University of Birmingham

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Head of School
Chair in Fluid Mechanics

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About

Mark Simmons is Professor in Fluid Mechanics.

Career History

- 2012 – date Professor of Fluid Mechanics, School of Chemical Engineering, UoB.
- 2009 – date Deputy Head of School of Chemical Engineering.
- 2007 – 2012 Reader in Fluid Mechanics, School of Chemical Engineering, University of Birmingham.
- 2005 – 2007 Senior Lecturer, Department of Chemical Engineering, University of Birmingham.
- 2000 - 2005 Lecturer, School of Chemical Engineering, University of Birmingham.
- 1999 - 2000 Postdoctoral Research Associate, Department of Chemical Engineering, University of Illinois at Urbana-Champaign, USA.
- 1995- 1998 Ph.D Student, School of Chemical, Environmental & Mining Engineering, University of Nottingham.

Qualifications

- Fellow of the Institution of Chemical Engineers and Chartered Engineer, 2009
- Postgraduate Certificate in Learning and Teaching in Higher Education, University of Birmingham, 2003
- PhD in Chemical Engineering (supervisor Prof. Barry Azzopardi), University of Nottingham, 1999
- MEng (Hons) in Chemical Engineering (First Class), University of Nottingham, 1995

Biography

Mark's research work involves flow visualisation, mathematical modelling and CFD. He uses optical imaging techniques including Particle Image Velocimetry (PIV) and Planar Laser Induced Fluorescence (PLIF) and has developed novel methods for imaging of multiphase flows, focussing on the complexity of interfacial motion during the rupture of liquid threads to form drops, and the impact of a dispersed phase upon continuous phase turbulence. Mark is Deputy Director of the EPSRC Programme Grant 'MEMPHIS': Multiscale Examination of Multiphase Physics in Flows which presents a new paradigm in unravelling the complexity of these class of flows.

Mark has published over 65 research papers in scientific journals and over 60 conference papers as well as reviews and book chapters in the fields of single and multiphase flow and reaction engineering of multiphase systems including biofilm reactors. He receives funding from the BBSRC and EPSRC in these fields as well as from major industrial companies including Johnson Matthey, Unilever and Procter and Gamble. He has received over £2.5M in funding over the last 10 years.

In addition, Mark has expertise in visualising flows in opaque systems using Positron Imaging Particle Tracking (PEPT) in collaboration with the School of Physics and Astronomy Prof David Parker). He has established research collaborations at the Chemistry-Chemical Engineering interface with the School of Chemistry at the University of St Andrews on the use of novel engineered biofilms to perform biotransformations

Teaching

Undergraduate Chemical Engineering Programme

- Liquid Mixing in Industrial Systems (10 credits, Level I) Lectures, tutorials and laboratories on laminar and turbulent mixing and blending, focussing on fundamental principles. (Module co-ordinator)

Postgraduate Taught Courses

- Process Engineering Fundamentals (10 credits Level I). Lectures, tutorials and laboratories on fluid flow, mass and energy balances, heat transfer (Module co-ordinator)

Postgraduate supervision

- Fluid mechanics and mixing in hydrometallurgy (Johnson Matthey)
- Formulation of catalysts to minimise deactivation (Johnson Matthey)

- Bubble size in three phase hydrogenation reactions (EPSRC)
- Emulsion creation in 'liquid whistle' sonolators (Unilever)
- Spray drying of granular detergents (Procter & Gamble)
- Predicting deposition in fluid systems within gas turbines (Rolls Royce)
- Production of multi-layer polymer films (Dupont-Teijin Films)
- Application of novel technologies for sustainable products (Unilever)
- Blending of non-Newtonian fluid mixtures using static mixers (Johnson Matthey)
- Novel biofilm biocatalysts for biotransformations (BBSRC)
- In vivo and invitro models of the lower intestine for drug delivery (with Dr Rachel Bridson) (EPSRC)

Research

Funding

EPSRC – Multiscale Examination of Multiphase Physics in Flows (MEMPHIS) Programme Grant EP/K003976/1, £4,9M. Led by Prof Omar Matar (PI).

