Water as A Reaction Medium: Realising Its Green Credentials

Dial-a-molecule Annual meeting 2019

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Dial-a-Molecule Grand Challenge - KEY CHALLENGES

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- ‘Key challenges documented in the Roadmap are the need to make synthesis predictable, developing smart synthesis by design, and providing a sustainable synthesis to answer the needs of a sustainable future.’
‘On water’ reactions

- Accelerated by up to 100s times compared to reactions in organic solvents
- Easy work-up, no organic solvent (in the reaction!)

‘On water’ reactions

The product can be solidified/filtered/washed with cooling or separated with a separation funnel giving >95% purity
‘On water’ reactions

- Water-accelerated catalytic N-alkylation in Leeds
- Water is pushed out of the organic droplets, driving the reaction forward
Critical process parameters

- Acceleration is related to interface area
- Microfluidic system has limited mass transfer rate

Challenges

• Lack of process knowledge and suitable reactors
• Known reactions are not very synthetically useful
• Still need organic solvents at work-up stage; waste water is contaminated.
Project vision

WP2: Wider range of synthetically useful water-accelerated reactions

WP3: Continuous workup, water recycling and demonstration of sustainability

WP1: Efficient and scalable reactors for ‘on water’ reactions with incorporated PAT, workup and water recycling

Reduction of organic solvents in HVCM and improved green metrics

Streamlined work-up and simple product purification

Accelerated reactions and improved space-time-yield

HVCM Processes using water as media
Reactor for water-accelerated processes

- Multiphasic flow reactors (mini-CSTRs), which accommodate longer reaction time, with excellent mass transfer
- Perfect starting point for water-accelerated reactions
- A study of reactions used by Lonza showed 63% of them are multiphase

[Link to Reactor website]

Analytical technology

‘On water’ reactions are:

- Fast
- Multiphase
- Non-trivial to collect data with traditional sampling techniques
Analytical technology

- Droplet size and concentration can be measured at the same time if one reaction component has a visible colour
Work-up and water recycling

- Sustainable use of water requires water recycling
- This is much easier in flow than in batch mode
Project team

Bao Nguyen (Physical organic chemistry)

John Blacker (Process chemistry)

Nik Kapur (Fluid dynamics)

Sannia Farooque (PDRA, reactors and analytics)

Sam Boobier (PhD, solubility prediction)

Alison McCorry (PhD, micellar catalysis)

Robin Adderley (MSc, image analysis)

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Imperial College London

Concept Life Sciences

Asynt

AstraZeneca