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

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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-Robles¹ and T.R. Bott²
¹University of Cadiz, Spain, ²University 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\(^1\), D.I. Wilson\(^2\), S.J. Pugh\(^3\) and E. Petitjean\(^4\)
\(^1\)Pinchtechnology Ltd, UK, \(^2\)University of Cambridge, UK, \(^3\)ESDU International plc, UK, \(^4\)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\(^1\), G.T. Polley\(^2\) and S.J. Pugh\(^3\)
\(^1\)University of Cambridge, UK, \(^2\)Pinchtechnology Ltd, UK, \(^3\)ESDU International plc, UK

09:45 – 10:10  Blending Effects in Fouling of four Crude Oils
Z.S. Saleh\(^1\), R. Sheikholeslami\(^1\) and A.P. Watkinson\(^2\)
\(^1\)The University of New South Wales, Australia, \(^2\)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\(^1\), S.J. Tonneijk\(^2\), W.R. Paterson\(^1\) and D.I. Wilson\(^1\)
\(^1\)University of Cambridge, UK, \(^2\)NeoResins bv, The Netherlands

11:55 – 12:20  Fouling Mitigation by Design
J.M. Nesta and C.A. Bennett
\(^2\)Fluor Canada Ltd., Canada, \(^2\)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. Yan¹, W.B. Hisham B. Wan Abdullah¹ and B.C. Isa²
¹Malaysia LNG SDN BHD, Malaysia, ²Petronas, 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 TiO₂ 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. Hays¹, E.S. Beardwood² and S.J. Colby³
¹Ashland Specialty Chemical Co, NJ, USA, ²Ashland 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. Ramachandra1, S. Wiehe2, M.M. Hyland1, X.D. Chen1, and B. Bansal1
1The University of Auckland, New Zealand, 2 University of Stuttgart, Germany

08:55 – 09:20
Anti-fouling Stainless Steel Based Surfaces for Milk Heating Processes
R. Rosmaninho1, G. Rizzo2, H. Müller-Steinhagen2,3  and L.F. Melo1
1University of Porto, Portugal, 2University of Stuttgart, Germany, 3German 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. Zhao1, Y. Liu1, C. Wang1, S. Wang2, and H. Müller-Steinhagen3
1University of Dundee, UK, 2University of Surrey, UK, 3German 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. Upadhyaya1, E. Eryurek2, K. Kavaklioglu2, X. Huang1, and B. Lu1
1University of Tennessee, USA, 2Emerson Process Management, USA

11:05 – 11:30
The Fouling of Alloy-800 Heat Exchanger Tubes by Nickel Ferrite
J.L. Cossaboom1 and D.H. Lister2
1 Centre for Nuclear Energy Research,Canada, 2University 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

M.A. Ayadi¹, T. Benezech¹, F. Chopard², M. Berthou³ and J.C. Leuliet³
¹INRA, France, ²ALFA LAVAL VICARB, France, ³EDF-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. Prieto¹,², X.D. Chen², R.J. Falconer¹, W.R. Paterson¹ and D.I. Wilson¹
¹University of Cambridge, UK, ²The University of Auckland, New Zealand

11:05 – 11:30  Pulsed Flow Cleaning of Whey Protein Fouling Layers
K. Bode¹, R.J. Hooper², W. Augustin¹, W.R. Paterson², D.I. Wilson² and S. Scholl¹
¹Technical University of Braunschweig, Germany, ²University 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 μPIV Flow Pattern Measurements
V. Heinzel, 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, E.F. de Boer and D.W. Sullivan
KLAREN BV, The Netherlands, 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

A.W. Krueger and F. Pouponnot
Petroval-Houston, USA, 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. Taler¹ and D. Taler²
¹Cracow University of Technology, Poland, ²University 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. Willibald¹, W. Frei¹, U. Traber¹ and H. Prinz²
¹Flucorrex AG, Switzerland, ²SaarEnergie GmbH, Germany *(may be cancelled)*

09:20 – 09:45  Monitoring And Modelling Of Gas-Side Boiler Fouling
R. Korbee¹, M. Losurdo², J. Lenssельink¹, M.K. Cieplik¹ and F. Verhoeff¹
¹Energy research Centre of the Netherlands (ECN), ²Delft University of Technology, The Netherlands

09:45 – 10:10  Initiation of CaSO₄ Scale Formation on Heat Transfer Surfaces under Pool Boiling Conditions
M.R. Malayeri¹ and H. Müller-Steinhagen¹²
¹German Aerospace Research Centre (DLR), Germany, ²University 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. Lecoeuche¹ and S. Lalot²
¹Mines de Douai, France, ²UVHC, 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. Celnik¹, M.J. Patel¹, M. Pore¹, F. Brahim², W. Augustin², S. Scholl², D.M. Scott¹ and D.I. Wilson¹
¹University of Cambridge, UK, ²Technical University of Braunschweig, Germany

**Effect of Polarization on Biofouling of Heat Exchanger Surfaces**
T. Kuosmanen¹, M. Peltola, M. Pulliainen², T. Laurila², J-F. Selin³, H. Huopalainen¹ and M. Salkinoja-Salonen²
¹University of Helsinki, Finland, ²Savcor, Mikkeli, Finland, ³Neste 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 Seawater Cooling Systems**
T. Casanueva-Robles, E. Nebot, J.C. Casanueva, M.M. Fernández-Bastón and D.Sales
University of Cádiz, Spain

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. Ranganayakulu¹, D. Gorenflo², G. Herres², A. Luke² and U. Chandra²
¹Aeronautical Development Agency, India, ²University of Paderborn, Germany

17:25 – 17:50

**Molecular Modelling Approach on Fouling of the Plate Heat Exchanger: Titanium Hydroxyls, Silanols and Sulphates on TiO₂ Surfaces**
E. Puhakka¹, M. Riihimäki² and R.L. Keiski²
¹VTT Processes, Finland, ²University 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. Rizzo¹ and H. Müller-Steinhagen¹,²
¹University of Stuttgart, Germany, ²German 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