

PROGRAM

Sixth International Conference

on

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

September 16-21, 2007

Seminaris SeeHotel
An der Pirschneide 40 - Potsdam, Germany

Conference Chair

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Subros Ltd.
New Delhi, India

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SUNDAY, SEPTEMBER 16, 2007

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

NOTES

- **Please observe “No Smoking” at ECI technical sessions, meals and social hours.**
- **Speakers should allow time at the end of their presentation for questions and discussion.**
- **Please silence your cell phone during technical sessions.**
- **All cameras, camera phones, audio, video and other recording devices are prohibited from technical sessions and poster sessions.**

MONDAY, SEPTEMBER 17, 2007

07:00 - 08:00 Breakfast

08:00 - 08:10 Welcome and Introduction

08:10 - 10:05 **Session 1: RECENT DEVELOPMENTS IN HEAT EXCHANGERS STUDIES**

Session Chair: V V Wadekar, HTFS, Aspen Technology, UK

Guest Lecture: Thermal-Hydraulic Phenomena in Microchannels with High Fluxes A.E. Bergles, Rensselaer Polytechnic Institute, Troy, NY, USA.

Heat Transfer during Annular Film Condensation in Microchannels: Calculations for R152a, R134a, R22, R410a, Propane, Ammonia and Carbon Dioxide

H.S. Wang¹, J. Ding² and J.W. Rose¹, ¹University of London, London, UK, ²Sun Yat-Sen University, Guangzhou, China

LMPD – A New Concept in the Analysis of the Flow Distribution in Parallel Channels of Plate Heat Exchangers

P.R. Bobbili¹, B. Sunden², S.K. Das³, ¹Hariot-Watt University, Edinburgh, UK, ²Lund University, Lund, Sweden, ³Indian Institute of Technology Madras, Chennai, TN, India

10:05 - 10:30 Coffee/Tea Break

10:30 - 12:30 **Session 2: SINGLE-PHASE HEAT TRANSFER ENHANCEMENT**

Session Chair: Y Takata, Kyushu University, Japan

Heat Transfer Enhancement with Small Shaped Protrusions Machined on Flat Plates, H. Iwai, M. Saito, H. Yoshida and M. Hiramatsu, Kyoto University, Kyoto, Japan

Turbulent Heat Transfer Performance of a Novel Enhanced Tube

J-A Meng, X-W Li, Tsinghua University, Beijing, P.R. China

Effect of Micro Structured Surfaces on Spray Cooling Heat Transfer

C. Sodtke, P. Stephan, Darmstadt University of Technology, Darmstadt, Germany

Heat Transfer Enhancement and Pressure Loss in a Triple Pipe Heat Exchanger

T. Matsunaga¹, M. Tada² and J. Kimura², ¹Kurume National College of Technology, Japan, ²Izumi Food Machinery Co., Ltd, 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 Break

16:00 – 17:00 **Session 3: MEASUREMENT TECHNIQUES FOR HEAT EXCHANGERS**

Session Chair: B. Sunden, Lund University, Sweden

Analysis of the Heat Distribution in a Tube Bank with Use of the Electrochemical Technique

K. Siejka, R. Ulbrich, Opole University of Technology, Opole, Poland

The Application of DPIV and DIP in the Measurements of the Flow along Tube Bundle

D. Zając, J. Guziałowska, R. Ulbrich, Opole University of Technology, Opole, Poland

MONDAY, SEPTEMBER 17, 2007 (continued)

17:00 – 17:20 Stretch Break

17:20 – 19:20 **Session 4: SINGLE-PHASE HEAT TRANSFER ENHANCEMENT WITH VORTEX FLOW**
Session Chair: J.W. Rose, University of London, UK

Experimental and Numerical Investigations of Heat Transfer in Complex Internal Flows with Vortex Inducing Elements - Introduction to a Joint Project and Some Results

U. Ahrend¹, S. Freund², M. Henze³, J. Koehler¹, ¹Institute for Thermodynamics, Technical University Braunschweig, Braunschweig, ²Institut fuer Thermodynamik, Helmut-Schmidt-Universitaet der Bundeswehr, Hamburg, ³Institut fuer Thermodynamik der Luft- und Raumfahrt, Universitaet Stuttgart, Stuttgart, Germany