EPSRC - Catalytic Advances for Sustainable Techologies (CASTECH) EP/G011133/1 (Co-Investigator) Part of a £5M collaborative project with Queens University Belfast and Cambridge University.

BBSRC - Engineered Biofilm Catalysts: a scalable and sustainable process route for biocatalysis BB/I006834/1 (Principle Investigator). Part of £1M joint project with University of St Andrews.

Industry - Over £300k of current industry support for PhD and EngD projects.

Current Projects

Multiphase Flow and Fluid Mechanics

- MEMPHIS Programme Grant – rupture and coalescence of fluid filaments and drops
- In-vivo fluid mechanical models of drug delivery to the colon and in-vitro testing methods (with Dr Dave Smith, School of Mathematics, Dr Hannah Batchelor, School of Pharmacy, UoB)
- Break-up of fluid jets to form droplets and particles (with Dr Jamal Uddin, School of Mathematics, UoB)

Chemistry and Chemical Engineering

- The use of novel non-petroleum based feedstocks to make useful organic intermediates is being investigated in collaboration with Queens University Belfast and the University of Cambridge (with Prof A Pacek, supported by EPSRC and Johnson Matthey)
- Novel biofilm biocatalysts and reactors are being developed in collaboration with the School of Chemistry, UEA to perform biotransformations (with Dr Tim Overton, supported by BBSRC)

Chemical Engineering and Industry

Through the EngD in Formulation Engineering (sponsored by the EPSRC), research is being carried out at the academic-industry interface in the general areas of multiphase flow and reaction engineering.

- Development of CFD models for single and multiphase processes used to create microstructured products (Unilever)
- Use of advanced flow diagnostics and other instrumentation to interrogate complex multiphase mixing and reaction processes (Johnson Matthey, Procter & Gamble))
- Development of general design rules for modelling of transients in catalyst behaviour during start-up (Johnson Matthey)
- Scale-up of production of complex microstructured catalysts (Johnson Matthey)
- Use of alternative energy-saving process technologies (Rolls-Royce)
- CFD modelling of polymer film production (Dupont Teijin Films)

Other activities

- Acted as an external PhD examiner at UCL, KCL, Cambridge, Bradford and Nottingham, Sheffield and Loughborough
- External Examiner for taught MSc in Chemical Engineering, University of Nottingham
- Fellow of the Institution of Chemical Engineers and Chartered Engineer
- Member of EPSRC since 2003 and acted as member and Chair of grant review and interview panels (PES Panel, Engineering Flow Panel, LSI Fellowship Interview Panel, Basic Technology Interview Panel)
- As Chair of the Young Academics' Network for Chemical Engineering, organised three national symposia
- Peer reviewer for Chemical Engineering Science, Experiments in Fluids, Int. J. Multiphase Flow, Transactions of the IChemE A: Chemical Engineering Research and Design, Journal of Hazardous Materials, Powder Technology, Metallurgical and Materials Transactions

Publications

Selected Recent Publications

1. Wilkinson, S.K., Simmons, M.J.H., Stitt, E.H., Baucherel, X., Watson, M.J. 2013. A novel approach to understanding and modelling evolution of catalysts during their initial operation under reaction conditions – case study of vanadium phosphorous oxides for n-butane selective oxidation. J. Catal. 299, 249-260, http://dx.doi.org/10.1016/j.jcat.2012.11.027.
2. Simmons, M.J.H., Alberini, F., Tsoligkas, A.N., Gargiuli, J., Parker, D.J., Fryer, P.J. Robinson, S., 2012. Development of a hydrodynamic model for the UV-C inactivation of milk in a novel 'SurePure turbulatorTM' swirl-tube reactor, Innov. Food Sci. Emerg. Tech. 14, 122-134. doi:10.1016/j.ifset.2011.11.006.
3. Mohsin, M., Uddin, J., Decent, S.P., Simmons, M.J.H., 2012. Breakup and droplet formation in shear-thinning compound liquid jets. IMA J. Applied. Math. 77 (1), SI: 97-108. doi: 10.1093/imamat/hxr075.
4. Winn, M., Foulkes, J.M., Perni, S., Simmons, M.J.H., Overton, T.W., Goss, R.J.M., 2012. Biofilms and their engineering counterparts: a new generation of immobilised biocatalysts, Catalysis Science and Technology, 2 (8), 1544–1547, doi:10.1039/c2cy20085f.

