

## *PROGRAM*

# Heat Exchanger Fouling and Cleaning - Challenges and Opportunities

June 5 - 10, 2005

Kloster Irsee/Swabian Conference Center  
Klosterring 4 D-87660 Irsee Germany

### *Conference Chairs*

Professor Hans Müller-Steinhagen  
DLR / University of Stuttgart, Germany

Professor Paul Watkinson  
University of British Columbia, Canada

### *Conference Scientific Secretary*

Dr. M. Reza Malayeri  
DLR, Germany

# ECI

**ENGINEERING CONFERENCES INTERNATIONAL**

6 Metro Tech Center, Brooklyn, NY 11201

Tel.: 1-718-260-3743; Fax: 1-718-260-3754

info@eci.poly.edu

www.engconfintl.org

Engineering Conferences International (ECI) is the successor program to the United Engineering Foundation conferences program that was established in 1962 to provide an opportunity for the exploration of problems and issues of concern to engineers from many disciplines. ECI is a not-for-profit partnership between the Engineering Conferences Foundation and Polytechnic University.

#### ECF BOARD MEMBERS

Barry C. Buckland  
John C. Chen  
Richard A. Gross  
Allen I. Laskin  
Raymond McCabe  
Eli Pearce  
Shivendra S. Panwar  
Gary W. Poehlein  
P. Somasundaran

Chair of ECF Conferences Committee: Jules Routbort

ECF Technical Liaison: Frank Schmidt

ECI Director: Barbara K. Hickernell

ECI Assistant Director: Kevin Korpics

Engineering Conferences International  
6 Metro Tech Center  
Brooklyn, NY 11201  
+1 718 260 3743  
+1 718 260 3754  
info@eci.poly.edu  
www.engconfintl.org

## NOTES

- Please observe “No Smoking” at ECI technical sessions, meals and social hours
- Speakers should allow sufficient time at the end of their presentation for questions and discussion
- Wireless internet access: Kloster Irsee has “HotSpot Passes” available for purchase. The duration is between one and twenty-four hours and may be charged to Mastercard or Visa. Prices:
  - 1 hour @ € 6.90 plus 16% VAT
  - 3 hours @ € 12.07 plus 16% VAT
  - 24 hours @ € 15.52 plus 16% VAT
- Audiotaping, videotaping and photography of presentations are strictly prohibited
- Turn your cellular telephones to vibrate or off during technical sessions
- Be sure to make any corrections to your name/contact information on the Master Participant List or confirm that the listing is correct. A corrected copy will be sent to all participants after the conference.

**Sunday, June 5, 2005**

15:00 – 18:00 Registration

16:30 – 16:40 **Welcome and Opening Address**  
Hans Müller-Steinhagen, Conference Chair

16:40 – 16:50 Frank Schmidt, ECI Technical Liaison

**SESSION 1: Review**

**Chair: Hans Müller-Steinhagen, DLR/University of Stuttgart, Germany**

16:50 – 17:15 **The Environmental Effect of Heat Exchanger Fouling: A Case Study**  
T. Casanueva-Robles<sup>1</sup> and T.R. Bott<sup>2</sup>  
<sup>1</sup>University of Cadiz, Spain, <sup>2</sup>University of Birmingham, UK

17:15 – 17:40 **Looking Back: 25 Years Research on Fouling of Heat Transfer Surfaces in Braunschweig**  
M. Bohnet  
Technical University of Braunschweig, Germany

17:40 – 18:05 **Fouling Around**  
N. Epstein  
University of British Columbia, Canada

18:25 - 19:30 Organ Concert: Roland Götz, Organist

19:30 – 21:00 Dinner

21:00 – 22:00 Reception (Bierstube)

**Monday, June 6, 2005**

07:00 – 08:30 Breakfast

**SESSION 2: CRUDE OIL**

**Chair: Stan Kistler, HTRI, USA**

08:30 – 08:55 **Deposition from Crude Oils in Heat Exchangers**

A.P. Watkinson  
The University of British Columbia, Canada

08:55 – 09:20 **Extraction of Crude Oil Fouling Model Parameters from Plant Exchanger Monitoring**

