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Emeritus Professor of Biochemical Engineering

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About

- Fellow of the Royal Academy of Engineering, 1984
- Honorary Member of the Czech Society of Chemical Engineering, 2008
- Fellow of the Institution of Chemical Engineers, 1981
- Member of the American Institute of Chemical Engineers, 2000
- Chartered Engineer, 1982
- Chartered Scientist, 2003.

Awards

- The Moulton Medal; Institution of Chemical Engineers for paper, “Particle-Gas-Liquid Mixing in Stirred Vessels (Part I to IV)”, Chemical Engineering Research and Design (with C.M. Chapman, M. Cooke and J.C. Middleton) for “the most notable contribution during 1983 to their published records”, 1984.
- The Jan E Purkyne Medal; The Academy of Sciences of the Czech Republic for services to Czech Chemical Engineering, 1993.
- Eminent Speaker; Institution of Engineers (Australia) Chemical Colleges, 1999.
- The Donald Medal; Institution of Chemical Engineers Subject Group on Biochemical Engineering for "lifetime contribution", 2000.
- Lifetime Recognition Award”; European Federation of Chemical Engineers for “Significant Lifetime Contribution to Mixing Research and Practice”, 2003.
- Special Issue, Transactions of the Institution of Chemical Engineers, Part A, published in his honour on the occasion of his retirement, September 2004.
- Honorary Life Chairman, Institution of Chemical Engineers Fluid Mixing Processes Subject Group, Sept., 2004.
- Honorary Member of the Czech Society of Chemical Engineering, 2008.
- Medal no 441 of Szczecin University of Technology for ‘Special Contributions’ (as part of its celebrations as it combined with the Agricultural Academy of Szczecin to form the West-Pomeranian University of Technology), 2008.
- Plenary Lecture Award, Pharmaceutical Group, American Institute of Chemical Engineers, 2009.
- Doctor honoris causa, West Pomeranian University of Technology, Szczecin, Poland, 2010
- Paper, "X-ray Studies of Cavern Sizes and Mixing Performance with Fluids Possessing a Yield Stress", (with TP Elson and DJ Cheesman), Chem. Eng. Sci., 41, (1986), 2555-2562 voted one of the 21 most influential papers on mixing by the AIChE’s North American Mixing Forum, 2011.
- Doctor honoris causa, Loughborough University, UK, 2012

Qualifications

- BSc (Eng) in Chemical Engineering, University College London
- PhD, University College London
- DSc (Eng), University College London

Biography

Employment history

- 1963 – 1980: Lecturer/Senior Lecturer, University College London
- 1980 – 1989: Professor of Chemical Engineering, The University of Birmingham
- 1989 – 2004: Professor of Biochemical Engineering
- 2004 – present: Emeritus Professor of Biochemical Engineering

Research

Research area

Mixing and Transport Phenomena in Stirred Reactors and Bioreactors.

Recent research grants

- Micro- and Macromixing Studies in Two- and Three-Phase (Gas-Solid-Liquid) Stirred Chemical Reactors, Huntsman ICI Europe BVBA (with W Bujalski), 2007
- Developing Scalable and Standardised Manufacturing Methods for Human Pluripotent Stem Cells, BRIC, (with Loughborough and Nottingham Universities), 2008
- Catalytic Advances for Sustainable Technologies (CASTech), EPSRC (with Queen's University, Belfast, University of Cambridge, Borregaard, Forestry Commission Research Agency, Robinson Brothers, Johnson Matthey and Sasol) (with A W Pacek and M J Simmons), 2008

Publications

Selected Recent Publications

"X-ray Studies of Cavern Sizes and Mixing Performance with Fluids Possessing a Yield Stress", (with TP Elson and DJ Cheesman), Chem. Eng. Sci., 41, (1986), 2555-2562 voted one of the 21 most influential papers on mixing by the AIChE's North American Mixing Forum, 2011.

Harnby, N., Edwards, M.F. and Nienow, A.W., (Eds), "Mixing in the Process Industries", 2nd Edition (in paperback), Butterworth Heinemann, London, 1997, 414 pages.

"Hydrodynamics of Stirred Bioreactors", in "Fluid Mechanics Problems in Biotechnology", R. Pohorecki, ed., App.Mech.Rev., 51, (1998), 3-32.

"Aeration-Biotechnology", Kirk Othmer Encyclopedia of Chemical Technology, 5th Edition, Wiley, New York, on-line edition 2003.

"Blending of Miscible Liquids" (with R. K. Grenville), in "Handbook of Industrial Mixing; Science and Practice", (Eds. E.L Paul, V.A Atiemo-Obeng and S.M. Kresta), Wiley-Interscience, N.Y., 2003, Ch. 9, pp 507-539.

"Mixing in the Fermentation and Cell Culture Industries" (with A. Amanullah and B.C. Buckland), in "Handbook of Industrial Mixing; Science and Practice", (Eds. E.L Paul, V.A Atiemo-Obeng and S.M. Kresta), Wiley-Interscience, N.Y., 2003, Ch. 18, pp 1071-1157.

