Process Intensification Network

The Beehive - Newcastle University:
Thursday 16.11.06.

PI IN FOOD & DRINK PROCESSING –

Opportunities, Barriers & Some Solutions To Savour

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In Collaboration with: The TECHNOLOGY PARTNERSHIP plc

Menu

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Opportunities for PI

Moving to PI – First Steps

Barriers to PI Uptake

Some Solutions To Savour

Closing Remarks

OPPORTUNITIES for PI

Must Accommodate:

Daily Raw Material Variability

Rapid Product Change-Over
(Inc. cleaning & sanitation)

Must Deliver:

Wide Product Range

Strict Product Quality & Safety
Consistent performance

FLEXIBLE

PROCESS CAPABILITY

TOTAL COST - CONSISTENT & LOW

Daily/Hourly Off-Take Changes

Despatch Pressures (delivery "windows")

Serious Cost Pressures
People/training, energy/water, margins

Constant Product Innovation

Cost-Effective Solutions

Ease of Auditing
Food quality/safety, H&S, & costs

OPPORTUNITIES for PI

Wrong sized, inflexible processing equipment:
SS kit looks good, but is often not fit for purpose – much waste of:
food materials, energy & water, human time & effort – *Example*

Consequences for UK Food Processing (% of totals for UK Plc)**:**

Energy – 14%, **Water – 10%** **Waste Output – 10% ***

"Sustainable" Food Production:

10% (est.) **- £6.6bn** of the sector's t/o is directly at risk from climate change **
The Stern Review – PI as a sector response??
More food from less: energy, water/waste water, raw materials, cleaning/sanitising

Low profit margins from current methods- typically 6%

Overseas competition now taking market share and some jobs

* *[Data: DEFRA, ** Environment Agency 2005]*

MOVING to PI – First Steps

Step 1: Demonstrate relevant PI capability and attractive total cost

Mix + heat/react + cool - a very common food processing sequence

The Continuous Oscillatory Baffle Reactor* is a potential PI solution
(PI for the stirred, jacketed "kettle" commonly used for mix + heat/react + cool)

Assemble PI demonstration modules to achieve this sequence
Produce the following data in support of PI:

- Equipment – capital and installation costs
- Typical operating costs: Product/material wastage and run-time limits, cleaning & sanitation, utilities usage, labour, technical support & consumables
- Cleaning and sanitation performance
- Product quality to match or exceed conventional processing

* [The speaker acknowledges the kind assistance of The Centre for Process Innovation, Wilton, in authorising the use of this example.]

BARRIERS to PI UPTAKE

Human: Letting go of what we know can be quite hard – e.g. career security

Sector product innovation, **not** always matched in process innovation

Faster, flexible processing **not** always as welcome by time-pressured people

Technical: Surface deposits - efficiency loss, cleaning problems

Cleaning/sanitation problems - resulting from surface deposits

Process control - from batch to faster, continuous flow - modelling

Transition issues - compatibility with service plant & batch plant

Equipment Cost(?): Intricate equipment made to food contact standards

SOME SOLUTIONS TO SAVOUR: Surface Deposits

[These *Solutions* are courtesy of The Technology Partnership plc]

Solutions to surface deposits still required, despite lower dwell times & ΔT

Solution to Savour – Micro-structured food contact surfaces:

Repel biological materials – the Lotus leaf effect

Can be tailored for a given duty – surface features down to 250nm diameter

Applicable to a variety of materials – e.g. polymers

Produced via low cost technologies – e.g. casting, embossing, or moulding

SOME SOLUTIONS TO SAVOUR: Surface Deposits

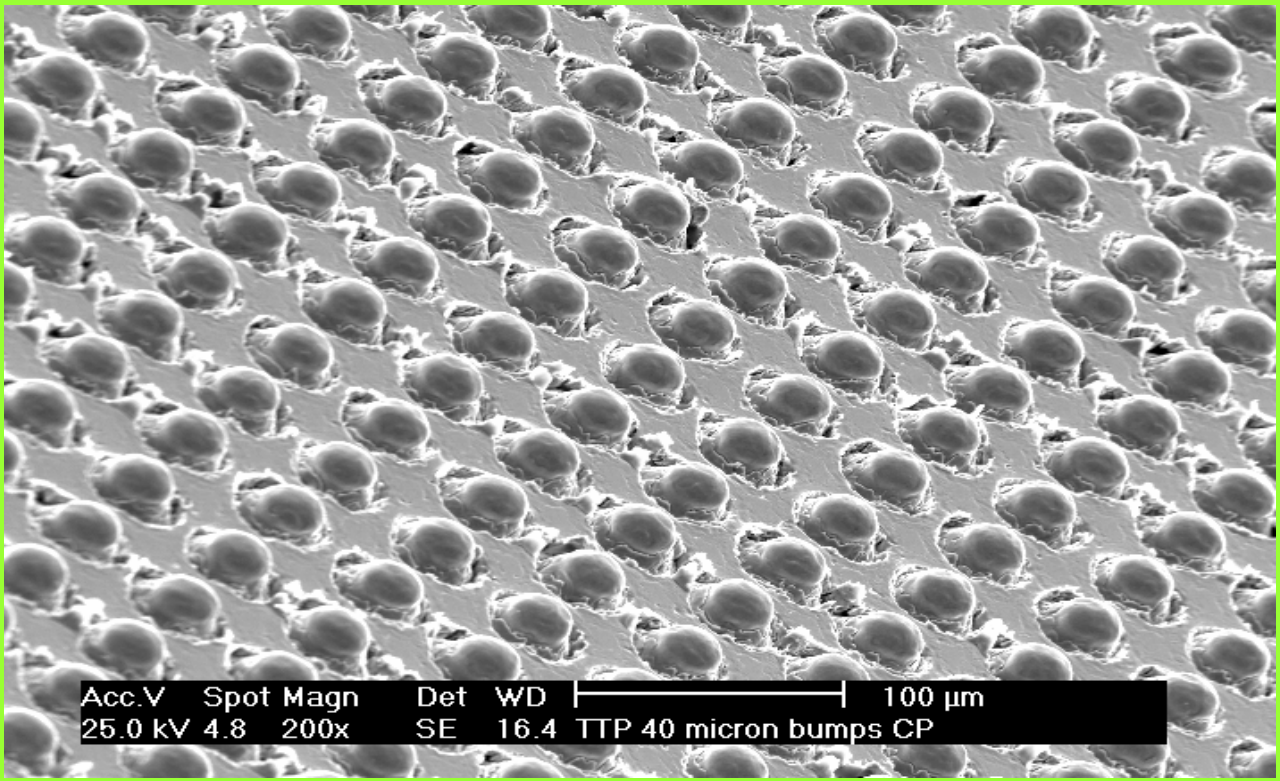

Fig 1: Micro-structured surface with hemispheres of 40µ diameter

SOME SOLUTIONS TO SAVOUR: Surface Cleaning

Surface cleaning is critical to the success of food processing equipment

Risk to product quality: Taint, contamination (previous batch or allergens)

Risk to product safety: Trapped micro-organisms – food spoilage or food poisoning

Solution to Savour – High velocity droplet spray systems:

Reduce water & cleaning reagent usage - typically 10ml/s per jet

Remove tenacious deposits, including small particles

Offer droplet size control in the range 20-60μ and velocity control

Compatible with micro-structured surfaces and polymeric materials – (droplet velocities should be optimised)

