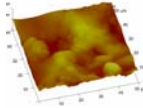
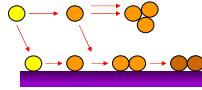


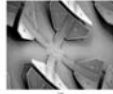
Mitigation technologies

- Can't change the process \Rightarrow change the unit
 - Better design
 - Exploit velocity effects in attachment
- Change the nature of attachment \Rightarrow change the surface
 - Geothermal systems
 - Crystallisation fouling



Attachment a_f(surface energy, roughness, moiety, shape)

Tailored nano-structured surfaces



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MODSTEEL

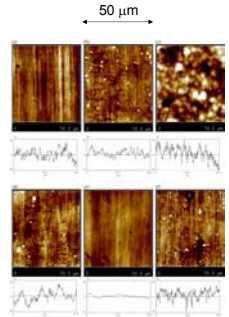
Hans Visser

- Lund, Porto, Stuttgart, Thessaloniki
- INRA-LGPTA, CR Isbergues
- EU Competitive & Sustainable Growth Programme GRD1-1999-10856

Surface treatment of stainless steels

- ion implantation SiF_3^+ , MoS_2^{2+}
- diamond-like carbon
- plasma enhanced CVD
- silica surfaces: hard glass (PECVD) and sol-gel (hydrophobic & -philic)
- Teflon by autocatalytic Ni-P-PTFE deposition (hydrophobic non-stick)
- Excalibur®
- Xylan®

- Rigorous characterisation and study of β -lg adsorption, fouling & cleaning

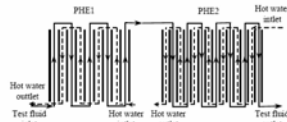


8

Published findings

Effects on adsorption of proteins

- surface energies noticeably affected
- strong f (surface, bulk conditions, T)
- DLC surface most effective, *but*
- alteration after cleaning



PHEx trials

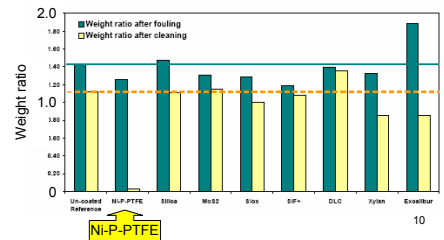
- no significant difference in fouling between modified steels

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Published findings

PHEx trials

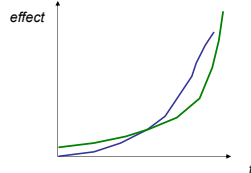
- no significant difference in fouling between modified steels
- cleaning efficiency of Ni-P-PTFE significantly better
- effect of fouling and cleaning on surfaces
- conditioning



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Problem overview

- Fouling and cleaning are symbiotic



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A holistic recipe list

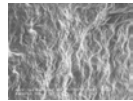
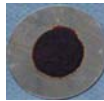
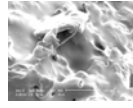
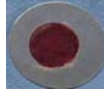
Are fouling mitigation and effective cleaning compatible?

- Fouling mechanisms
 - processing
 - design
 - surfaces
- Ageing : initial conditions for cleaning
- Cleaning
 - method
 - mechanisms
 - atmosphere
 - environmental impact
- Disinfection
 - pre-conditioning for fouling (sorry, processing)

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Ageing – the linking phenomenon

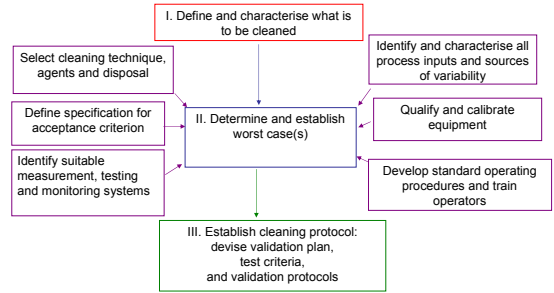
'The most poorly understood aspect of fouling'



Also : thermophile survival

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A systematic approach

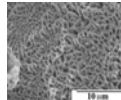
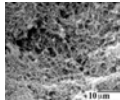
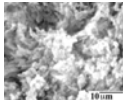
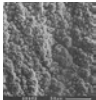


after Crockford [2003]

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The science of cleaning and detachment