5. Tsoligkas, A.N., Bowen J., Winn, M., Goss, R.J.M., Overton, T.W., Simmons, M.J.H. 2012. Characterisation of spin coated engineered Escherichia coli biofilms using atomic force microscopy. Colloids and Surfaces B: Biointerfaces, 89 (1), 152– 160, doi:10.1016/j.colsurfb.2011.09.007.
6. Gabriele, A., Tsoligkas, A.N., Kings, I.N., Simmons, M.J.H., 2011. Use of PIV to measure turbulence modulation in a high throughput stirred vessel with the addition of high Stokes number particles for both up- and down-pumping configurations. Chem. Eng. Sci., 66 (23), 5862–5874, doi:10.1016/j.ces.2011.08.007.
7. Tsoligkas, A.N., M. Winn, Bowen J., Overton, T.W., Simmons, M.J.H., Goss R., 2011. Engineering biofilms for biocatalysis, ChemBioChem., 12 (9), 1391-1395, doi:10.1002/cbic.201100200.
8. Gurney, C.J., Simmons, M.J.H., Hawkins, V.L., Decent, S.P., 2010. The impact of multi-frequency and forced disturbances upon drop size distributions in prilling, Chem. Eng. Sci., 65 (11), 3474-3484, doi:10.1016/j.ces.2010.02.030.
9. Hawkins, V.L., Gurney, C.J., Decent, S.P., Simmons, M.J.H., Uddin, J., 2010. Unstable waves on a curved non-Newtonian liquid jet, J. Phys. A: Mathematical and Theoretical., 43, 055501, doi:10.1088/1751-8113/43/5/055501.
10. Simmons, M.J.H., Edwards, I.W., Hall, J.F., Fan, X., Parker, D.J., Stitt, E.H., 2009. Techniques for visualisation of cavern boundaries in industrial mixing systems, AIChE J. 55 (11), 2765-2772, doi:10.1002/aic.11889.
11. Chung, K.H.K., Simmons, M.J.H., Barigou, M., 2009. Local gas and liquid phase velocity measurement in a miniature stirred vessel using PIV combined with a new image processing algorithm, Exp. Therm. Fluid Sci. 33 (4), 743-753, doi:10.1016/j.expthermflusci.2009.01.010.
12. Gabriele, A., Nienow, A.W., Simmons, M.J.H., 2009. Use of angle resolved PIV to estimate energy dissipation rates for up- and down-pumping pitched blade agitators in a stirred tank. Chem. Eng. Sci. 64 (1), 126 -143, doi:10.1016/j.ces.2008.09.018.
13. Uddin, J., Decent, S.P., Simmons, M.J.H., 2008. Non-linear waves along a rotating non-Newtonian liquid jet. Int. J. Eng. Sci. 46 (12), 1253-1265, doi:10.1016/j.ijengsci.2008.06.016.
14. Marston, J.O., Decent, S.P., Simmons, M.J.H., 2008. Experimental evidence of non-unique solutions to a steady non-linear coating flow. IMA J. Appl. Math. 73 (4), 698-702, doi:10.1093/imamat/hxm062.
15. Marston, J.O., Decent, S.P. & Simmons, M.J.H. 2006. Hysteresis and non-uniqueness in the speed of onset of instability in curtain coating, J. Fluid Mech., 569, 349 – 363, doi:10.1017/S0022112006002886.
16. Marston, J.O., Simmons, M.J.H., Decent, S.P. & Kirk, S.P. 2006. Influence of the flow field in curtain coating onto a pre-wet substrate, Phys. Fluids 18 (11), Article 112102, doi:10.1063/1.2378562.