Heat Exchanger Fouling and Cleaning Fundamentals and Applications

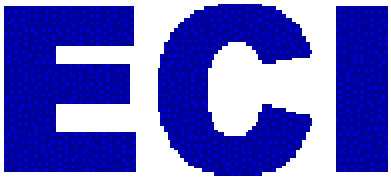
May 18-22, 2003

Hotel Santa Fe
Santa Fe, New Mexico, USA

Conference Chairs
Professor Paul Watkinson
University of British Columbia, Canada

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

Conference Scientific Secretary
Dr M. Reza Malayeri
DLR, Germany



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

SUNDAY, MAY 18, 2003

17:00 – 19:00	Registration
19:00	Dinner
	WELCOME Paul Watkinson, Conference Chair Frank Schmidt, ECI Technical Liaison
21:00-22:00	Opening Reception

NOTES

- **All Technical sessions will be held at Kiva C**
- **Breakfast coupons will be distributed at check-in – present to wait-staff at Amaya Restaurant**
- **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.**

MONDAY, MAY 19, 2003

7:00 – 8:30 Breakfast

8:30 – 8:45 **Opening Comments**
Paul Watkinson
Conference Chair

SESSION I: WATER AND AQUEOUS SYSTEMS FOULING
Chair: Reg Bott, University of Birmingham, UK

8:45 – 9:20 **Keynote Lecture - Fouling During the Use of Seawater as Coolant- The Development of a 'User Guide'**
S. Pugh[1], G.F. Hewitt[2] and H. Müller-Steinhagen[3]
[1]ESDU International, UK, [2]Imperial College of Science, technology and Medicine, UK, [3]German Aerospace Centre, Germany

9:20 – 9:55 **Keynote Lecture - Physical Water Treatment for the Mitigation of Mineral Fouling in Cooling-Tower Water Applications**
Y.I. Cho[1], S.H. Lee[1], W. Kim[1] and Sangho Suh[2]
[1]Drexel University, USA, [2] Soong-Sil University, Seoul, Korea

9:55 – 10:20 **Investigation of Initial Fouling Rates of Calcium Sulfate Solutions under Non-boiling Conditions - Work in progress**
F. Fahiminia, A.P. Watkinson and N. Epstein
The University of British Columbia, Canada

10:20 – 10:55 Coffee Break

10:55 – 11:20 **Chlorine Dioxide in Seawater for Fouling Control in Power Station and Petrochemical Plant**
G. Petrucci and M. Rosellini
Caffaro S.p.A., Italy

11:20 – 11:45 **Crystallisation Fouling of Mixed Salts During Convective Heat Transfer and Sub-Cooled Flow Boiling Conditions**
A. Helalizadeh[1], H. Müller-Steinhagen[2] and M. Jamialahmadi[3]
[1] University of Surrey, England, [2] University of Stuttgart, Germany, [3] University of Petroleum Industry, Iran

11:45 – 12:10 **Crystallization Fouling of the Aqueous Two-Component System $CaSO_4/CaCO_3$**
V. Höfling, W. Augustin and M. Bohnet
Technical University of Braunschweig, Germany

12:10 – 12:35 **Deposition of Na_2CO_3 in Supercritical Water Oxidation Systems and its Mitigation**
M.S. Khan and S.N. Rogak
The University of British Columbia, Canada

12:35 – 13:00 **Heat Exchanger Fouling in Phosphoric Acid Evaporators –Evaluation of Field Data-**
R.M. Behbahani[1], H. Müller-Steinhagen[2], and M. Jamialahmadi[3]
[1] University of Surrey, England, [2] University of Stuttgart, Germany, [3] University of Petroleum Industry, Iran

13:00 – 14:00 Lunch

14:00 – 15:00 *Ad hoc* Sessions and/or Free Time

SESSION II: WATER AND AQUEOUS SYSTEMS FOULING
Chair: Hans Müller-Steinhagen, DLR/University of Stuttgart

15:00 – 15:25 **Fundamentals of Sodium Aluminosilicate Scale Formation During Process Heat Transfer**
J. Addai-Mensah
University of South Australia, Australia

15:25– 15:50 **Bayer Process Heat Exchangers Cleaning Efficiency: Optimizing the Acid Dissolution of Sodalite Scale**
S. Fortin and R. Breault
Alcan International Limited, Canada