Heat Transfer in Complex Internal Flows – Wedge Shaped Vortex Generators

M. Henze, C. F. Dietz, B. Weigand, J. von Wolfersdorf, O. Neumann, Institute of Aerospace Thermodynamics, Universität Stuttgart, Stuttgart, Germany

Flow and Heat Transfer Investigations behind Vortex Inducing Elements as Benchmark for Complex Turbulence Models

C. F. Dietz, M. Henze, O. Neumann, J. von Wolfersdorf, B. Weigand, Institute of Aerospace Thermodynamics, Universität Stuttgart, Stuttgart, Germany

Local Heat Transfer Coefficients at Aerodynamic Vortex Generators Measured with Temperature Oscillation IR Thermography

S. Freund, S. Kabelac, Institute for Thermodynamics, Helmut-Schmidt-University of the Federal Armed Forces, Hamburg, Germany

19:20 – 21:00 Dinner followed by

21:00 -22:00 Social Hour

TUESDAY, SEPTEMBER 18, 2007

07:00 - 08:00 Breakfast

08:00 - 10:00 **Session 5: COMPACT HEAT EXCHANGER DESIGN DATA**

Session Chair: A.E. Bergles, Rensselaer Polytechnic Institute, USA

Performance Characteristics of a Range of Multi-louvered Corrugated Fin and Flat Tube Heat Transfer Surfaces

J.P. Brakell¹, P. Kanefsky² and T. Cowell³, ¹KBR Ltd., UK, ²Ford Motor Company, USA, ³University of Brighton, Brighton, UK

Thermo-Hydraulic Characteristics of Inclined Louvered Fins

C. T'Joene, A. Willockx, H. J. Steman, M. De Paepe, Ghent University, Ghent, Belgium

Numerical Study of Flow Patterns of Compact Plate-Fin Heat Exchangers and Generation of Design Data for Offset Strip and Wavy Fins

Ch. Ranganayakulu¹, L. Sheik Ismail¹, R.K. Shah², ¹Aeronautical Development Agency, Bangalore, India, ²Subros Limited, Noida, UP, India.

Research and Development of High-Performance Compact Finless Heat Exchanger

N. Shikazono¹, D. Okawa¹, M. Kobayashi¹, N. Kasagi¹, T. Waki², I. Kandori³ and S. Hataya⁴, ¹The University of Tokyo, Tokyo, Japan, ²Waki Factory, Inc., Saitama, Japan, ³Kandori Weld Techno Industry, Aichi, Japan, ⁴Iwamoto, Co., Ltd., Tokyo, Japan

10:00 - 10:30 Coffee/Tea Break

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

Session Co-Chairs: TBA

- 1. Heuristic Modeling of Heat Exchange in Microreactors Using Artificial Neural Networks** P. Woehl¹, M. Moreno¹, C.W. Tanner², E.D. Lavric¹, ¹Corning SAS, Avon, France, ²Corning Inc., Corning, NY, USA
- 2. Intensification of Heat Transfer in Heat Exchangers with Helical Tubes** B.V. Dzyubenko, A.S. Myakochin, E.N. Nikiporets, V.V. Chervakov, Moscow Aviation Institute, Moscow, Russia
- 3. Numerical Analysis of Entropy Production of Louvered Fin Heat Exchanger** J. Herpe, S. Russeil, D. Bougeard, Ecole des Mines de Douai, Douai Cedex, France
- 4. Mechanism of Development of Rational Enhancement of Heat Transfer Process in Rectangular Ducts for Extended Surfaces** V. Ya. Vasilyev, Astrakhan State Technical University, Astrakhan, Russia
- 5. Modeling and Parametric Study of a Compact Ceramic High Temperature Heat Exchanger and Chemical Decomposer for Hydrogen Production** V. Ponyavin¹, Y. Chen¹, A.E. Hechanova¹, M. Wilson², ¹University of Nevada, Las Vegas, USA, ²Ceramatec, Inc., Salt Lake City, USA
- 6. Experimental Modeling of the Separated Flow and the Heat Transfer Enhancement behind a Flat Rib Installed at an Angle toward the Free Stream** V.I. Terekhov, N.I. Yarygina, Ya. I. Smulsky, Institute of Novosibirsk, Novosibirsk, Russia
- 7. Numerical Investigation of the Effect of Geometrical Parameters on Forced Convection Heat Transfer in Coil-in-Shell Heat Exchanger**, H. Mirgolbabaei¹, H. Taherian², ¹Khajenasir University of Technology, Tehran, Iran, ²Mazandaran University, Babol, Iran

