FINAL PROGRAM

Heat Exchanger Fouling and Cleaning – 2017

June 11–16, 2017

Occidental Aranjuez (formerly Barceló Aranjuez)
Aranjuez (Madrid), Spain

Conference Chair:
Dr.-Ing. Hans U. Zettler
Heat Transfer Research, Inc., USA

Honorary Conference Chair:
Prof. Hans Müller-Steinhagen
Technische Universität Dresden, Germany

Technical Committee:

Dr.-Ing. Wolfgang Augustin
TU Braunschweig, Germany

Aaron D. Smith, Ph.D.
Heat Transfer Research, Inc., USA

Prof. Derek Lister
University of New Brunswick, Canada

Prof. A. Paul Watkinson
The University of British Columbia, Canada

Prof. Luis Melo
University of Porto, Portugal

Prof. Ian Wilson
University of Cambridge, UK

Sunday, June 11, 2017

15:00 – 17:30 Registration

17:30 – 17:45 Welcome and Opening Address

SESSION 1: INTRODUCTION
Chair: Hans Zettler

17:45 – 18:10 **Industrial Perspective on Fouling Research - Fouling Mitigation through Modifications of Heat Transfer Surfaces**
L. Jackowski, T.Y. Lam, E. Rogel, C.A. Bennett, K. Hench, S. Taylor, and T. Swangphol
Chevron, USA

18:10 – 18:35 **Translating Crude Oil Fouling Testing Rig Data to the Field: A Road Map for Future Research**
A.D. Smith, E.M. Ishiyama, M.R. Lane, and J.S. Harris
Heat Transfer Research, Inc., USA

18:35 – 19:00 **Suitability Of Thin Ceramic Coatings Towards Scale Reduction In Heat Exchangers**
O. Santos[1], M. Nilsson[1], A. H. Jensen[2], and A. B. Christiansen[2]
[1] Alfa Laval, Sweden
[2] SiOx , Denmark

19:30 – 20:30 Dinner

20:30 Social Hour

Monday, June 12, 2017

07:00 – 09:00 Breakfast and Registration

SESSION 2: CRUDE OIL AND HYDROCARBON FLUID FOULING
Chair: Aaron Smith

09:00 – 09:25 **Quantifying Implications of Deposit Aging from Crude Refinery Preheat Train Data**
E.M. Ishiyama[1,3], E.S. Falkeman[2], D.I. Wilson[3], and S.J. Pugh[1]
[1] Heat Transfer Research, Inc. USA
[2] Preem Raffinaderi AB, Sweden
[3] University of Cambridge, UK.

09:25 – 09:50 **Evaluation and Prediction of the Thermal and Hydraulic Impact of Crude Oil Fouling in Exchanger Design Using Pressure Measurements**
K.S. Chunangad, R.Y. Chang, and R.P. Casebolt
ExxonMobil Research and Engineering, USA

09:50 – 10:15 **Complex Crude Oil Fouling Layers: Model Predictions vs. Experimental Compositional Analysis of Refinery Deposits**
E. Diaz-Bejarano[1], F. Coletti[1], and S. Macchietto[1,2]
[1] Hexxcell Ltd., Imperial College Incubator, Imperial College London, UK
[2] Imperial College London, UK

10:15 – 10:45 Break

10:45 – 11:10 **Coke Formation in Bulk and on Surfaces During Heating of Heavy Oils**
W. Wang and A.P. Watkinson
The University of British Columbia, Canada

11:10 – 11:35 **Assessment of Crude Oil Fouling Behavior Using Empirical and Semi-Empirical Models**
A.P. Mello[1], A.R. Souza[1], W.M. Andrade[1], A.L.H. Costa.[1], E.M. Queiroz[2], B.C.G. Assis[3], S.G. de Oliveira[3], and F.S. Liporace[3]
[1] Rio de Janeiro State University (UERJ), Brazil
[2] Federal University of Rio de Janeiro (UFRJ), Brazil
[3] Petróleo Brasileiro S.A. (PETROBRAS), Brazil

