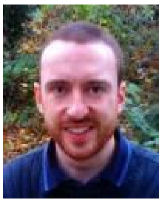
David Ryan



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Sponsors: EPSRC; Unilever Research & Development, Port Sunlight.

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David Ryan graduated with a MMath degree in Mathematics in 2002 from the University of Oxford. He has worked as Office and Facilities Manager for Partridge Muir & Warren Ltd, a role which included IT and database administration. He has also taught mathematics at a secondary school before joining the University of Birmingham.

In October 2009 he commenced his EngD with Unilever. He is supervised academically by Dr. Mark Simmons and industrially by Dr. Mike Baker.

EngD Project Background

The manufacture of many products involves a high-intensity mixing stage, typically conducted using an in-line static or dynamic mixer. Liquid Whistles (such as the Sonolator ex Sonic Corp) are an efficient design of static mixers where a high velocity jet (20-100m/s) is produced by pumping fluid at high pressure (10 – 100 bar) through a small orifice or slit; the emerging jet is directed at a fixed blade resulting in intense vortex shedding. Often a valve is installed directly after the Liquid Whistle which is used to fine tune the mixing performance. The dispersion performance of such devices is not in doubt but the mode of operation is far from clear with a range of possible mechanisms proposed for the mixing effect including:

- hydrodynamic cavitation
- elongation / shear through the orifice
- energy dissipation from turbulent jet or along the edges of the blade

The current lack of clarity over the prevailing mixing mechanism is thought to be due to the relative importance of different break-up mechanisms depending upon the mixing duty (inlet conditions: pre-emulsion versus stratified flows) and flow regime.

David's EngD project will elucidate the alternate mixing mechanisms generated by Liquid Whistles. This will involve the following:

- Computational fluid dynamics will be applied to elucidate the flow through a Liquid Whistle highlighting the impact of orifice shape / area and flowrate on mixing performance
- Construction of a low pressure transparent whistle section which will enable instantaneous and average flow fields and turbulent properties (rms velocities, Reynolds stresses, vorticity) be measured in a region of interest using PIV, or estimates of energy dissipation to be made at points in the flow field using LDV. Dimensional analysis will be applied to develop scaling rules between the lab scale mixer and the pilot scale device. To check for cavitation effects, different organic liquids will be used of varying vapour pressure to mimic the aqueous system and the presence of bubbles detected using a fluorescence technique using the PIV camera and laser sheet.
- The dispersion performance of a liquid whistle will be assessed using pilot scale facilities at Unilever R&D Port Sunlight using a model emulsion developed in a separate EngD project by Steven Hall.

Current Project Aims

- Characterisation of the flow within typical Liquid Whistles highlighting regions where liquid mixing is most intense at the lab scale to develop scaling rules to transfer to the pilot plant scale.
- An assessment of the impact of fluid properties (rheology/viscosity/vapour pressure) and geometry (orifice shape and size, position of fixed blade) on fluid dynamics.
- Experimental assessment of the emulsification performance of a typical Liquid Whistle using model & commercially important emulsions.

Other work

David's other research interests include fractals, music theory using just intonation, prime numbers and network theory. Outside of work David enjoys badminton, being part of a local church, cinema, go-karting, playing piano and drum kit.