TUESDAY, SEPTEMBER 18, 2007 (continued)

- 8. Branching Fluid Networks for Ultra-Compact Heat Removal**
R. M. Moreno and Y-X Tao, Florida International University, Miami, FL, USA
- 9. Compact Electrohydrodynamic Heat Exchangers for Distillation**
M.K. Bologna, E.P. Maximuk, S.P. Condratenco, Institute of Applied Physics, Kishinau, Moldova
- 10. Heat Exchangers Modification for Heat Supply**
Yu. A. Kuzma-Kichta¹, A. S. Sedlov¹, D. D. Kavkaev¹, D.D. Lavkaev¹, M.V. Fedorov¹, M.V. Fedorov², D. A. Barshak², ¹Moscow Power Engineering Institute, Moscow, Russian, ²Mosenergo Company, Moscow, Russia
- 11. Characterisation of a Miniature Low Profile Cooling Solution for Portable Electronics**, V. Egan, P. Walsh, E. Walsh, R. Grimes, Stokes Research Institute, University of Limerick, Limerick, Ireland
- 12. Aerodynamic Performance of Radial Flow Fans for Low Profile Heat Sinks**
R. Grimes, E. Walsh, P. Walsh, V. Egan, University of Limerick, Limerick, Ireland
- 13. Rotor and Heat Sink Aerodynamic and Thermal Interaction in Low Profile Thermal Management Solutions**
E.J. Walsh, P. Walsh, C. Bigerel, R. Grimes, and V. Egan, University of Limerick, Ireland.
- 14. Effect of Thermal Management of Pt-Based PEFC Catalyst**
K. Fushinobu, N. Miki, J. Murai, and K. Okazaki, Tokyo Institute of Technology, Tokyo, Japan
- 15. Fundamental Study on Simple Measuring Method of Thermal Conductivity of Silicone Grease and Evaluation of Its Thermal Resistance at Contacting Interface with Rough Surface**
T. Tomimura¹, S. Nomura¹, M. Ishizuka², ¹Kyushu University, Kyushu, Japan, ²Toyama Prefectural University, Toyama, Japan
- 16. Dimensionless Correlations of Frost Properties on a Cold Cylinder Surface**
J-S Kim, D-K Yang, and K-S Lee, Hanyang University, Seoul, Korea
- 17. Sensitivity Analysis on Thermal Sizing of a Lab-Scale SO₂ Decomposer for Nuclear Hydrogen Production**
C-S. Kim, S-D. Hung, Y-W. Kim, W-J. Lee, J-W. Chang, Korea Atomic Energy Research Institute, Daejeon, Korea
- 18. Thermoelectric Micro-Cooler of Bismuth Telluride Thin Films**
K. Miyazaki¹, J. Kurosaki¹, M. Takashiri², H. Tsukamoto¹, B. Lenoir³, and A. Dauscher⁴, ¹Kyushu Institute of Technology, Kitakyushu, Japan; miyazaki@life.kyutech.ac.jp, ²Komatsu Ltd., Hiratsuka, Japan; masayuki_takashiri@komatsu.co.jp, ³Ecole des Mines de Nancy, Nancy, France; lenoir@mines.inpl-nancy.fr, ⁴CNRS, Nancy, France; anne.dauscher@mines.inpl-nancy.fr

12:30 - 13:30 Lunch

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

15:30 – 16:00 Coffee/Tea break

TUESDAY, SEPTEMBER 18, 2007 (continued)

16:00 - 17:45 **Session 7: HEAT TRANSFER ENHANCEMENT AND HIGH TEMPERATURE HEAT EXCHANGERS**

Session Chair: R. K. Shah, Subros Limited, India

Keynote Lecture: Enhancing Heat Transfer in the Core Flow by forming an Equivalent Thermal Boundary Layer in the Fully Developed Tube Flow

W. Liu¹, K. Yan¹, A. Nakayama², ¹Huazhong University of Science and Technology, Wuhan, P.R. China, ²Shizuoka University, Hamamatsu, Japan.