Could be developed to integrate with PI equipment

SOME SOLUTIONS TO SAVOUR: Cleaning

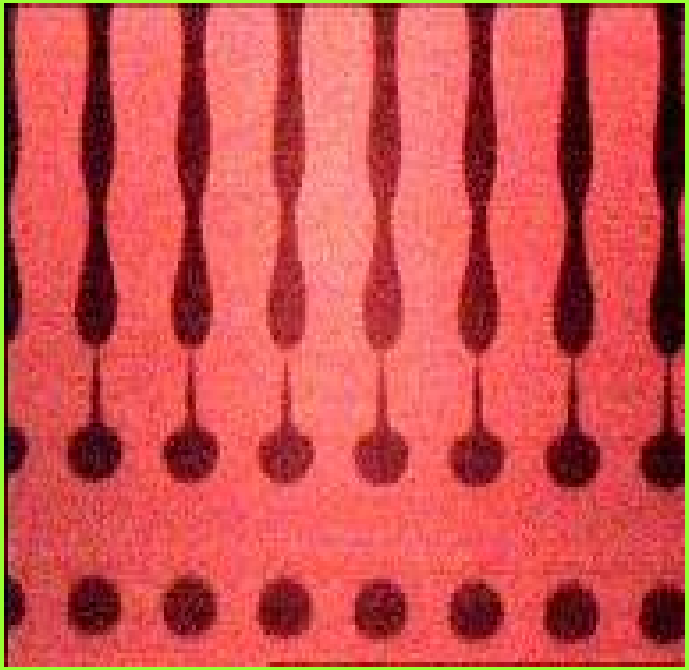

Fig. 2: Droplet control in spray cleaning

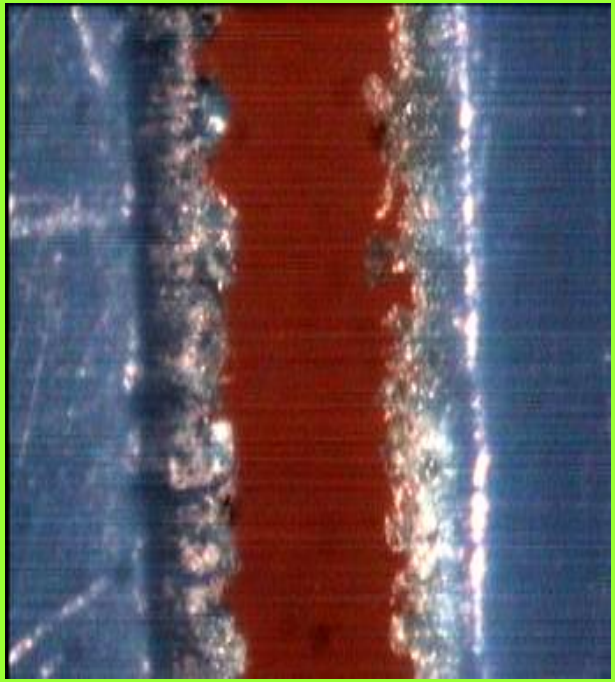

Fig. 3: Cleaning force: polythene 150μ thick cut by 30μ droplets jet

SOLUTIONS TO SAVOUR: Cleaning – Monitoring

To be accepted, PI equipment will have to be seen to be cleanable

Solution to savour – "Lab-on-chip" devices: Integrate with PI equipment

Detect food residues & tell-tale bug proteins – rapid spot tests, or in-line testing

Already in use in (non-PI) continuous reactors, mixers and separators

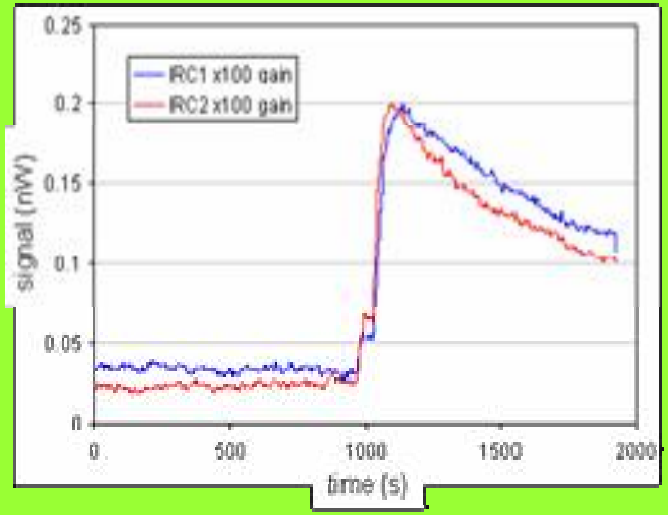

Fig. 4: "Lab-on-a-chip" with typical read-out.

SOME SOLUTIONS TO SAVOUR: Process Control

Batch to continuous processing with PI = more sophisticated process control

Measure what needs to be managed, **not** manage what is easy to measure

Solution to Savour – Process control modelling:

Modelling enables control through multiple parameters to be optimised

Back to the Continuous Oscillatory Baffle Reactor:

Product flow rate, product viscosity/temperature, oscillation frequency

We can use modelling to optimise these parameters in combination to:

Define the control “envelopes” which set the operator limits for process control

SOLUTIONS TO SAVOUR: Process Control

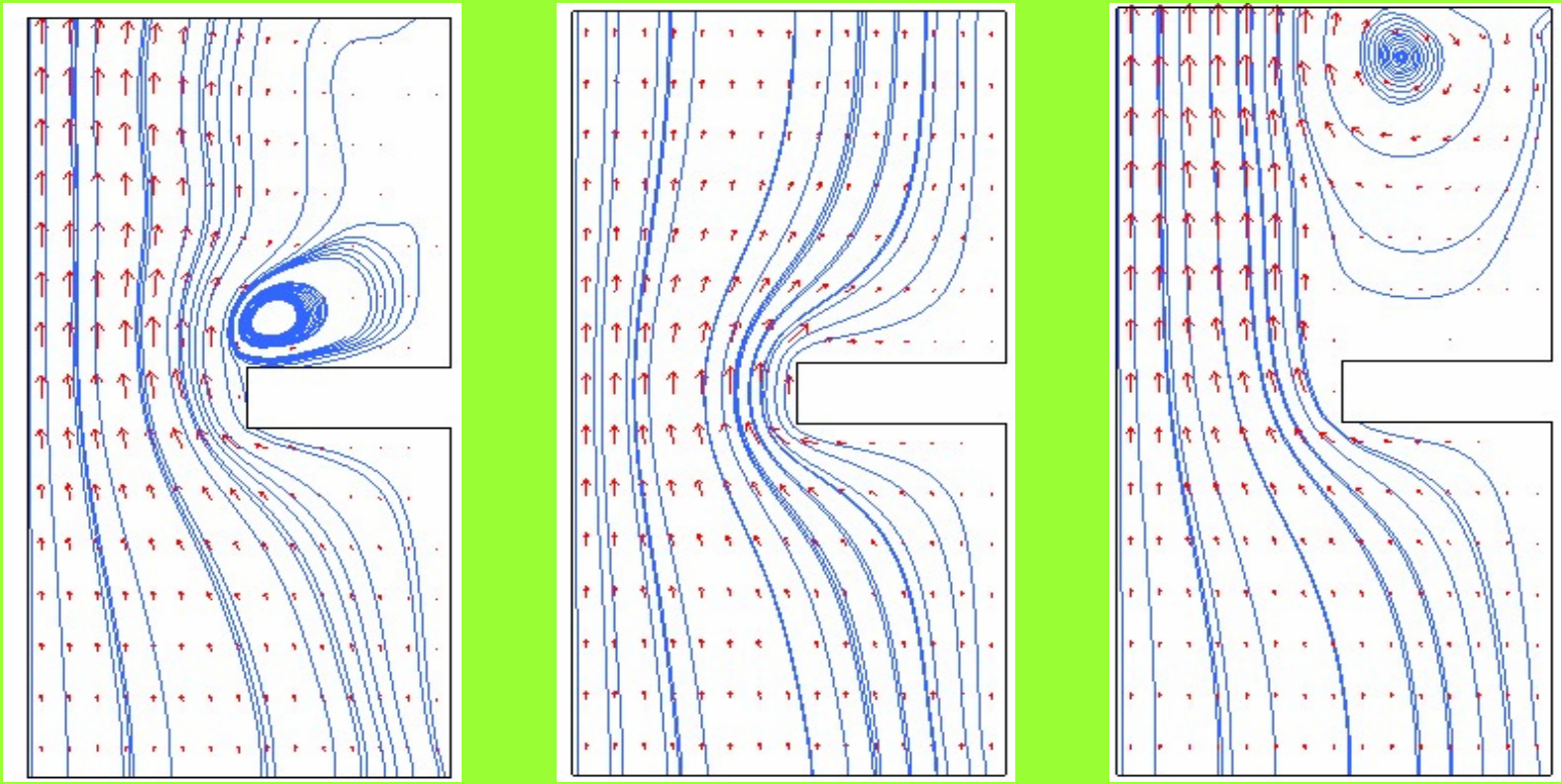

Fig. 5: **a) Flow/Oscillation Optimum (turbulence & mixing)** **b) F/O Non-optimum (no mixing)** **c) F/O Non-optimum (poor mixing)**

CLOSING REMARKS

The food & drink sector:
Needs a step change in processing to add more value from much reduced inputs

Is now actively looking for solutions, e.g. new processing network & new journal

Process Intensification:
Has relevant solutions, which now need developing for this sector

Should gain from engaging with the extensive opportunities in the food & drink sector

There are new opportunities for PI in the food & drink sector
We now need a Plan and some Initiative, to grasp them productively

Thank you.