

## TABLE OF CONTENTS

<b>PREFACE</b> .....	5
<b>CRUDE OIL</b>	
<b>Deposition from Crude Oils in Heat Exchangers</b> ..... A.P. Watkinson	7
<b>Extraction of Crude Oil Fouling Model Parameters from Plant Exchanger Monitoring</b> ..... G.T. Polley, D.I. Wilson, S.J. Pugh and E. Petitjean	17
<b>Ten years of Ebert, Panchal and the ‘Threshold Fouling’ Concept</b> ..... D.I. Wilson, G.T. Polley and S.J. Pugh	25
<b>Blending Effects in Fouling of four Crude Oils</b> ..... Z.S. Saleh, R. Sheikholeslami and A.P. Watkinson	37
<b>HYDROCARBON PROCESSING</b>	
<b>Fouling Behavior of Pyrolysis Gasoline over Carbon Steel and Stainless Steel Alloys</b> ..... M. Sprague, P. Herrera and A. Krzywicki	47
<b>Mathematical Modeling of Deposition of Carbonaceous Material from Heavy Hydrocarbon Vapors</b> ..... W. Zhang and A.P. Watkinson	53
<b>Fouling Mitigation by Design</b> (Full-length manuscript on page 342) ..... J. Nesta and C.A. Bennett	54
<b>INDUSTRIAL PROCESSES</b>	
<b>Contributing Factor Analysis and its Application for an Alcohol Plant Reboiler Fouling Phenomena</b> ..... S. Isogai, M. Nakamura and S. Nishimura	55
<b>Deposit Formation in the Evaporator of a Sulfuric Acid Recovery Plant for TiO<sub>2</sub> Pigment Production</b> ..... H. Müller-Steinhagen and D. Lancefield	59
<b>Fouling Mitigation of a Reboiler by Optimization of the Additive and Operating Conditions</b> ..... S. Isogai and M. Nakamura	65
<b>Enhanced Heat Exchanger Tubes: Their Fouling Tendency and Potential Cleanup</b> ..... G.F. Hays, E.S. Beardwood and S.J. Colby	71
<b>A Preliminary Study of the Effect of Surface Coating on the Initial Deposition Mechanisms of Dairy Fouling</b> .....	88

S.S. Ramachandra, S. Wiehe, M.M. Hyland, X.D. Chen, and B. Bansal

**Anti-fouling Stainless Steel Based Surfaces for Milk Heating Processes**..... 97  
R. Rosmaninho, G. Rizzo, H. Müller-Steinhagen and L.F. Melo

**Development and Evaluation of Ni–Cu–P–PTFE Composite Coatings to Minimize Microbial Adhesion** ..... 103  
Q. Zhao, Y. Liu, C. Wang, S. Wang and H. Müller-Steinhagen

## PARTICULATE FOULING

**The Fouling of Alloy-800 Heat Exchanger Tubes by Nickel Ferrite under Bulk Boiling Conditions** ..... 109  
J.L. Cossaboom and D.H. Lister

**Particulate Fouling Growth Rate as Influenced by the Change in the Fouling Layer Structure**..... 119  
M.S. Abd-Elhady, C.C.M. Rindt, J.G. Wijers and A.A. van Steenhoven

**Today's Techniques for Heat Exchanger Protection via Particle Filtration** ..... 127  
K. Colby and C. Hoffmann

## DAIRY PROCESSING

**Skim Milk Fouling during Ohmic Heating**..... 133  
B. Bansal, X.D. Chen and S.X.Q. Lin

**Heat Treatment of Dairy Product by a Flat Ohmic Cell: Impact of the Reynolds Number, Fluid Rheology and Fouling Presence on the Electrode Surface Temperature** ..... 141  
M.A. Ayadi, T. Benezech, F. Chopard, M. Berthou and J.C. Leuliet

**Fouling of Heat Exchanger by Dairy Fluids – A Review**..... 149  
B. Bansal and X.D. Chen

**The Poor Performance of NaOH in the Dissolution of Whey Protein Gels at very High pH**..... 158  
R. Mercade-Prieto, X.D. Chen, R.J. Falconer, W.R. Paterson and D.I. Wilson

**Pulsed Flow Cleaning of Whey Protein Fouling Layers**..... 165  
K. Bode, R.J. Hooper, W. Augustin, W.R. Paterson, D.I. Wilson and S. Scholl

**Analytical Approaches for Calculation of Shear Stress Enhancement in Laminar Pulsed Flows** ..... 174  
M.S. Celnik, M.J. Patel, M. Pore, F. Brahim, W. Augustin, S. Scholl, D.M. Scott and D.I. Wilson