Fabrication of Metallic and Ceramic Microstructured Plate Heat Exchangers/Reactors for High Temperature Applications

J. Schürer, G. Kolb, C. Hofmann, H. Löwe, F. Meschke, IMM Institute für Mikrotechnik Mainz GmbH, Mainz, Germany

Single-Phase Heat Transfer Characteristics of a Micro-Fin Tube

X-W. Li, J-A Meng, Tsinghua University, Beijing, P. R. China

17:45 – 18:00 Stretch Break

18:00 - 19:30 **Session 8: HIGH TEMPERATURE HEAT EXCHANGERS**

Session Chair: S. Scholl, University of Braunschweig, Germany

Development of a Ceramic Plate-Fin Heat Exchanger for Operation Temperatures up to 1250 °C

J. Schulte-Fischedick¹, S. Zunft¹, S. Streuber², ¹German Aerospace Centre, Stuttgart, Germany, ²University of Applied Sciences Wilesbaden, Russelsheim, Germany.

High Temperature Heat Exchanger Studies for Applications to Gas Turbines

J.H. Jeong, J.K. Lee, M.Y. Ha, K.S. Kim, Pusan National University, Pusan, Korea

Advanced EGR Coolers – Some Thermal Hydraulic and Environmental Aspects

V. Bravo, MT Catálan, C. Pérez, Valeo Engine Cooling, Zaragoza, Spain

19:10 - 20:00 Social

20:00 - 21:00 Dinner

WEDNESDAY, SEPTEMBER 19, 2007

07:00 - 08:00 Breakfast

08:00 - 10:00 **Session 9: SINGLE-PHASE HEAT EXCHANGER DEVELOPMENT & APPLICATIONS – I**
Session Chair: A. Jacobi, University of Illinois, USA

Keynote Lecture: Time Accurate Prediction Techniques for Component Design in Heat Exchangers

D. K. Tafti, Virginia Polytechnic Institute and State University, Blacksburg, VA, USA.

Prediction of Sensible Heat Transfer and Pressure Drop for Cross-Finned Tube Heat Exchangers with Plain Fins

C. Kondou¹, T. Senshu², K. Oguni¹, ¹Hitachi Appliances, Inc., Shizuoka, Japan, ²Yamaguchi University, Yamaguchi, Japan;

Temporally-Periodic Developing Laminar Flow and Heat Transfer in Staggered-Plate Arrays

A. Lamoureux, B.R. Baliga, McGill University, Montreal, Canada

10:00 - 10:30 Coffee/Tea Break

10:30- 12:30 **Session 10: SINGLE-PHASE HEAT EXCHANGER DEVELOPMENT & APPLICATIONS – II**
Session Chair: Ch. Ranganayakulu, Aeronautical Development Agency, India

Approach on Improvement in the Compact Performance of Counter-Flow Heat Exchanger

T. Kojima, A. Okuyama, K. Shiromoto, M. Fukaya and K. Wang, Fujitsu General Institute of Air-Conditioning Technology Ltd., Kawasaki, Japan

A Micro Heat Exchanger Design for Very High Specific Power Transfer

J.J. Brandner, E. Anurjew, E. Hansjosten, U. Schygulla and K. Schubert, Forschungszentrum Karlsruhe, Karlsruhe, Germany

Effect of Overall Dimensions and Heat Capacity Rate Scaling on Micro Channel Heat Exchanger Performance

F. Rogiers, T. Stevens, M. Baelmans, Katholieke Universiteit Leuven, Leuven, Heverlee, Belgium

Experimental Investigation of Fuel Evaporation on Microstructured Surfaces for Microcombustion