G.T. Polley<sup>1</sup>, D.I. Wilson<sup>2</sup>, S.J. Pugh<sup>3</sup> and E. Petitjean<sup>4</sup>  
<sup>1</sup>Pinchtechnology Ltd, UK, <sup>2</sup>University of Cambridge, UK, <sup>3</sup>ESDU International plc, UK, <sup>4</sup>Centre de recherche de Gonfreville, Total, Le Havre

09:20 – 09:45 **Ten years of Ebert, Panchal and the 'Threshold Fouling' Concept**

D.I. Wilson<sup>1</sup>, G.T. Polley<sup>2</sup> and S.J. Pugh<sup>3</sup>  
<sup>1</sup>University of Cambridge, UK, <sup>2</sup>Pinchtechnology Ltd, UK, <sup>3</sup>ESDU International plc, UK

09:45 – 10:10 **Blending Effects in Fouling of four Crude Oils**

Z.S. Saleh<sup>1</sup>, R. Sheikholeslami<sup>1</sup> and A.P. Watkinson<sup>2</sup>  
<sup>1</sup>The University of New South Wales, Australia, <sup>2</sup>The University of British Columbia, Canada

10:10 – 10:40 Coffee Break

**SESSION 3: HYDROCARBON PROCESSING**

**Chair: Ian Wilson, University of Cambridge, UK**

10:40 – 11:05 **Carbonaceous Material Deposition from Heavy Hydrocarbon Vapors: Mathematical Modeling**

W. Zhang and A.P. Watkinson  
The University of British Columbia, Canada

11:05 – 11:30 **Fouling Behavior of Pyrolysis Gasoline over Carbon Steel and Stainless Steel Alloys**

M. Sprague, P. Herrera and A. Krzywicki  
NOVA Chemicals Corporation, Canada

11:30 – 11:55 **Solvent-Based Cleaning of Emulsion Polymerisation Reactors**

J.Y.M. Chew<sup>1</sup>, S.J. Tonneijk<sup>2</sup>, W.R. Paterson<sup>1</sup> and D.I. Wilson<sup>1</sup>  
<sup>1</sup>University of Cambridge, UK, <sup>2</sup>NeoResins bv, The Netherlands

11:55 – 12:20 **Fouling Mitigation by Design**

J.M. Nesta and C.A. Bennett  
<sup>1</sup>Fluor Canada Ltd., Canada, <sup>2</sup>HTRI, USA

12:30 – 14:00 Lunch

14:00 – 16:00 *Ad hoc* Sessions and/or Free Time

#### **SESSION 4: INDUSTRIAL PROCESSES**

Chair: Reg Bott, University of Birmingham, UK

- 16:00 – 16:25      **Impact of Sea Cooling Water (SCW) Management and Heat Exchanger Design on Tube Failure in Once-Through Sea Cooling Water System**  
K.S. Yan<sup>1</sup>, W.B. Hisham B. Wan Abdullah<sup>1</sup> and B.C. Isa<sup>2</sup>  
<sup>1</sup>Malaysia LNG SDN BHD, Malaysia, <sup>2</sup>Petronas, Malaysia
- 16:25 – 16:50      **Contributing Factor Analysis and its Application for an Alcohol Plant Heat Exchanger Fouling Phenomena**  
S. Isogai, M. Nakamura and S. Nishimura  
Mitsubishi Chemical Corporation, Japan
- 16:50 – 17:20      Afternoon Coffee
- 17:20 – 17:50      **Fouling Mitigation of a Reboiler by Optimization of the Additive and Operation Conditions**  
S. Isogai and M. Nakamura  
Mitsubishi Chemical Corporation, Japan
- 17:50 – 18:20      **Deposit Formation in the Evaporator of a Sulfuric Acid Recovery Plant for TiO<sub>2</sub> Pigment Production**  
H. Müller-Steinhagen  
German Aerospace Research Centre (DLR), University of Stuttgart, Germany
- 18:20 – 18:45      **Enhanced Heat Exchanger Tubes: Their Fouling Tendency and Potential Cleanup**  
G.F. Hays<sup>1</sup>, E.S. Beardwood<sup>2</sup> and S.J. Colby<sup>1</sup>  
<sup>1</sup>Ashland Specialty Chemical Co, NJ, USA, <sup>2</sup>Ashland Specialty Chemical Co. Ltd, Ontario, Canada
- 19:00 – 20:30      Dinner
- 20:30 – 22:00      Social Hour