"A Vessel for Mixing a Cell Lysate", (with A.G. Hitchcock and G.L. Riley);. European patent 1159062, 12th November 2003, 14 pages.

"Further Studies Related to the Scale-up of High Cell Density *Escherichia coli* Fed-batch Fermentations: the Additional Effect of a Changing Micro-environment When Using Aqueous Ammonia to Control pH", (with H. Onyeaka and C J. Hewitt), Biotechnol. Bioeng.,84, (2003), 474 –484.

"Break-up, Coalescence and Catastrophic Phase Inversion in Turbulent Contactors", Advances in Colloid and Interface Science, 108-109C, (2004), 95-103.

"The Versatility of Up-Pumping Hydrofoil Agitators", (with W. Bujalski), Chem. Eng. Res. Des. (Trans. I. Chem. E, Part A), 82, (2004), 1073-1081.

"The Suspension of Microcarriers for Cell Culture with Axial Flow Impellers", (with S. Ibrahim), Chem. Eng. Res. Des. (Trans. I. Chem. E, Part A), 82, (2004), 1082-1088.

"Intensifying Micromixing in a Semi-Batch Reactor Using a Rushton Turbine", (with M. Assirelli, W. Bujalski, A. Eaglesham), Chem. Eng. Sci., 60, (2005), 2333-2339.

The Impact of Fluid Mechanical Stress on *Corynebacterium glutamicum* During Continuous Cultivation in an Agitated Bioreactor", (with S. Chamsartra and C. J. Hewitt), Biotech. Letters, 27, (2005), 693-700.

"Reactor Engineering in Large Scale Animal Cell Culture", Cytotechnology, 50, (2006), 9-33.

"Bubble Sizes In Agitated Solvent/Reactant Mixtures Used In Heterogeneous Catalytic Hydrogenation of 2-Butyne-1, 4-diol", (with Binjie Hu, E Hugh Stittand Andrzej W. Pacek), Chem. Eng. Sci., 61, (2006) 6765-6774.

"A Comparison of High Cell Density Fed-Batch Fermentations Involving Both Induced and Non-Induced Recombinant *Escherichia Coli* Under Well-Mixed Small-Scale and Simulated Poorly-Mixed Large-Scale Conditions" (with C J. Hewitt, H Onyeaka, G Lewis and I W. Taylor), Biotechnol. Bioeng., 96, (2007), 495–505.

"Simultaneous Measurement of *In-situ* Bubble Size and Reaction Rates with a Heterogeneous Catalytic Hydrogenation Reaction" (with B. Hu, R.P. Fishwick, A.W. Pacek, J.M.Winterbottom, J.Wood and E.H. Stitt), Chem. Eng. Sci. 62, (2007), 5392 – 5396.

"Mixing in Bioreactors using Agitators with a High Solidity Ratio and Deep Blades", (with M. J. H. Simmons, H. Zhu, W. Bujalski and C. J. Hewitt), Chem. Eng. Res. Des. (Trans. I. Chem. E., Part A), 85, (2007), 551-559.

"The Scale-Up of Microbial Batch and Fed-Batch Fermentation Processes", (with C. J. Hewitt), (Eds A. L. Laskin, S. Sariaslani, G. M. Gadd), Elsevier/Academic Press, (ISBN:978-0-12-373669-7); Adv. in Applied Microbiology, 62, (2007), 105-136.

"Bubble Sizes in Agitated Water-Hydrophilic Organic Solvents for Heterogeneous Catalytic Reactions", (with B. Hu, E. H. Stitt and A. W. Pacek), Ind. Eng. Chem. Res., 46. (2007), 4451-4458.

"Macro- and Micro-Mixing Studies in an Unbaffled Vessel Agitated by a Rushton Turbine", (with M. Assirelli; W. Bujalski; A. Eaglesham), Chem. Eng. Sci, 63, (2008), 35–46.

"An Extension to the Incorporation Model of Micromixing and its Use in Estimating Local Specific Energy Dissipation Rates", (with M. Assirelli, E. J. W. Wynn, W Bujalski and A. Eaglesham), Ind. Eng. Chem. Res. 47,(2008), 3460-3469.

"Mixing by Rotary Jet Heads: Indications of the Benefits of Head Rotation Under Turbulent and Transitional Flow Conditions", (with M. Nordkvist, M. Vognsen, J. Villadsen and K. V. Gernaey), Chem. Eng. Res. Des., (Trans. I Chem Eng. Part A),. 86, (2008), 1454-1461.

"Mixing Studies in a Model Aerated Bioreactor Equipped with an Up- or a Down-Pumping 'Elephant Ear' Agitator; Power, Hold-up and Aerated Flow Field Measurements", (with H. Zhu, W Bujalski and M. J. H. Simmons), Chem. Eng. Res. Des. (Trans. I. Chem. E., Part A) 87, (2009), 307-317.

"Use of angle resolved PIV to estimate local specific energy dissipation rates for up- and down-pumping pitched blade agitators in a stirred tank", (with A. Gabriele and M.J.H. Simmons), Chem. Eng. Sci., 64, (2009), 126-143.