SESSION 3: INDUSTRIAL FOULING PROBLEMS
Chair: Les Jackowski

11:35 – 12:00 **Effects of Temperature Conditions and Heat Treatment Within a Multiple Effect Evaporator on Thin Stillage Fouling Characteristics**
B.Y. Zhang[1], D.B. Johnston[2], N.J. Engeseth[1], B.S. Dien[3], V. Singh[1], M.E. Tumbleson[1], and K.D. Rausch[1]
[1] University of Illinois at Urbana-Champaign, IL, USA
[2] Eastern Regional Research Center, ARS, USDA, PA, USA
[3] National Center for Agricultural Utilization Research, ARS, USDA, IL, USA

12:00 – 12:25 **Fouling in a Steam Cracker Convection Section Part 1: A Hybrid CFD-1D Model to Obtain Accurate Tube Wall Temperature Profiles**
P. Verhees[1], A.R. Akhras[2], K.M. Van Geem[1], and G.J. Heynderickx[1]
[1] Laboratory for Chemical Technology, Belgium
[2] Saudi Aramco, KSA

13:00 – 14:00 Lunch

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

SESSION 4: FOULING IN POWER PLANTS
Chair: Derek Lister

16:00 – 16:25 **Calcium Phosphate Scale Formation in Power Station Condensers Fed by Cooling Towers: A Case of when Not to Use Scaling Indices**
D. Hawthorn[1] and D.I. Wilson[2]
[1] minDEP Research, UK
[2] University of Cambridge, UK

16:25 – 16:50 **Design of an Experimental Set-Up to Determine the Influence of Corrosion on Heat Transfer**
W. Faes[1,2], S. Lecompte[1], J. Van Bael[2], R. Salenbien[2], and M. De Paepe[1]
[1] Ghent University, Belgium
[2] VITO, Belgium

16:50 – 17:15 **Characterization of Fouling Deposits Formed by Laboratory Tests on Nickel Based Tubes Under Pressurized Water Reactor Steam Generator Secondary Side Conditions**

K. Ardon[1,2], F. Gaslain[2], C. Duhamel[2], G. Lefèvre[1], S. Delaunay[3], and C. Goujon[3]
[1] PSL Research University, CNRS, Institut de Recherche de Chimie Paris (IRCP), France
[2] MINES ParisTech, PSL Research University, Centre des Matériaux, France
[3] EDF R&D/Chemistry and Corrosion Group, France

17:15 – 19:00 Afternoon Coffee followed by Poster Session

SESSION 5: POSTERS
Chair: Hans Zettler

Characterization of Fouling in Wet Cooling Towers and Impact on Heat Transfer

I.S.M. Pinel[1], D. Moed[2], M.C.M. van Loosdrecht[1], and J.S. Vrouwenvelder[1]
[1] Delft University of Technology, The Netherlands
[2] Evides Industriewater, The Netherlands

Compositional and Structural Changes on Heat Exchanger Deposits after Concentrated Sodium Hydroxide Treatment

B. Phakam, L. Moghaddam, A. G. Baker, C. P. East, and W. O. S. Doherty
[1] Postal address: GPO Box 2432, 2 George St, Brisbane, QLD 4001, Australia

Structural investigations of calcium oxalate/silica composites from heat exchangers by FTIR and ^{29}SI NMR analysis

B. Phakam, L. Moghaddam, and W.O. S. Doherty
Queensland University of Technology, Australia

Predicting Deposition onto Superheater Tubes in Biomass and Coal-Fired Combustion Systems

C. Riccio, N.J. Simms, and J.E. Oakey
Cranfield University, UK

The Effect of EGR Cooler Design on Particulate Fouling

Jiří Bazala[1], Guillaume Hébert[2], and Oliver Fischer[3]
Hanon Systems
[1] Korytná 373, 687 52, Czech Republic
[2] Za Radnicí 1889, Staré Město, 686 03, Czech Republic
[3] August-Macke-Str. 52, 52076 Aachen, Germany

