Project title:

Fundamental understanding and modelling of turbulent coal particle laden mixtures using Direct Numerical Simulations

Project description

Multi-phase turbulent reacting flows play a key role in several important engineering processes such as coal combustion for power generation, droplet combustion in Internal Combustion (IC) engines and gas turbines. This has major implications in the context of the grand challenges faced by modern societies with respect to energy efficiency and environmental friendliness. In spite of having several engineering applications in seminal areas, much of the existing body of research in multi-phase reacting flow applications is based on experimental observations, and often relies heavily on empirical relations. The proposed work will address the gasification and combustion process for coal using Direct Numerical Simulations (DNS), where the physical processes associated with turbulent flow will be addressed without any major physical approximation. Such simulations are either rare or non-existent in the open literature. The fundamental physical understanding obtained from DNS simulations will be utilised to develop more accurate combustion models for Large Eddy Simulations (LES) and Reynolds Averaged Navier Stokes (RANS) simulations of pulverised coal particle laden combustion. In the present study new models will not only be devised based on analysis of DNS data (i.e. a-priori analysis. This exercise will give rise to high fidelity computational tools for analysing and designing efficient and environment friendly new generation combustors.

The outcome of this project will be of interest to those involved with designing new generation boilers (e.g. Doosan Babcock, Electricity Supplies Research network) combustors. The interested industrial parties will be kept informed during the course of this project and they will be invited to attend the progress review meetings. In addition to this, the project outcomes will be published in reputed journals (e.g. Combust. Flame, Phys. Fluids, Proc. of Combust. Instit. etc) and conference proceedings (e.g. Int. Combust. Symp., European Combustion Meeting etc.). Moreover, the proposed project fits comfortably with the theme of Energy research within the School of Mechanical & Systems Engineering.

Given the fundamental nature of this work, it is anticipated that the project outcome will be published in internationally reputed journals. There will also be ample scope for the student to interact with combustion groups in the University of Cambridge as well as reputed combustion researchers in the USA, France and Germany. Students with 1st class or 2:1 degree in Aerospace, Mechanical and Chemical Engineering, Applied Mathematics, Applied Physics who are interested to work in general area of turbulent combustion will be eligible for the proposed project.

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