**Tuesday, June 7, 2005**

07:00 – 08:30 Breakfast

**SESSION 5: SURFACE EFFECTS**

**Chair: Wolfgang Augustin, Technical University of Braunschweig, Germany**

08:30 – 08:55 **Modification of Heating Surfaces to Reduce the Effects of Fouling in the Dairy Industry**

S.S. Ramachandra<sup>1</sup>, S. Wiehe<sup>2</sup>, M.M. Hyland<sup>1</sup>, X.D. Chen<sup>1</sup>, and B. Bansal<sup>1</sup>

<sup>1</sup>The University of Auckland, New Zealand, <sup>2</sup> University of Stuttgart, Germany

08:55 – 09:20 **Anti-fouling Stainless Steel Based Surfaces for Milk Heating Processes**

R. Rosmaninho<sup>1</sup>, G. Rizzo<sup>2</sup>, H. Müller-Steinhagen<sup>2,3</sup> and L.F. Melo<sup>1</sup>

<sup>1</sup>University of Porto, Portugal, <sup>2</sup>University of Stuttgart, Germany, <sup>3</sup>German Aerospace Centre (DLR), Germany

09:20 – 09:45 **Surface Treatment of Metallic Heat Exchangers**

S. Piesslinger-Schweiger  
Poligrat GmbH, Germany

09:45 – 10:10 **Development and Evaluation of Ni–Cu–P–PTFE Composite Coatings to Minimize Microbial Adhesion**

Q. Zhao<sup>1</sup>, Y. Liu<sup>1</sup>, C. Wang<sup>1</sup>, S. Wang<sup>2</sup> and H. Müller-Steinhagen<sup>3</sup>

<sup>1</sup>University of Dundee, UK, <sup>2</sup>University of Surrey, UK, <sup>3</sup>German Aerospace Research Centre (DLR), University of Stuttgart, Germany

10:10 – 10:40 Coffee Break

**SESSION 6: PARTICULATE FOULING**

**Chair: Paul Watkinson, University of British Columbia, Canada**

10:40 – 11:05 **Data-based Monitoring and Experimental Studies of Particulate Fouling in Industrial Heat Exchangers**

B.R. Upadhyaya<sup>1</sup>, E. Eryurek<sup>2</sup>, K. Kavaklioglu<sup>2</sup>, X. Huang<sup>1</sup>, and B. Lu<sup>1</sup>

<sup>1</sup>University of Tennessee, USA, <sup>2</sup>Emerson Process Management, USA

11:05 – 11:30 **The Fouling of Alloy-800 Heat Exchanger Tubes by Nickel Ferrite**

J.L. Cossaboom<sup>1</sup> and D.H. Lister<sup>2</sup>

<sup>1</sup> Centre for Nuclear Energy Research, Canada, <sup>2</sup>University of New Brunswick, Canada

11:30 – 11:55 **Influence of Change in Heat Exchangers-Surfaces on the Growth Rate of Particulate Fouling**

M.S. Abd-Elhady, C.C.M. Rindt, J.G. Wijers and A.A. van Steenhoven  
Eindhoven University of Technology, The Netherlands.

11:55 – 12:20 **Today's Techniques for Heat Exchanger Protection via Particle Filtration**

L. Hardin and K. Colby  
LAKOS Separators & Filtration Systems, USA

13:00 – 19:30 Optional Excursion with boxed Lunch

20:00 – 21:30 Dinner

21:30 – 23:00

Social Hour



**Wednesday, June 8, 2005**

07:00 – 08:30 Breakfast

**SESSION 7 DAIRY PROCESSING**

**Chair: Luis Melo, University of Porto, Portugal**

08:30 – 08:55 **Skim Milk Fouling during Ohmic Heating**  
B. Bansal, X.D. Chen and S.X.Q. Lin  
The University of Auckland, New Zealand