19:30 – 20:30 Dinner

20:30 Social Hour

Tuesday, June 13, 2017

07:00 – 08:30 Breakfast

SESSION 6: CRYSTALLIZATION FOULING
Chair: Wolfgang Augustin

08:30 – 08:55 **Measuring Local Crystallization Fouling in a Double-Pipe Heat Exchanger**
F. Schlüter[1], L. Schnöing[1], H. Zettler[2], W. Augustin[1], and S. Scholl[1]
[1] Technische Universität Braunschweig, Germany
[2] Heat Transfer Research, Inc., USA

08:55 – 09:20 **Impact of Crystallization Fouling on the Moisture Transfer Resistance of a Liquid-To-Air Membrane Energy Exchanger**
A.O. Olufade[1] and C.J. Simonson[1]
[1] University of Saskatchewan, Canada

09:20 – 09:45 **A Novel Fouling Cell to Study Influence of Solution on Crystallisation Fouling**
P. Besevic[1], S.M. Clarke[2], G. Kawaley[3], and D.I. Wilson[1]
[1] Department of Chemical Engineering and Biotechnology, West Cambridge Site, UK
[2] Department of Chemistry and BP Institute, Madingley Rise, UK
[3] Mitsubishi Electric R&D Centre Europe BV, UK

09:45 – 10:10 **Effect of Silica on Calcium Carbonate Fouling, Including the Effect of Silica on Aging of Calcium Carbonate Fouling Material**
P. Besevic[1], S.M. Clarke[2], G. Kawaley[3], and D.I. Wilson[1]
[1] Department of Chemical Engineering and Biotechnology, West Cambridge Site, UK
[2] Department of Chemistry and BP Institute, Madingley Rise, UK
[3] Mitsubishi Electric R&D Centre Europe BV, UK

SESSION 7: BIOFOULING
Chair: Luis Melo

10:10 – 10:35 **Effects of the Corrosion Product Layer on Copper-Nickel Tubes on Crystallization Fouling in Multiple-Effect Distillers for Seawater Desalination**
H. Glade[1], M. Waack[1], A. Stärk[1], S. Sujandi[2], and S. Nied[3]
[1] University of Bremen, Germany
[2] BASF SE, Singapore
[3] BASF SE, Germany

10:35 – 11:05 Break

11:05 – 11:30 **A New and Novel Abiotic-Biotic Fouling Sensor for Aqueous Systems**
P. Bierganns[1] and E.S. Beardwood[2]
[1] Solenis Technologies, Germany
[2] Solenis LLC, USA

11:30 – 11:55 **Interaction of *E.Coli* and Autochthonous River Water Microorganisms With Polymers in Heat Transfer Applications**
S. Pohl[1], M. Madzgalla[2], W. Manz[2], and H.-J. Bart[1]
[1] University of Kaiserslautern, Germany
[2] University of Koblenz-Landau, Germany

11:55 – 12:20 **Understanding Biofouling by Resorting to Meso-Scale Modelling**
R. Qiu§, J. Xiao, and X. D. Chen
Soochow University, China

13:00 – 14:00 Lunch

14:30 Conference Excursion including Dinner

22:15 Social Hour

Wednesday, June 14, 2017

07:00 – 08:30 Breakfast

SESSION 8: FOULING DURING FOOD PROCESSING
Chair: Kent Rausch

08:30 – 08:55 **Continuous Monitoring of Whey Protein Fouling Using a Non-Intrusive Sensor**
L. Bouvier[1], G. Delaplace[1], and S. Lalot[2]
[1] Univ. Lille, France
[2] LAMIH UMR 8201 - Campus Mont Houy, France

08:55 – 09:20 **Influence of Calcium/ B-LG Molar Ratio on Plate Heat Exchanger Fouling for Various Whey Protein Solutions**
G. Delaplace[1], Y. Gu[1,2] M. Khaldi[1], L. Bouvier[1], C. André[1,4], J. Petit[1,3], R. Guerin[1], G. Ronse[1], T. Six[1], A. Moreau[1], M. Jimenez[1], S. Bellayer[1], T. Croguennec[2], R. Jeantet[2], and P. Blanpain-avet[1]
[1] Univ. Lille, France
[2] Laboratoire de Génie des procédés, France
[3] Univ. de Lorraine - LIBio, France
[4] Agrocampus Ouest, France

