University of Birmingham

Jamie Sandells BSc (Hons)

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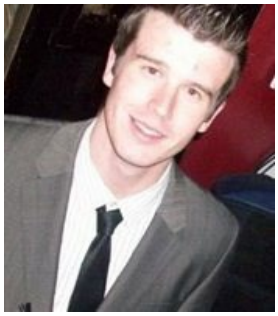

DTC Project - Mathematical modelling of Fuel cells

Supervisors: **Dr. Jamal Uddin (/staff/profiles/maths/uddin-jamal.aspx)** , Professor Stephen Decent, **Professor Kevin Kendall (/staff/profiles/chemical-engineering/kendall-kevin.aspx)**

About

Jamie graduated from the University of Birmingham in 2009 with first class honours degree in Mathematics, and joined the fuel cells group to begin his PhD in the integrated study of hydrogen and fuel cell applications in October of the same year. Jamie's PhD within the Doctoral Training Centre, which is funded by EPSRC, focuses on the applications of boundary layer theory to single and dual chamber SOFCs.

Project Details

Open all sections

Boundary layer theory states that even for fluids of low viscosity the viscous effects cannot be neglected near the surface of a solid boundary, due to high velocity gradients. Using this theory the Navier-Stokes equations can be simplified to a form in which we can derive an analytical solution. The aim of the project is to couple the a priori knowledge of the mathematical theory with the a posteriori knowledge of electrochemical kinetics that occurs during fuel cell operation.

Many engineering models of fuel cells exist which tend to use computational fluid dynamics to solve a series of complex three dimensional partial differential equations. However, little consideration seems to be given about whether the problem has a solution and whether or not that solution is unique, as well as the overall accuracy of such commercial programs at obtaining a solution to these systems. Furthermore, these systems can sometimes be computed without a full set of boundary conditions which produces underdetermined problems which can be shown to have an infinite number of solutions.

Using mathematical theory of fluid dynamics and numerical methods we can simplify the problem of fluid flow and chemical reactions and gain accurate asymptotic solutions to certain regions of the domain. All of this can be done with computational codes which take seconds to produce numerically accurate solutions. Furthermore, full numerical solutions can be obtained with a very high level of computational efficiency. The outputs of mass concentration and its dependence on cell potential can be examined in order to obtain optimal operating conditions for fuel cell performance.

Papers

- J. Sandells, J. Uddin & S.P. Decent Boundary layer flow over a reacting plate with electrochemistry **2011,** *In Prep*.

Presentations

- 1st International conference on Fluid Problems in Process Engineering (University of Leeds, 2010) - Link
- 1st Annual DTC Conference
- British Applied Mathematics Colloquium (University of Birmingham, 2011) - Link

Posters Presented

- 6th International Hydrogen and Fuel Cell Conference (NEC, Birmingham)
- 7th International Hydrogen and Fuel Cell Conference (NEC, Birmingham)

Other Events

- Sustainability Live (NEC, Birmingham, 2010)

Outreach

- Presentation to 100 school teachers on climate change and the use of mathematics and predicting and solving its outcomes. (Annual Mathematics Teacher's Conference, University of Birmingham, 2010)
- Presentation to Prof Paul Kenis (University of Illinois)
- Green Event, Cocks Moor Wood Leisure Centre, Birmingham

Responsibilities

- Organiser of Postgraduate Applied Mathematics Seminar Series 2010-2011.
- Undergraduate teaching of various modules in mathematics.
- Captain of Postgrad Mathletic football team.