B. Schilder, I. Zorbach, S. Hardt, P. Stephan, F. Wondra, T. Klotzbücher, Darmstadt University of Technology, Darmstadt, Germany

12:30 - 14:00 Lunch

14:00 – 15:30 Networking/Informal Discussions/Free Time

15:30 – 16:00 Coffee/Tea break

16:00 – 17:35 **Session 11: PHASE-CHANGE HEAT EXCHANGER STUDIES – I**
Session Chair: K. Suzuki, Tokyo University, Japan

Keynote Lecture: Irregularities of Two-Phase Gas-Liquid Flow in Real Heat Exchangers

R. Ulbrich, Opole University of Technology, Opole, Poland.

A Micro-Channel Heat Exchanger with Steam Condensing and CO₂ Boiling Heat Transfer for a Waste Heat Recovery System

T. Ishizuka, K. Nikitin, N. Tsuzuki, Y. Tokyo Institute of Technology, Tokyo, Japan

WEDNESDAY, SEPTEMBER 19, 2007 (continued)

Development of a Self-Cooling System Utilizing Waste Heat from Electronic Equipment

M. Ishizuka, S. Nakagawa and K. Koizumi, Toyama Prefectural University, Toyama, Japan

17:35 – 17:50 Stretch Break

17:50 – 19:30 **Session 12: PHASE-CHANGE HEAT EXCHANGER STUDIES – II**

Session Chair: H. Yoshida, Kyoto University, Japan

Two-Phase Distribution of R-134a in a Brazed Aluminum Parallel Flow Heat Exchanger

N-H Kim J-H, Ham, D-Y, Kim, University of Incheon, Korea.

Boiling Two-Phase Pressure Drop in Small Diameter Tubes

X. Huo¹, D. Shiferaw², T.G. Karayiannis² and D.B.R. Kenning², ¹Oaksmere Refrigeration Design and Consultancy, Suffolk, UK, ²Brunel University, West London, UK

Experimental Study on Phase-Change Heat Transfer in Rectangular Micro-Capillary Grooves Cooling System

B. Li¹, X-B Zhao¹ and Z-G Liu², ¹Nanjing Normal University, Nanjing, P.R. China, ²Institute of Energy Resources Research in Shandong Province, P.R. China

Heat Transfer of Humid-Air Flow in a Compact Heat Exchanger with Plate Ribbing

V.I. Terekhov¹, Yu.V. Djachenko², A.V. Chichindaev², ¹Institute of Thermophysics SB RAS, Novosibirsk, ²Novosibirsk State Technical University, Russia

19:30 - 21:00 Dinner

THURSDAY, SEPTEMBER 20, 2007

07:00 - 08:00 Breakfast

08:00 - 15:30 Optional Excursion to either Berlin or Sans Souci (in Potsdam)
(box lunches)

15:30 - 16:00 Coffee/Tea Break

16:00 - 17:30 **Session 13: PHASE-CHANGE HEAT EXCHANGER FUNDAMENTAL STUDIES AND APPLICATIONS**

Session Chair: S. Kabelac, Helmut-Schmidt-University, Germany

Keynote Lecture: Two-Phase Flow and Heat Transfer in Plate Heat Exchangers

S. Kabelac, X. Luo, S. Freund, Helmut-Schmidt-University of the Federal Armed Forces, Hamburg, Germany

Local Heat Transfer Coefficient during Condensation inside a Single Minichannel

A. Cavallini, D. Del Col, M. Matkovic, L. Rossetto, University of Padova, Padova, Italy

Condensation in Horizontal Smooth, Crosshatch Helical and Crosshatch Herringbone Tubes with R410A

H. Wu¹, B. Newell², and M. Heidenreich¹, ¹Advanced Heat Transfer LLC, Memphis, TN, USA, ²Newell Instruments, Urbana, IL, USA

17:30 – 17:45 Coffee/Tea Break

17:45 - 19:30 **Session 14: PHASE-CHANGE HEAT EXCHANGER APPLICATIONS**

Session Chair: T.G. Karayiannis, Brunel University, UK

Integration of Process Simulation and Heat Exchanger Design Tools for a Plate-Fin Heat Exchanger