SESSION 9: FOULING MITIGATION AND DESIGN
Chair: Nicolas Aubin

09:20 – 09:45 **Shell-and-Tube Heat Exchanger Geometry Modification: An Efficient Way to Mitigate Fouling**
A. Chambon[1], Z. Anxionnaz-Minvielle[2], G. Cwicklinski[2], N. Guintrand[1], A. Buffet[3], and B. Vinet[2]
[1] TOTAL Research & Technology Gonfreville, France
[2] Univ. Grenoble Alpes, France
[3] TECHNIP, France

09:45 – 10:10 **Fouling Mitigation Using Estimated Fouling Layer Thickness in Finned Tube Heat Exchanger**
T. Kuwahara
Mitsubishi Chemical Corporation, Japan

10:10 – 10:35 **The Impact of Fouling on the Optimal Design of a Heat Exchanger Network: An Industrial Case Study**
E. Diaz-Bejarano[1], M. Yugo Santos[2], Manolo García Dopico[3], L. Lanchas-Fuentes[1], and F. Coletti[1]
[1] Hexxcell Ltd., Imperial College Incubator, Imperial College London, UK
[2] Repsol, Corporate Safety, Environment & Sustainability Division
[3] Repsol, Heat Transfer, Engineering Division

10:35 – 11:05 Break

SESSION 10: EFFECT OF SURFACE PROPERTIES
Chair: Olga Santos

11:05 – 11:30 **Experimental Analysis of Soot Particle Fouling on EGR Heat Exchangers: Effect of Velocity on the Deposited Particle Size Distribution**
Paz C., Suarez E., Concheiro M., and Vence J.
University of Vigo, Spain

11:30 – 11:55 **Development of Thin Sol-Gel Coatings for Heat Exchanger Fouling Mitigation at Elevated Temperatures**
C. Bischoff[1], R. Losada[1], T. Poulsen[1], L. Jackowski[2], and S. Taylor[2]
[1] Danish Technological Institute, Denmark
[2] Chevron Energy Technology Company, USA

11:55 – 12:20 **A Holistic Approach to Heat Exchanger Plate Surface Design**
J. Lebga-Nebane and S. Chizen
Armorix Inc., Alberta

12:20 – 12:45 **Progress Update Bioinspired Anti-Adhesive Surfaces**
S. Mulansky, M. Saballus, and E. Boschke
Technische Universität Dresden, Germany

13:00 – 14:00 Lunch

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

16:00 – 16:25 **A Fouling Micro-System For Investigating Fluoropolymer Anti-Fouling Coatings In Bovine Milk Pasteurization**
O.M. Magens[1], J. Hofmans[2], and D.I. Wilson[1]
[1] University of Cambridge, UK,
[2] Chemours Belgium BVBA, Belgium

16:25 – 16:50 **Thermo-Hydraulic Analysis of Structured Heat Transfer Surfaces Under Consideration of Particulate Fouling Using A Multiphase Eulerian-Lagrangian Method**
R. Kasper, J. Turnow, and N. Kornev
University of Rostock, Germany

16:50 – 17:15 **Fouling-Release Coatings for Steam Condensers in Thermal Power Plants**
S. Holberg and R. Losada
Danish Technological Institute, Denmark

17:15 – 17:45 Afternoon Coffee

17:45 – 18:10 **Crystallization Fouling by Modified Heat Exchanger Surfaces**
M. Riihimäki[1], T.M. Pääkkönen[1], J. Guillot[2], E. Lecoq[2], E. Muurinen[1], C.J. Simonson[3], and R.L. Keiski[1]
[1] University of Oulu, Finland
[2] Luxembourg Institute of Science and Technology, Luxembourg
[3] University of Saskatchewan, Canada

18:10 – 18:35 **Inhibition of Fouling with Titania and Silica Coatings on Plate Heat exchanger in 80℃ Simulated Geothermal Water**
F. Zhang[1], M.Y. Liu[1, 2], and W.D. Zhou[1]
[1] Collaborative Innovation Center of Chemical Science and Engineering School of Chemical Engineering and Technology, Tianjin University, China
[2] State Key Laboratory of Chemical Engineering, Tianjin University, China