08:55 – 09:20 **Heat Treatment of Dairy Product by a Flat Ohmic Cell: Impact of the Reynolds Number, Fluid Rheology and Deposit Presence on the Electrode Surface Temperature**  
M.A. Ayadi<sup>1</sup>, T. Benezech<sup>1</sup>, F. Chopard<sup>2</sup>, M. Berthou<sup>3</sup> and J.C. Leuliet<sup>1</sup>  
<sup>1</sup> INRA, France, <sup>2</sup>ALFA LAVAL VICARB, France, <sup>3</sup> EDF-R&D, France

09:20 – 09:45 **Fouling of Heat Exchanger by Dairy Fluids – A Critical Review**  
B. Bansal and X.D. Chen  
The University of Auckland, New Zealand

09:45 – 10:10 **In-line control of Fouling**  
A.J. van Asselt, M.M.M. Vissers, F. Smit and P. De Jong  
NIZO food research B.V., The Netherlands

10:10 – 10:40 Coffee Break

10:40 – 11:05 **The Poor Performance of NaOH in the Dissolution of Whey Protein Gels at very High pH**  
R.M. Prieto<sup>1,2</sup>, X.D. Chen<sup>2</sup>, R.J. Falconer<sup>1</sup>, W.R. Paterson<sup>1</sup> and D.I. Wilson<sup>1</sup>  
<sup>1</sup>University of Cambridge, UK, <sup>2</sup>The University of Auckland, New Zealand

11:05 – 11:30 **Pulsed Flow Cleaning of Whey Protein Fouling Layers**  
K. Bode<sup>1</sup>, R.J. Hooper<sup>2</sup>, W. Augustin<sup>1</sup>, W.R. Paterson<sup>2</sup>, D.I. Wilson<sup>2</sup> and S. Scholl<sup>1</sup>  
<sup>1</sup>Technical University of Braunschweig, Germany, <sup>2</sup>University of Cambridge, UK

**SESSION 8: COMPACT HEAT EXCHANGERS**

**Chair: Simon Pugh, ESDU International, UK**

11:30 – 11:55 **Strategies against Particle Fouling in the Channels of a Micro Heat Exchanger Subject to  $\mu$ PIV Flow Pattern Measurements**  
V. Heinzl, A Jianu and H. Sauter  
Forschungszentrum Karlsruhe, Institut für Reaktorsicherheit, Germany

11:55 – 12:20 **Fouling Processes in Micro Structured Devices**  
N. Kockmann, M. Engler and P. Woias  
Albert-Ludwig University of Freiburg, Germany

12:30 – 14:00 Lunch

14:00 – 16:00 *Ad hoc* Sessions and/or Free Time

## **SESSION 9: MECHANICAL MITIGATION**

**Chair: Reza Malayeri, DLR, Germany**

- 16:00 – 16:25      **Fouling Reduction Characteristics of a Circulating Fluidized Bed Heat Exchanger**  
Y.D. Jun, K.B. Lee, S.Z. Islam and S.B. Ko  
Kongju National University, Korea
- 16:25 – 16:50      **Compact Self-Cleaning Fluidized Bed Heat Exchangers with EM Baffles**  
D.G. Klaren and E.F. de Boer  
KLAREN BV, The Netherlands
- 16:50 – 17:15      Afternoon Coffee
- 17:15 – 17:30      **'Zero Fouling' Self-Cleaning Heat Exchanger**  
D.G. Klaren<sup>1</sup>, E.F. de Boer<sup>1</sup> and D.W. Sullivan<sup>2</sup>  
<sup>1</sup>KLAREN BV, The Netherlands, <sup>2</sup>Whitson Sullivan Company, USA
- 17:30 – 17:55      **Fouling Removal Characteristics in a Heat Exchanger by Ball Circulation**  
N.S. Hwang, D.X., Jin and Y.P. Lee  
Korea Institute of Science and Technology, Korea