15:50 – 16:15 Afternoon Coffee

16:15 – 16:40 **Aluminosilicate Formation in High Level Waste Evaporators: A Method for Uranium and Plutonium Accumulation**
W.R. Wilmarth, C.J. Martino, B.L. Lewis and C. Boley
Savannah River Technology Center, USA

16:40 – 17:05 **Sodium Aluminosilicate Solid Phase Specific Fouling Behaviour**
J. Addai-Mensah[1], J. Li[1], M. Zbik and S. Rosencrance[2]
[1]University of South Australia, Australia, [2]Westinghouse Savannah River Company, USA

17:05 – 17:30 **A Comparison of the Operating Characteristics of Two Cooling Water Systems using Chlorine and Chlorine Dioxide Biocides**
T.R. Bott and I.E.C. Mott
University of Birmingham, UK

17:30 – 19:00 **Panel Discussion: What is to be Done? Routes for Fouling Mitigation**
Chair: Norman Epstein, University of British Columbia, Canada
Panel: T.R. Bott, Y. Cho, S.Klimas, H. Muller-Steinhagen
Topics: Mitigation by-Experiments and Modelling, Chemical Additives, Self-Cleaning Exchangers, Surface Treatment, Physico-chemical and Other Methods

19:00 – 21:00 Dinner – on your own. A list of Santa Fe restaurants is available.

21:00 – 23:00 Social Hour

TUESDAY, MAY 20, 2003

7:00 – 8:30 Breakfast

SESSION III: SURFACE MODIFICATION AND MODELLING OF FOULING PROCESSES
Chair: Wolfgang Augustin, Technical University of Braunschweig, Germany
Co-chair : Paul Watkinson, UBC

8:30 – 8:55 **Low Fouling Heat Transfer Surfaces for Industrial Applications**
M. Förster and B. Rumpf
BASF, Germany

8:55 – 9:20 **Large-scale Polymer Coatings on Heat Exchanger Fin for Improving the Wettability Using Plasma Polymerization**
K.H. Kim[1], D.H. Yeu[1], S. Ha[2], and S.K. Koh[1]
[1] P&I Corporation, Korea, [2] LG Electronics Inc., Korea

9:20 – 9:45 **Potency of Stainless Steel Modifications in Reducing Fouling and in Improving Cleaning of Plate Heat Exchangers Processing Dairy Products**
M. Beuf [1], G. Rizzo [2], J.C. Leuliet [1] , H. Müller-Steinhagen [2], S. Yiantsios [3], A. Karabelas [3] and T. Benezech [1]
[1] INRA-LGPTA, France, [2] University of Stuttgart, Germany, [3] Aristote University of Thessaloniki, Greece

9:45 – 10:10 **Permanent Hydrophilic Surface Formation by Ion Assisted Reaction**
KH. Kim[1], J.S. Cho[1], S. Han[1], Y.W. Beag[1], B.H. Kang[2], S. Ha[3] and SK Koh[1]
[1] P&I Corporation, Korea, [2] Kook-Min University, Korea, [3] LG Electronics Inc., Korea

10:10 – 10:35 Coffee Break

10:35 – 11:00 **The Influence of Bulk Properties and Surface Characteristics on the Deposition Process of Calcium Phosphate on Stainless Steel**
R. Rosmaninho[1], G. Rizzo[2], H. Muller-Steinhagen[2] and L. Melo[1]
[1] Universidade do Porto, Portugal, [2] University of Stuttgart, Germany

11:00 – 11:25 **Numerical Simulation of the Fouling Process on Structured Heat Transfer Surfaces**
F. Brahim, W. Augustin and M. Bohnet
Technical University of Braunschweig, Germany

11:25 – 11:50 **Removal of Particles from a Powdery Fouled Surface due to Impaction**
M.S. Abd-Elhady, C.C.M. Rindt, J.G. Wijers and A.A. van Steenhoven
Eindhoven University of Technology, The Netherlands

11:50 – 12:15 **Heat Transfer Improvement of Diary Products via Ohmic Heating Processes: Thermal and Hydrodynamic Effect on Fouling**
M.A. Ayadi[1]., L. Bouvier[1]., F. Chopard[2], M. Berthou[3], L. Fillaudeau[1] and J.C. Leuliet[1]
[1] INRA, LGPTA, France, [2] ALFA LAVAL VICARB, France, [3] EDF-DER, France