19:30 – 22:30 Conference Banquet

22:30 Social Hour

Thursday, June 15, 2017

07:00 – 08:30 Breakfast

SESSION 11: CLEANING OF HEAT EXCHANGERS
Chair: Paul Watkinson

08:30 – 08:55 **Stainless Steel Filter Screen With Bipolar Wettability for Gravity-Driven Oil-Water Separation**
Y. Xu[1], M.Y. Liu[1, 2], and H. Li[1]
[1] Collaborative Innovation Center of Chemical Science and Engineering, School of Chemical Engineering and Technology, Tianjin University, China
[2] State Key Laboratory of Chemical Engineering (Tianjin University), China

08:55 – 09:20 **Cost Reduction by Merging Cleaning and Decontamination**
Ing. W. van de Meent
Keurweg 10, 5145 NX Waalwijk, The Netherlands

09:20 – 09:45 **Fluid Dynamic Gauging of Pulsed Flow Cleaning**
N. Gottschalk, S. Foisel, F. Schlüter, W. Augustin, and S. Scholl
Technische Universität Braunschweig, Germany

09:45 – 10:10 **Mechanical Online System for Cleaning Heat Exchanger Tubes by Sponge Rubber Balls (TAPROGGE-System)**
R. Kleinebrahm
TAPROGGE GmbH, Germany

10:10 – 10:35 **The Custom Design and Fabrication of a Condenser Automatic Tube Cleaning System for Dominion Power**
D.P. Ross[1], P.A. Cirtog[1], M. Crocker[2], and C. Dirks[2]
[1] Pangolin Associates, Australia
[2] Innovas Technologies LLC, USA

10:35 – 11:05 Break

11:05 – 11:30 **Prediction of Cleaning by Means of Computational Fluid Dynamics: Implication of the Pre-Wetting of a Swellable Soil**
M. Joppa, H. Köhler, F. Rüdiger, J.-P. Majschak, and J. Fröhlich
Technische Universität Dresden, Germany

11:30 – 11:55 **Energy savings from the Automatic Tube Cleaning System (ATCS)**
D.P. Ross[1], P.A. Cirtog[1], Z. Cuckovic[2], G. Bridges[2], M. Crocker[3], and C. Dirks[3]
[1] Pangolin Associates, Australia
[2] University of Adelaide, Australia
[3] Innovas Technologies LLC, USA

11:55 – 12:20 **Improved Methods for Removal of Silicate Deposits**
T.R. McCartney, Samar Gharaibeh, and Roxanne Shank
2-321 37 N.E. Calgary, AB

12:20 – 12:45 **Crude Oil Fouling Mitigation Using Internally Finned Tubes**
H.M. Joshi[1], T. Lang[2], J. El Hajal[2], and A.D. Smith[3]
[1] Shell Global Solutions (US) Inc., USA
[2] Wieland-Werke AG, Germany
[3] Heat Transfer Research, Inc., USA

13:00 – 14:00 Lunch

14:00 – 16:30 Ad hoc Sessions and/or Free Time

SESSION 12: PARTICULATE FOULING
Chair: Francesco Coletti

16:30 – 16:55 **Design of a Cooled Fouling Probe to Investigate Scaling Mechanisms from the Aluminium Production Off-Gas**
D.P. Clos[1], Heiko Gaertner[1,3], Petter Nekså[2], Sverre Gullikstad Johnsen[3], and Ragnhild Elizabeth Aune[1]
[1] Norwegian University of Science and Technology (NTNU), Norway
[2] SINTEF Energy Research, Norway
[3] SINTEF Materials and Chemistry, Norway

16:55 – 17:20 **Soot Fouling On EGR Coolers (EGRC): Diesel EGRC-Soot Characterization**
Y. Bravo, C. Arnal, and C. Larrosa
Valeo Powertrain Thermal Systems, Spain