## **SESSION 10: ENHANCED HEAT TRANSFER**

**Chair: Matthias Bohnet, Technische Universitat Braunschweig, Germany**

- 17:55 – 18:20      **Heat Exchanger Tube Inserts - An Update in New Applications with Trouble-Shooting Aspects in Air Coolers, FCC Units, Residue Flows, U-Tubes**  
A.W. Krueger<sup>2</sup> and F. Pouponnot<sup>2</sup>  
<sup>1</sup>Petroval-Houston, USA, <sup>2</sup>Petroval, France
- 18:20 – 18:45      **Particle-fluid Velocities and Fouling in a Grooved Channel Flow**  
D.X. Jin, D.Y. Lee and Y.P. Lee  
Korea Institute of Science and Technology, Korea,
- 19:30                  Conference Banquet followed by Social Hour

**Thursday, June 9, 2005**

07:00 – 08:30 Breakfast

**SESSION 11: POWER PLANTS**

**Chair: Derek Lister, University of New Brunswick, Canada**

08:30 – 08:55 **Tubular Type Heat Flux Meter for Monitoring Internal Scale Deposits in Large Steam Boilers**

J. Taler<sup>1</sup> and D. Taler<sup>2</sup>

<sup>1</sup>Cracow University of Technology, Poland, <sup>2</sup>University of Science and Technology, Poland

08:55 – 09:20 **Report on the Operational Performance and the Fouling Characteristics of a Full-Scale Flue Gas Cooler downstream a Bituminous Coal Fired Power Station Boiler**

U. Willibald<sup>1</sup>, W. Frei<sup>1</sup>, U. Traber<sup>1</sup> and H. Prinz<sup>2</sup>

<sup>1</sup>Flucorrex AG, Switzerland, <sup>2</sup>SaarEnergie GmbH, Germany (may be cancelled)

09:20 – 09:45 **Monitoring And Modelling Of Gas-Side Boiler Fouling**

R. Korbee<sup>1</sup>, M. Losurdo<sup>2</sup>, J. Lensselink<sup>1</sup>, M.K. Cieplik<sup>1</sup> and F. Verhoeff<sup>1</sup>

<sup>1</sup>Energy research Centre of the Netherlands (ECN), <sup>2</sup>Delft University of Technology, The Netherlands

09:45 – 10:10 **Initiation of CaSO<sub>4</sub> Scale Formation on Heat Transfer Surfaces under Pool Boiling Conditions**

M.R. Malayeri<sup>1</sup> and H. Müller-Steinhagen<sup>1,2</sup>

<sup>1</sup>German Aerospace Research Centre (DLR), Germany, <sup>2</sup>University of Stuttgart, Germany

10:10 – 10:40 Coffee Break

**SESSION 12: MONITORING**

**Chair: George Hays, Ashland Specialty Chemical, USA**

10:40 – 11:05 **Neural Network based On-line Detection of Fouling in a Water Circulating Temperature Controller (WCTC)**

S. Lecoeuche<sup>1</sup> and S. Lalot<sup>2</sup>

<sup>1</sup>Mines de Douai, France, <sup>2</sup>UVHC, France

11:05 – 11:30 **Development and Applications of new Fouling Sensors for the Heat Exchanger Fouling Problems**

H. Inokuchi, S. Morisada and S. Iwahashi

Mitsubishi Chemical Corporation, Japan

11:30 – 12:30 **Panel discussion: Chemical or Mechanical Fouling Mitigation – which way are we going?**

12:30 – 14:00 Lunch

14:00 – 16:00 *Ad hoc* Sessions and/or Free Time

16:00 – 17:00

Afternoon Coffee and

### **SESSION 13: POSTERS**

#### **Real Time Fouling Diagnosis and Heat Exchanger Performance**

F. dos Santos Liporace and S.G. de Oliveira  
Petrobras R&D Center (CENPES), Brazil

#### **Calculation of Shear Stress Enhancement Using Slow Pulsed Flows**

M.S. Celnik<sup>1</sup>, M.J. Patel<sup>1</sup>, M. Pore<sup>1</sup>, F. Brahim<sup>2</sup>, W. Augustin<sup>2</sup>, S. Scholl<sup>2</sup>, D.M. Scott<sup>1</sup>  
and D.I. Wilson<sup>1</sup>

<sup>1</sup>University of Cambridge, UK, <sup>2</sup>Technical University of Braunschweig, Germany