V.V. Wadekar, HTFS, Aspen Technology Ltd, Reading, UK,

Increase in Critical Heat Flux for Flow Boiling in Deviced Narrow Channels with Enhanced Liquid Supply

Y. Shinmoto, K. Ariki, S. Miura, Y. Inada and H. Ohta, Kyushu University, Fukuoka, Japan

Two Phase Heat Transfer: Two Phase Flow and Flow Instabilities in Horizontal Micro Channels

C. M. Rops¹, R. Lindken² and J. Westerweel¹, ¹TNO Science and Industry, Delft, The Netherlands, ²Delft University of Technology, Delft, The Netherlands

Microbubble Emission Boiling toward Advanced High Heat Flux Cooling Devices for Power Electronics

K. Suzuki¹, S. Tamura¹, H. Kawamura¹, H. Ohta², Y. Abe³ and H. Iwasaki⁴, ¹Tokyo University of Science, Japan, ² Kyushu University, Japan, ³ AIST, Ibaragi, Japan, ⁴ Toshiba Corp., Kawasaki, Japan

19:30 - 20:00 Social

20:00 - 21:30 Conference Banquet

FRIDAY, SEPTEMBER 21, 2007

07:00 - 08:00 Breakfast

08:00 – 10:15 **Session 15: PHASE-CHANGE HEAT EXCHANGER DEVELOPMENT AND APPLICATIONS**

Session Chair: M. Ishizuka, Toyama University, Japan

Keynote Lecture: Research Project of Hydrogen Thermophysical Properties at Ultra High Pressure

Y. Takata¹, N. Sakoda², K. Shinzato², K. Fujii² and M. Fujii², ¹Kyushu University, Fukuoka, Japan, ²National Institute of Advanced Industrial Science and Technology, Fukuoka, Japan, ³National Institute of Advanced Industrial Science and Technology, Ibaraki, Japan.

Experimental Study of the Tube Number Effects in Different Pass of a Four-Pass Circuitry on the Performances of Multi-Port Parallel Flow Condenser

W Sun , X-L Zhu, Y-L, Zeng, Li, Y-L He, W-Q Tao, Xi'an Jiaotong University, Xi'an, P.R. China

Numerical Simulation of the Tube Number Effects in Different Pass of Two Circuitries on the Performances of Multi-Port Parallel Flow Condenser

W Sun, Z-G Qu, Y-L He, W-Q Tao, Xi'an Jiaotong University, Xi'an, China

Numerical Simulation of Flow, Heat and Mass Transfer in a Five-Row Plate-Fin and Tube Heat Exchanger with Dehumidification

M. Mohammed, S. Russel, B. Bauoin, Ecole des Mines de Douai, Douai, France

10:15 - 10:30 Coffee/Tea Break

10:30 - 12:20 **Session 16: PHASE-CHANGE HEAT EXCHANGER DEVELOPMENT AND APPLICATIONS**

Session Chair: M Wagner, Air Liquide, France

Design of a Commercial-Scale Heat-Integrated Distillation Column Based on Plate-Fin Heat Exchangers

J.A. Hugill, E.M. van Dorst, G. de Jong, Energy research Centre of the Netherlands, Petten, The Netherlands

Local Evaporation Heat Transfer coefficient of Ammonia on a Vertical Flat Plate Heat Exchanger

H. Arima, J-H. Kim, A. Okamoto and Y. Ikegami, Saga University, Japan

Numerical Study on the Performance of a two Evaporators' Parallel Connection System

Y.B. Tao, Y.L. He, L.W. Tang, and W.Q. Tao, Xi'an Jiaotong University, Xi'an, P.R. China

Dynamic Performance of Compact Heat Exchangers under Dry/Wet Conditions Based on 3D Distributed Parameter Model

Z. LiNa and C-X.Yang, Beijing University of Aeronautics and Astronautics, Beijing, P.R. China

12:20 - 12:30 Future Plans and Vote of Thanks

12:30 Lunch and Departure