Tube

A. Briggs, H. S. Wang, T. Murase and J. W. Rose, Queen Mary, University of London, London, UK.

Condensate Retention and Dynamic Drainage from the Air-Side Surface of Automotive-Style Heat Exchangers

J. Kaiser, Y. Zhong, A.M. Jacobi, C. Zhang, and H. Hu, The University of Illinois, Urbana, IL, USA.

12:30 - 13:30 Lunch

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

15:30 - 16:00 Coffee/Tea/Soft Drink Break

WEDNESDAY, OCTOBER 1, 2003 (continued)

16:00 - 17:20 **Session 11: VAPORIZATION AND CONDENSATION AUGMENTATION AND DATA**
Session Chair: TBA

Visual Observations of the Frost Formation in Fin Arrays

C.C. Wang¹, S.J. Fan², W.J. Sheu² and Y.J. Chang¹, ¹Energy & Resources Laboratories, Industrial Technology Research Institute, Hsinchu, Taiwan, ²National Tsing Hua University, Hsinchu, Taiwan.

Development of a New High Density Package Cooling Technology Using Low Melting Point Alloys

M. Ishizuka, Toyama Prefectural University, Kosugi, Japan.

An Extension of the Flow Boiling Correlation to Transition, Laminar and Deep Laminar Flows in Minichannels and Microchannels

S.G. Kandlikar and P. Balasubramanian, Rochester Institute of Technology, Rochester, New York, USA.

17:20 – 17:40 Coffee/Tea/Cola Break

17:40 - 19:20 **Session 12: VAPORIZATION AND CONDENSATION AUGMENTATION AND DATA**
Session Chair: Y.S. Lee

Some Investigations on Two-Phase Upward Flow in Small Channels at Small Mass Fluxes

T. Hecht, Linde Engineering, Hoellriegelskreuth near Munich, Germany.

Modelling of Laminar Film Reflux Condensation in an Inclined Small Diameter Tube and Experimental Verification

S. Fiedler¹ and H. Auracher², ¹Degussa AG, Hanau, Germany, ²TU Berlin, Berlin, Germany.

Development of Plasma Spray-Coated Tubes for Compact Evaporator

H. Asano¹, D. Schäfer², E. Bouyer² and H. Müller-Steinhagen^{2, 3}, ¹Kobe University, Kobe, Japan, ²German Aerospace Centre (DLR), Stuttgart, Germany, ³University of Stuttgart, Stuttgart, Germany.

Experimental Study on R-407C Evaporation Heat Transfer Characteristics in Plate and Shell Heat Exchanger

J.H. Park¹, Y.S. Kim², ¹Department of Refrigeration and Air-conditioning Engineering, PuKyong National University, Busan, Korea, ²PuKyong National University, Busan, Korea.

19:20 - 20:00 Social

20:00 - 21:00 Dinner

THURSDAY, OCTOBER 2, 2003

- 7:00 - 8:00 Breakfast
- 8:00 - 15:30 Personal Time (Lunch at the hotel or box lunches)
- 15:30 - 16:00 Coffee/Tea/Cola Break
- 16:00 - 17:30 **Session 13: PHASE-CHANGE HEAT EXCHANGER DEVELOPMENT AND APPLICATIONS**
Session Chair: TBA

Keynote Lecture: Compact Heat Exchangers as Chemical Reactors

S.W. Churchill, The University of Pennsylvania, Philadelphia, PA, USA.

Ultra Thin and Light Weight RS Evaporator

H. Shimanuki, T. Nakamura, I. Kuroyanagi, S. Kamiya and T. Ohara, Denso Corporation, Kariya, Japan.

Advanced and High Performances Heat Exchangers for the Gas Processing Industries

B. Thonon, CEA-Greth, Grenoble, France.

- 17:30 – 17:50 Coffee/Tea/Cola Break
- 17:50 - 19:15 **Session 14: PHASE-CHANGE HEAT EXCHANGER DEVELOPMENT AND APPLICATIONS (cont'd) and TURBULENT FLOW**
Session Chair: C.C. Wang

Development of Aluminum Micro Channel Condenser for Air Conditioners

Y.C. Sa, Y.J. Hwang and B.Y. Chung, Digital Appliance Research Laboratory, LG Electronics Inc., Seoul, Korea.

Modelling of the Fluid Distribution in a Parallel PFHE Arrangement for the Liquefin LNG Process

M. Rolland, B. Fischer, G. Ferschneider and T. Gauthier, Institut Français du Pétrole, Vernaison, France.

Heat Transfer at Turbulent Separated Flow in Models of Compact Heat Exchanger

V.I. Terekhov, Russian Academy of Sciences, Siberian Branch, Novosibirsk, Russia.

- 19:15 - 20:00 Social
- 20:00 - 21:30 Conference Banquet

FRIDAY, OCTOBER 3, 2003

7:00 - 8:00 Breakfast

8:00 - 9:25 **Session 15: PHASE-CHANGE HEAT EXCHANGER DEVELOPMENT AND APPLICATIONS (cont'd)**
Session Chair: M.H. Kim

Thermal and Hydraulic Performance of Plate Heat Exchangers as Condensers
L. Wang and B. Sundén, Lund Institute of Technology, Lund, Sweden.

Condensation of Pure Fluids and Mixtures of Process Fluids in Compact Welded and Spiral Heat Exchangers

B. Thonon¹, R. Christensen² and F. Chopard³, ¹CEA-Greth, Grenoble, France, ²Alfa-Laval, Sweden, and ³Alfa-Laval, France

A Model for Design of a Newly Developed Melting-Freezing Rotating Device Transferring Heat from a Heat Source to a Heat Sink

S. Lin¹, T.F. Chen¹, and Z. Jaing², ¹Concordia University, Montreal, Quebec, Canada, ²Flomerics Inc., Southborough, MA, USA.

9:25 - 9:50 Coffee/Tea Break

9:50 - 10:50 **Session 16: FOULING IN HEAT EXCHANGERS and TURBULENT FLOW**
Session Chair: H. Müller-Steinhagen, University of Stuttgart, Stuttgart, Germany.

Combating Heat Exchanger Fouling and Corrosion Phenomena in Process Waters

K.D. Demadis, University of Crete, Crete, Greece.

Reduce Fouling and Downtime using Helixchanger[®] Heat Exchangers

K.S. Chunangad¹, B.I. Master¹, L. Curcio², and V. Pushpanathan¹, ¹ABB Lummus Heat Transfer, Bloomfield, NJ, USA, ²ExxonMobil R & E, Bloomfield, NJ, USA.

10:50 - 11:50 **Session 17: Open Discussion**
Session Chair: R.K. Shah, Delphi Harrison Thermal Systems, Lockport, NY, USA.

Prioritizing the Efforts to Accelerate the Technology

11:50 - 12:00 Future Plans and Vote of Thanks

12:00 - 13:00 Lunch