12:15 – 12:40 **Analysis of Fouling Data Based on Prior Knowledge**
M.R. Malayeri and H. Müller-Steinhagen
German Aerospace Agency, Germany

12:40 – 14:00 Lunch

14:00 – 15:30 *Ad hoc* Sessions and/or Free Time

SESSION IV: FOULING AND CLEANING IN FOOD AND RELATED INDUSTRIES
Chair: Prof. X.D. Chen, Co-chair: H. Müller-Steinhagen

15:30 – 16:05 **Keynote Lecture - Challenges in Cleaning: Recent Developments and Future Prospects**
D.I. Wilson
University of Cambridge, UK

16:05 – 16:30 **A Mathematical Model of the Removal of Milk Protein Deposit**
H. Xin, X.D. Chen and N. Özkan
The University of Auckland, New Zealand

16:30 – 17:00 Afternoon Coffee

17:00 – 17:25 **The Balance between Chemical and Physical Effects in the Cleaning of Milk Fouling Deposits**
G.K. Christian and P.J. Fryer
University of Birmingham, UK

17:25 – 17:50 **Study of Whey Protein Adsorption under Turbulent Flow Rate**
O. Santos[1], T. Nylander[1], G. Rizzo [3], H. Müller-Steinhagen[3], C. Trägårdh[1] and M. Paulsson[1]
[1] Lund University, Sweden, [2] University of Stuttgart, Germany

17:50 – 18:15 **Direct Measurement of the Forces Required to Disrupt and Remove Fouling Deposits**
W. Liu, Z Zhang G.K. Christian and P.J. Fryer
University of Birmingham, UK

18:15 – 19:30 **Panel Discussion: Designing for Cleaning**
Chair: Ian Wilson, University of Cambridge, UK
Panel : TBA
Topics: Designing for Cleaning, Transfer of Cleaning Technologies, Assurance Issues, Micro-monitoring

19:30 – 21:00 Dinner – on your own. A list of Santa Fe restaurants is available.

21:00 – 23:00 Social Hour

WEDNESDAY, MAY 21, 2003

7:00 – 8:30 Breakfast

SESSION V: PETROLEUM AND ORGANIC FLUID FOULING
Chair: Stanley Kistler, University of Cambridge, Co-Chair: Norman Epstein

8:30 – 8:55 **Fouling of some Canadian Crude Oils**
M. Srinivasan and A.P. Watkinson
The University of British Columbia, Canada

8:55 – 9:20 **Preheat Train Crude Distillation Fouling Propensity Evaluation by Ebert and Panchal Model**
M. Bories and T. Patureaux
TOTALFINAELF, France

9:20 – 9:45 **Retrofitting Crude Oil Refinery Heat Exchanger Networks to Minimise Fouling while Maximising Heat Recovery**
B.L. Yeap[1], D.I. Wilson[1], G.T. Polley[2] and S.J. Pugh[3]
[1] University of Cambridge, UK, [2]pinchtechnology.com, [3]ESDU International plc, UK

9:45 – 10:10 **Chemical Cleaning of Oil Refinery Heat Exchangers - The Need for a Joint Effort -**
H.M. Joshi and G. Brons
ExxonMobil Research and Engineering Co., USA

10:10 – 10:35 Coffee Break

10:35 – 11:00 **Analysis and Countermeasure for Heat Exchanger Fouling in the Aromatic Plant**
S. Isogai and M. Nakamura
Mitsubishi Chemical Co., Japan

11:00 – 11:25 **Heat Exchanger Fouling by a Light Australian Crude Oil**
Z.S. Saleh[1], R. Sheikholeslami[2] and A.P. Watkinson[1]
[1] The University of British Columbia, Canada, [2] The University of New South Wales, Australia

11:25 – 11:50 **Comparison of Crude Oil Fouling Using Two Different Probes**
A.P. Watkinson
The University of British Columbia, Canada

11:50 – 12:15 **Measurement and Modeling for Solution of Crystallization Fouling**
M. Nakamura, H. Inokuchi, H. Kimura, Y. Koga and S. Isogai
Mitsubishi Chemical Co., Japan

12:30 – 13:30 Lunch

13:30 – 15:00 *Ad Hoc* Sessions and/or Free Time

15:00 – 16:00 **Panel Discussion: Issues in Crude Oil and Organic Fouling**
Chair: Himanshu Joshi
Panel: S. Kistler, P. Watkinson
Topics: Industry and Research Needs, Testing Protocols, Deposit Characterization, Task Force Approach