"Positron Emission Particle Tracking in a Mechanically Agitated Solid-Liquid Suspension of Coarse Particles" (withA. Guida, X. Fan, D.J. Parkerand M. Barigou), Chem. Eng. Res. Des., (Trans. I Chem Eng. Part A), 87, (2009), 421-429.

"Using Positron Emission Particle Tracking (PEPT) to Study Mixing in Stirred Vessels: Validation and Tackling Unsolved Problems in Opaque Systems", (with M. Barigou, F. Chiti, P. Pianko-Oprych, A. Guida, L. Adams,X. Fan and D. J. Parker), J. Chem. Eng., Japan, 42, (2009), 839 -846.

"Scale-Up Considerations Based on Studies at the Bench Scale in Stirred Bioreactors", J. Chem. Eng., Japan, 42, (2009), 789 -796.

"The Effect of Viscosity on Particle Suspension in an Aerated Stirred Vessel with Different Impellers and Bases", (with S. Ibrahim), Chem. Eng. Comm., 197, (2010), 434 – 454.

“Stirred Tank Reactors”. In: Ullmann's Encyclopedia of Industrial Chemistry (7th Edition), Wiley-VCH Verlag GmbH & Co. Weinheim, Germany, CD and Online Posting Date: January 15, 2010; **DOI (http://www3.interscience.wiley.com/doiinfo.html)** : 10.1002/14356007.b04_167.pub2.

“Impeller Selection: Animal Cell Culture”. In: Encyclopedia of Industrial Biotechnology, John Wiley & Sons, Inc., Hoboken, NJ, USA, **DOI (http://www3.interscience.wiley.com/doiinfo.html)** : 10.1002/9780470054581.eib636 Online Posting Date: April 15, 2010; Vol. 5, pp 2959-2971.

“Scale-Up, Stirred Tank Reactors”. In: Encyclopedia of Industrial Biotechnology, John Wiley & Sons, Inc., Hoboken, NJ, USA, **DOI (http://www3.interscience.wiley.com/doiinfo.html)** : 10.1002/9780470054581.eib535 Online Posting Date: April 15, 2010; Vol. 7, pp 4328 – 4341.

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“Shannon Entropy for Local and Global Description of Mixing by Lagrangian Particle Tracking”, (with A. Guida and M. Barigou), Chem. Eng. Sci., 65, (2010), 2865-2883:

“**The Effects of the Azimuthal Position of the Measurement Plane on the Flow Parameters Determined by PIV within a Stirred Vessel (http://apps.isiknowledge.com.ezproxyd.bham.ac.uk/full_record.do?product=UA&search_mode=GeneralSearch&qid=1&SID=S2LHDHKd@CK3h2Bm59@&page=1&doc=7&colname=WOS)** ”, (with A. Guida and M. Barigou), Chem. Eng. Sci., 65, (2010), 2454-2463.

“Micromixing in Two-phase (g-l and s-l) Systems in a Stirred Vessel”, (with J. Hofinger, R. W. Sharpe, W. Bujalski, S. Bakalis, M. Assirelli and A. Eaglesham), Can. J. Chem. Eng., 89, (2011), 1029-1039.

“Using Positron Emission Particle Tracking (PEPT) to Study the Turbulent Flow in a Baffled Vessel Agitated by a Rushton Turbine: Improving Data Treatment and Validation”, (with F. Chiti, S. Bakalis, W. Bujalski, M. Barigou and A. Eaglesham), Chem. Eng. Res. Des., (Trans. I Chem Eng. Part A), 89, (2011), 1947 -1960.

"Scale-Down/Scale-up Studies Leading to Improved Commercial Beer Fermentation", (with M. Nordkvist and C. J. Boulton), Biotechnol. J., 6, (2011), 911 – 925

“Expansion of Human Mesenchymal Stem Cells on Microcarriers”, (with C. J. Hewitt, K. Lee, R. J. Thomas, M. Smith and C. R. Thomas), Biotechnol. Letters, 33, (2011), 2325-2335

"Further Studies of Micromixing: Scale-up, Baffling and Feed Pipe Backmixing", (with M. Assirelli and S. P. Lee), J. Chem. Eng., Japan, 44, (2011), 901 -907.

“Lagrangian Tools for the Analysis of Mixing in Single- and Multi-Phase Flow Systems” (with A. Guida and M. Barigou), AIChE Journal, 58, (2012), 31 – 45.

“The Large Scale Expansion and Exploitation of Pluripotent Stem Cells for Regenerative Medicine Purposes: Beyond the T-Flask”, (with A. J. Want, C. J. Hewitt and K. Coopman), Regen. Med., 7, (2012), 71–84.

“On the Generation of Hydrogen Gas during the Catalytic Oxidation of Sodium Lignosulphonate to Vanillin: Initial Results”, (with P. Ding, M. Garrett, Ø. Loe and A.W. Pacek), Ind. Eng. Chem. Res**.,** 51, (2012),184-188

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