#### **Effect of Polarization on Biofouling of Heat Exchanger Surfaces**

T. Kuosmanen<sup>1</sup>, M. Peltola, M. Pulliainen<sup>2</sup>, T. Laurila<sup>2</sup>, J-F. Selin<sup>3</sup>, H. Huopalainen<sup>3</sup> and  
M. Salkinoja-Salonen<sup>1</sup>

<sup>1</sup>University of Helsinki, Finland, <sup>2</sup>Savcor, Mikkeli, Finland, <sup>3</sup>Neste Oil, Porvoo, Finland

#### **Anti Fouling Investigations with Ultrasound in a Microstructured Heat Exchanger**

W. Benzinger, U. Schygulla, M. Jäger and K. Schubert  
Karlsruhe Research Center (IMVT), Germany

#### **Economic and Performance Evaluation of two Oxidising Biocides in Sea-water Cooling Systems**

T. Casanueva-Robles, E. Nebot, J.C. Casanueva, M.M. Fernández-Bastón and D.Sales  
University of Cádiz, Spain

### **SESSION 14: MODELLING AND FUNDAMENTALS**

Chair: Jan Taler, Cracow University of Technology, Poland

17:00 – 17:25

#### **Heat Transfer from Horizontal Tubes in Pool Boiling: Influence of Heat Conduction in the Wall of the Tube and Fouling Aspects - A Finite Element Analysis**

C. Ranganayakulu<sup>1</sup>, D. Gorenflo<sup>2</sup>, G. Herres<sup>2</sup>, A. Luke<sup>2</sup> and U. Chandra<sup>2</sup>

<sup>1</sup>Aeronautical Development Agency, India, <sup>2</sup>University of Paderborn, Germany

17:25 – 17:50

#### **Molecular Modelling Approach on Fouling of the Plate Heat Exchanger: Titanium Hydroxyls, Silanols and Sulphates on TiO<sub>2</sub> Surfaces**

E. Puhakka<sup>1</sup>, M. Riihimäki<sup>2</sup> and R.L. Keiski<sup>2</sup>

<sup>1</sup>VTT Processes, Finland, <sup>2</sup> University of Oulu, Finland

17:50 – 18:15

#### **Calcium Sulfate Scaling Delay Times under Sensible Heating Conditions**

F. Fahiminia, A.P. Watkinson and N. Epstein  
The University of British Columbia, Canada

18:15 – 18:40

#### **Induction Period for Heterogeneous Nucleation during Crystallisation Fouling**

G. Rizzo<sup>1</sup> and H. Müller-Steinhagen<sup>1,2</sup>

<sup>1</sup>University of Stuttgart, Germany, <sup>2</sup>German Aerospace Centre (DLR), Germany

19:30 – 20:30

Dinner

20:30 – 22:00

Social Hour

**Friday, June 10, 2005**

07:00 –08:30 Breakfast

**SESSION 15: MECHANICAL CLEANING**

**Chair: Hans Müller-Steinhagen, DLR/University of Stuttgart, Germany**

08:30 – 08:55 **Optimised Heat Exchanger Management - Achieving Financial and Environmental Targets**

S. Rädler

Raedler Maschinenbau GMBH, Austria

08:55 – 09:20 **Cleaning of Welded Plate Type Heat Exchangers by Controlled Combustion**

P.X. Bussonnet and D. Sabin

Packinox, France

09:20 – 09:45 **Cleaning of Air Cooled Heat Exchangers as Efficiency Increasing Measure**

D. Jaresch

J&W Reinigungssysteme für Trockenkühlanlagen GmbH, Germany

09:45 – 10:15 Coffee Break

10:15 – 10:40 **On-line Cleaning Schedule for Heat Exchangers in a Heat Exchanger Network– the Case of Crude Distillation Unit**

M. Markowski and K. Urbaniec

Warsaw University of Technology, Poland

10:40 – 11:05 **Latest Developments in Selective Cleaning of Coal Fired Boilers**

S. Simon

Clyde Bergemann GmbH, Germany

11:05 – 11:30 Final Discussion

12:00 – 13:00 Lunch and Conference Adjournment