16:00 – 16:25 Coffee Break

SESSION VI: FOULING IN THE POWER INDUSTRIES AND IN BOILING SYSTEMS

Chair: Hans Müller-Steinhagen, German Aerospace Research Centre, Germany

16:25 – 16:50 **Development of a Data-based Method for Performance Monitoring of Heat Exchangers**

A. Sawyer[1], A. E. Ruggles[1], B. R. Upadhyaya[1], E. Eryurek[2], K. Kavaklioglu[2] and J. Miller[2]

[1] University of Tennessee, USA, [2] Emerson Process Management, USA

16:50 – 17:15 **The Early Stages of Deposition of Magnetite Particles onto Alloy-800 Heat Exchange Surfaces**

N. Arbeau, W. Cook and D. Lister

University of New Brunswick, Canada

17:15 – 17:40 **Fouling Enhancement under Flow Boiling at Elevated Steam Qualities**

S.J. Klimas J. M. Pietralik[1], K. Fruzzetti[2] and R.L. Tapping[1]

[1] Atomic Energy of Canada Ltd., Canada, [2] Electric Power Research Institute, California, USA

17:40 – 18:05 **Costs due to Utility Boiler Fouling in China**

Z.M. Xu[1], S.R. Yang[1], S.Q. Guo[2], H. Zhao[3], B. Qi[3]

[1] Northeast China Institute of Electric Power Engineering, China, [2] Chinese Academy of Science, China, [3] Huaneng Dalian Power Plant, China

18:05 – 18:30 **Evaluation of Anti-fouling Performance for Ion-Stick Water Processor by an Automatic Dynamic Simulator of Fouling**

L. F. Sun [1.2], S. R. Yang [1], R. Zhang [1], F. B. Xu [1], Z. M. Xu [1]

[1]Northeast China Institute of Electric Power Engineering, China, [2]North China Electric Power University, China

18:30 – 18:55 **Identification and Testing of Amines for Steam Generator Corrosion and Fouling Control**

S. J. Klimas[1], K. Fruzzetti[2], C.W Turner[1], P.V. Balakrishnan[1], G.L. Strati[1] and R.L Tapping[1]

[1]Atomic Energy of Canada Ltd., Canada, [2] Electric Power Research Institute, USA

18:55 – 19:20 **Overview of Actual Methods for Characterization of Ash Deposition**

Ch. López, S. Unterberger, J. Maier, K.R.G. Hein

University of Stuttgart, Germany

20:00 Conference Banquet followed by Social Hour

THURSDAY, MAY 22, 2003

7:00 – 8:30 Breakfast

SESSION VII: FOULING MITIGATION AND CLEANING
Chair: Peter Fryer, Co-chair: Paul Watkinson

8:30 – 8:55 **Improvements and New Developments - In Self-Cleaning Heat Transfer Leading to New Applications**
D.G. Klaren
Klarex Technology, The Netherlands

8:55 – 9:20 **The Practical Application and Innovation of Cleaning Technology for Heat Exchangers**
G.E. Saxon, Jr and R.E. Putman
Conco Systems, Inc., USA

9:20 – 9:45 **Understanding and Quantifying Cleaning Processes Using Fluid Dynamic Gauging**
J.Y.M. Chew, S.S.S. Cardoso, W.R. Paterson and D.I. Wilson
University of Cambridge, UK

9:45 – 10:10 **Biocide Dosing Strategies for Biofouling Control**
D.M. Grant and T.R. Bott
University of Birmingham, UK

10:10 – 10:35 Coffee Break

10:35 – 11:00 **Fouling Mitigation Using Helixchanger® Heat Exchangers**
B.I. Master[1], K.S. Chunangad[1], and V. Pushpanathan[1]
[1] ABB Lummus Heat Transfer, USA

11:00 – 11:25 **An Effective CIP Procedure for Removing Dairy Protein Based Deposit – A Laboratory Investigation**
X.D. Chen, N. Özkan, F.G. F. Qin, H. Xin, and L. Lin
The University of Auckland, New Zealand

11:25 – 12:30 **Final Discussion and Conference Closure**
Paul Watkinson, University of British Columbia, Canada

12:30 – 14:00 Lunch