## MICRO HEAT EXCHANGERS

**Strategies against Particle Fouling in the Channels of a Micro Heat Exchanger Subject to  $\mu$ PIV Flow Pattern Measurements**..... 183  
V. Heinzl, A. Jianu and H. Sauter

<b>Particulate Fouling Processes in Micro-Structured Devices</b> .....	191
N. Kockmann, M. Engler and P. Woias	
<b>Anti Fouling Investigations with Ultrasound in a Microstructured Heat Exchanger</b> .....	197
W. Benzinger, U. Schygulla, M. Jäger and K. Schubert	
<b>MECHANICAL MITIGATION</b>	
<b>‘Zero Fouling’ Self-Cleaning Heat Exchanger</b> .....	202
D.G. Klaren, E.F. de Boer and D.W. Sullivan	
<b>Fouling Reduction Characteristics of a Circulating Fluidized Bed Heat Exchanger</b> .....	208
Y.D. Jun, K.B. Lee, S.Z. Islam and S.B. Ko	
<b>Compact Self-Cleaning Fluidized Bed Heat Exchangers with EM Baffles</b> .....	215
D.G. Klaren and E.F. de Boer	
<b>ENHANCED HEAT TRANSFER</b>	
<b>Heat Exchanger Tube Inserts - An Update in New Applications with Trouble Shooting Aspects in Crude Units, Residue Service, Reboilers, U-Tubes</b> .....	221
F. Pouponnot and A.W. Krueger	
<b>Measurement of Particle-fluid Velocities of a Particle Containing Fluid Flow in a Grooved Channel</b> .....	231
D.X. Jin, D.Y. Lee and Y.P. Lee	
<b>POWER PLANTS</b>	
<b>Tubular Type Heat Flux Meter for Monitoring Internal Scale Deposits in Large Steam Boilers</b> .....	239
J. Taler and D. Taler	
<b>Monitoring and Modelling of Gas-Side Boiler Fouling</b> .....	248
R. Korbee, M. Losurdo, J. Lensselink, M.K. Cieplik and F. Verhoeff	
<b>Initiation of CaSO<sub>4</sub> Scale Formation on Heat Transfer Surfaces under Pool Boiling Conditions</b> .....	255
M.R. Malayeri and H. Müller-Steinhagen	
<b>MONITORING</b>	
<b>Neural Network based On-line Detection of Fouling in a Water Circulating Temperature Controller (WCTC)</b> .....	263
S. Lecoeuche and S. Lalot	
<b>Real Time Fouling Diagnosis and Heat Exchanger Performance</b> .....	267
F. dos Santos Liporace and S.G. de Oliveira	

## BIOFOULING

- The Environmental Effect of Heat Exchanger Fouling: A Case Study**..... 278  
T. Casanueva-Robles and T.R. Bott
- Effect of Polarization on Manganese Biofouling of Heat Exchanger Surfaces** ..... 283  
T. Kuosmanen, M. Peltola, M. Raulio, M. Pulliainen, T. Laurila, J-F. Selin,  
H. Huopalaainen and M. Salkinoja-Salonen
- Economic and Performance Evaluation of two Oxidising Biocides in  
Sea-water Cooling Systems** ..... 289  
T. Casanueva-Robles, E. Nebot, J.F. Casanueva, M.M. Fernández-Bastón and D.Sales

## MODELLING AND FUNDAMENTALS

- Crystallization Fouling on Heat Transfer Surfaces – 25 Years Research in Braunschweig** ..... 295  
M.W. Bohnet
- Molecular Modelling Approach on Fouling of the Plate Heat Exchanger:  
Titanium Hydroxyls, Silanols and Sulphates on TiO<sub>2</sub> Surfaces** ..... 303  
E. Puhakka, M. Riihimäki and R.L. Keiski
- Calcium Sulfate Scaling Delay Times under Sensible Heating Conditions** ..... 310  
F. Fahiminia, A.P. Watkinson and N. Epstein
- Induction Period of Heterogeneous Nucleation during Crystallisation Fouling**..... 316  
G. Rizzo, H. Müller-Steinhagen and E. Richter

## MECHANICAL CLEANING

- Optimised Heat Exchanger Management - Achieving Financial and  
Environmental Targets**..... 327  
S. Rädler and U. Ousko-Oberhoffer
- On-line Cleaning Schedule for Heat Exchangers in a Heat Exchanger  
Network– the Case of Crude Distillation Unit** ..... 332  
M. Markowski and K. Urbaniec