17:20 – 17:50 Afternoon Coffee

SESSION 13: HEAT EXCHANGER FOULING MONITORING
Chair: Ian Wilson

17:50 – 18:15 **Fouling Monitoring of a Thermosiphon Reboiler**
Y. Yamashita[1], S. Iwahashi[2], T. Kuwahara[2], K. Kawabata[2], and Y. Yamane[2]
[1] Tokyo University of Agriculture and Technology, Japan
[2] Mitsubishi Chemical Corporation, Japan

18:15 – 18:40 **Effect of Flow Distribution in Parallel Heat Exchanger Networks: Use of Thermo-Hydraulic Channeling Model in Refinery Operation**
E.M. Ishiyama[1,2] and S.J. Pugh[1]
[1] Heat Transfer Research, Inc., USA
[2] University of Cambridge, UK

19:30 – 20:30 Dinner

20:30 Social Hour

Friday, June 16, 2017

07:00 – 08:30 Breakfast

SESSION 14: FOULING OF COMPACT AND MICRO HEAT EXCHANGERS
Chair: Stephan Scholl

08:30 – 08:55 **Development Of A CFD Model For Predicting Fouling Process Using Dynamic Mesh Model**
Paz C., Suarez E., Conde M., and Vence J.
University of Vigo, Spain

08:55 – 09:20 **Review of Recent Research on Fouling in PHEs**
H.B. Luan[1,2], J.P. Kuang[1], Z. Cao[3], Z. Wu[3], and B. Sunden[3]
[1] Shenhua Ningxia Coal Industry Group Co. Ltd, China
[2] Shanghai Marine Diesel Engine Research Institute, China
[3] Lund University, Sweden

09:20 – 09:45 **Fouling of Polymeric Hollow Fiber Heat Exchanger by ASHRAE 52.1 Test Dust**
I. Astrouski[1], M. Raudensky[2], and M. Dohnal[3]
[1] Heat Transfer Systems, Czech Republic
[2] Brno University of Technology, Czech Republic
[3] Zena Membranes, Czech Republic

09:45 – 10:10 **The Role Of Binary Mixtures of Particles on Air-Side Fouling of Compact Heat Exchangers**
F M J McCluskey and R Haghighi-Khoshkhoo
Université Grenoble Alpes, France

10:10 – 10:35 **Corrosion and Fouling Properties of Material Surfaces in Simulated Huabei Oilfield Geothermal Water**
Y. Lv[1,2], M.Y. Liu[1,3], and Y.S.H. Xu[1]
[1] Tianjin 300350, China
[2] Tangshan University, China
[3] State Key Laboratory of Chemical Engineering (Tianjin University), China

10:35 – 11:05 Break

SESSION 15: FLUIDIZED BED
Chair: Simon Pugh

11:05 – 11:30 **Horizontal Shell Side Fluidized Bed Heat Exchanger, Design Considerations and Experiences from a Pilot Unit**
M.C. van Beek and M. Cancela Vallespin
Klaren International, The Netherlands

11:30 – 11:55 **Concentration of Extraction Liquids of Traditional Chinese Medicines in an Industrial Scale Fluidized Bed Evaporator**
M.Y. Liu [1, 2], N.S. Ling [3], J. Zheng [1], Y.G. Fan [3], H.H. Zhang [1], Z.X. Li [3], Y. Ma [1], D.L. Li [3], X.P. Xu [1], Y. Wang [3], and X.L. Li[1]
[1] Collaborative Innovation Center of Chemical Science and Engineering, School of Chemical Engineering and Technology, Tianjin University, China
[2] State Key Laboratory of Chemical Engineering, Tianjin University, China
[3] Zhongxin Pharmaceutical Factory, Zhongxin Pharmaceuticals Group, Ltd., China

11:55 – 12:20 **Fluidized Bed Heat Exchangers for the Evaporation of Waste Waters: Design Advantages and Operational Experiences**
M. Cancela Vallespin, P. Kedia, and M.C. van Beek
Klaren International, The Netherlands

12:30 – 13:00 **Final Discussion, Chair: Hans Zettler**

13:00 – 14:00 Lunch