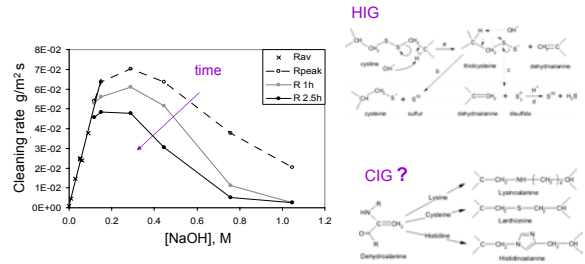
• CIP



- improvements in
 - understanding
 - models
 - measurements

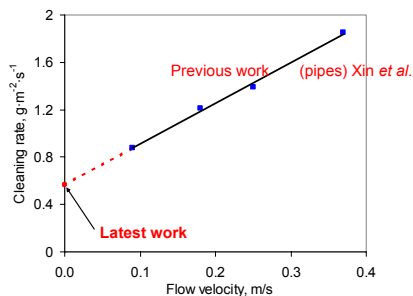
15

Concentration optima in caustic cleaning



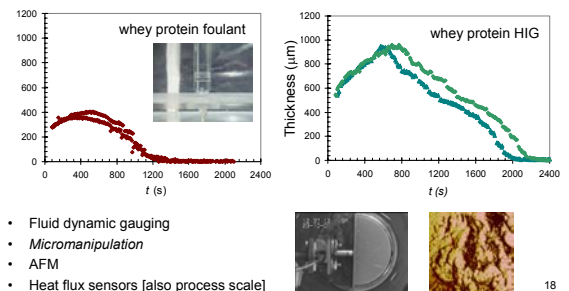
[Mercade & Chen, Auckland] 16

CIP : hydraulic and chemical effects



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studying cleaning : fine scale

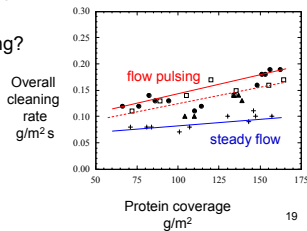


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Alternative processes

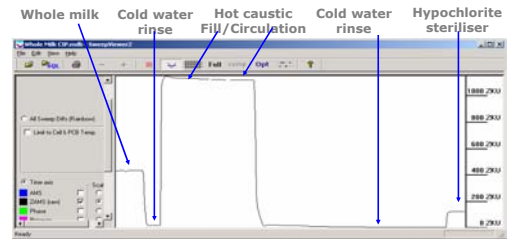
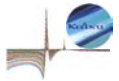
- Chemistry better understood
- Physical strength can be measured
- Predictive capacity for cleaning

Use clever processing : pulsing?

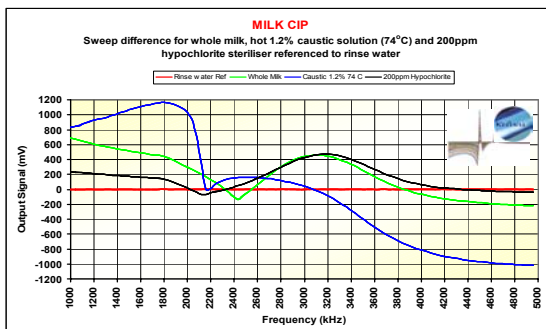


Closing the loop: monitoring

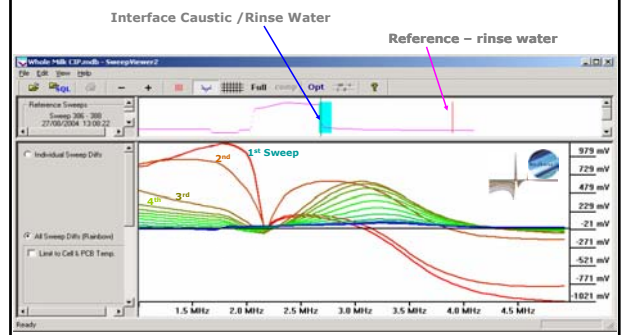
- Assuring CIP
- Better sensors



CIP Process – Product Signatures



CIP – Interface – Caustic / Rinse water



Summary

- Thermal processing of milk is unlikely to be free from fouling
- Our understanding of fouling means that we can identify fouling resistant designs and surfaces
- Our understanding of cleaning is improving so that we can clean and monitor cleaning more effectively
- Real progress lies in a holistic and synergistic approach where fouling mitigation and cleaning effectiveness are considered **together** from the outset

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- Rowan Hooper, John Chew & Bill Paterson, Cambridge
- Kaiku www.kaiku.co.uk



www.cheng.cam.ac.uk/FCD2006.html/

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[slide #]

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