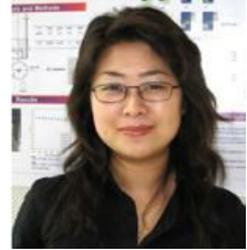


## Hui Zhu

### Mixing in a Model Bioreactor using Agitator with High Solidity Ratio and Deep Blades'

I am Hui Zhu, final year PhD student in fluid dynamic group, chemical engineering department of the University of Birmingham. It has been a really nice time studying and working within the group with our very kind supervisor Dr Mark Simmons and other colleagues, where I have learnt a lot during the last few years!



My research project title is 'Mixing in a Model Bioreactor using Agitator with High Solidity Ratio and Deep Blades'.

The aim of the work is to study the hydrodynamics of the liquid phase in a model aerated bioreactor using an Elephant Ear Impeller (EE), which is described as 'low shear' to animal cells. To investigate the turbulence characteristics in fluid flow in this work, Particle Image Velocimetry (PIV) has been applied in both single phase and two phase (gas-liquid) mixing, and time-averaged and angle-resolved measurements are taken in the study.

The mixing performance of EE impeller in single phase mixing is also compared with that of more conventional PBT and B2 impellers. It is found that EE impeller has a better performance in gas handling and dispersion than PBT and B2, but none of the measurements give any support to the use of the term 'low shear' to describe the characteristics of the EE impeller.

In Figure 1, the mean flow field obtained from PIV is shown, which is then used to calculate turbulent parameters such as turbulent kinetic energy, energy dissipation rate, vorticity and pumping capacity.

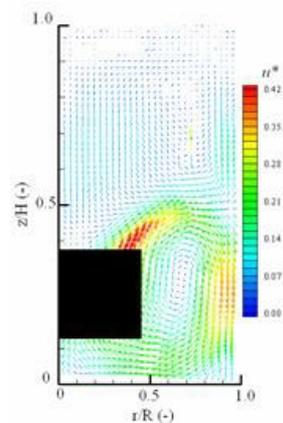


Figure 1 Normalised mean flow field of Elephant Ear Impeller using PIV at aspect ratio of  $H/T=1$ .

Figure 2 shows the experiment set-up for PIV measurement in single-phase mixing. The angle resolved images were obtained by use of a triggering device, which synchronized the impeller position to the image capture. The device was capable of resolving blade angles to less than half a degree.

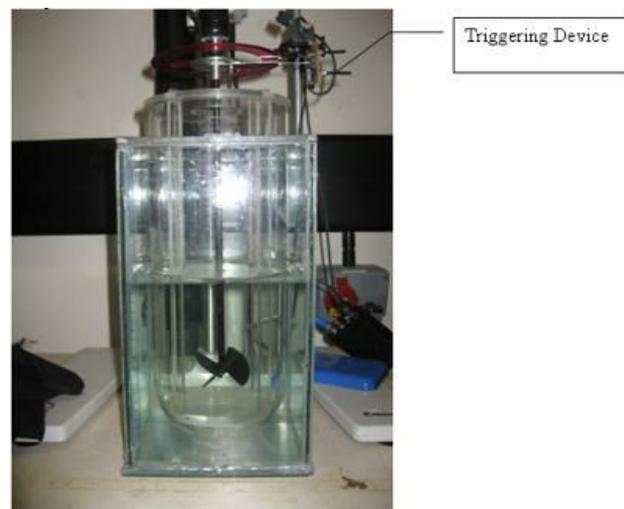


Figure 2 Experiment set-up for Angle-resolved measurement using PIV.

### Publications

#### Journal

Simmons, M.J.H., Zhu, H., Bujalski, W., Hewitt, C.J., Nienow, A.W., 2007. Mixing in a model bioreactor using agitators with a high solidity ratio and deep blades. *Chemical Engineering Research & Design*. 85(A5), 551-559, doi: 10.1205/cherd06157

#### Conference Papers

Zhu, H., Simmons, M.J.H., Bujalski, W., Nienow, A.W., 2007. Paper PS6\_17, Mixing of the liquid phase in a model aerated bioreactor equipped with 'elephant ear' agitators using Particle Image Velocimetry, 6th International Conference on Multiphase Flow, ICMF 2007, Leipzig, Germany, July 9-13, 2007, CDROM, ISBN: 978-3-86010-913-7.

Zhu, H., Bujalski, W., Hewitt, C.J., Nienow, A.W., Simmons, M.J.H., 2006. Mixing in bioreactors using agitators with a large swept volume, in *Proceedings of the 12th European Conference on Mixing (Mixing 2006)*, 657th Event of the European Federation of Chemical Engineering, Bologna, Italy, June 27-30 2006, ISBN: 88-901915-9-7