Cardiff University Gas Turbine Research Centre - UK

The large scale utilisation of biofuels will undoubtedly require a flexible and robust generating technology. In the current European energy mix, gas turbines will play a vital role in maintaining efficient and reliable energy both now and in the future. Given the potentially fluctuating nature of wind, solar and hydro projects, gas turbines fired with biomass derived fuels will become essential in addressing grid demand issues.

Cardiff University, via the BRISK project and other sources, is currently undertaking research to determine the fundamental behaviour of low-emission gas turbine burners using biomass derived fuel, either in gaseous or liquid form. Key areas of research include combustion properties of alternative fuels, low-carbon biomass derived gas and gasification products such as hydrogen rich syngas. The main research facility is the Gas Turbine Research Centre (GTRC), which examines the combustion behaviour of these fuels. The facility comprises a high pressure, high temperature combustion rig capable of simulating the conditions within a gas turbine combustion chamber. To simulate the potential biomass derived gas compositions, a five gas mixing facility has been installed at the GTRC to enable gas mixtures to be synthesised on site and varied real time. This unique mixing facility can provide a gas mixtures equivalent to 1MWth.

Previous research has examined burner design for integrated plants with gaseous fuel (e.g. Integrated Gasification Combined Cycle (IGCC) - syngas and land fill/sewage) for energy efficiency. The experimental activity included burning velocity measurements at elevated pressures and temperatures with H_2 and CO_2 mixtures with methane. In combination with modern IGCC gas turbines, this will make negative carbon power generation possible. As the price and demand for natural gas rises, alternative fuels will become increasingly important.

Biomass derived fuels have great potential for the production of renewable hydrogen. This facility is capable of testing high H_2 content fuels for use with industrial gas turbines. Problems with existing

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Figure 1: Cardiff University's GTRC facility, which shows the gas storage area in the foreground.

Figure 2: Rig room view of the High Pressure Combustion Rig.

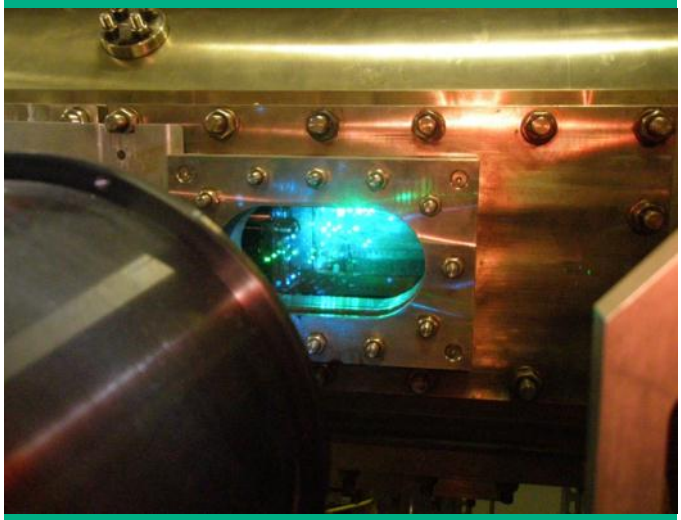

Figure 3: Close up view of one of the High Pressure Optical Chamber (HPOC) windows during setup of the Laser Dopler Anemometry (LDA) system.

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Figure 4: High Pressure Optical Rig shown on the right hand side of the image with the newly designed High Pressure Generic Swirl Burner installed. The syngas fuel board can be seen in the background.

and new designs of lean premixed combustors include flashback, excessive localised temperatures and elevated NOx emissions. There is a need for reliable, low emission, competitive technologies for undiluted premixed syngas combustion. This research, carried out using the GTRC facilities, has been done to examine the fundamental properties of hydrogen rich syngases, to derive burning velocities and related data at conditions pertaining to gas turbine combustors; little has been carried out experimentally to examine the fundamental combustion processes of high hydrogen content syngases in realistic generic premixed combustion systems.

As part of BRISK, Cardiff University is aiming to work with European organisations to study:

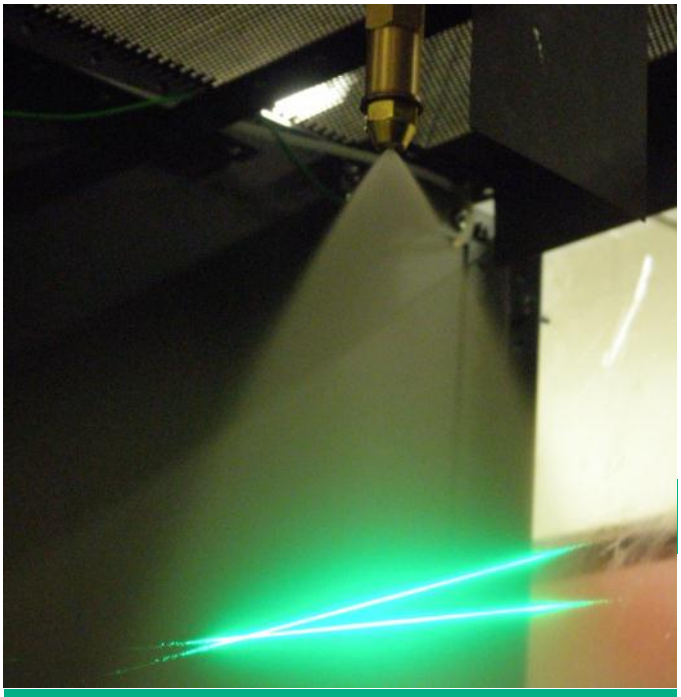

Figure 5: Close up view of a biofuel spray from a Delevan nozzle with LDA in the Atmospheric Spray Rig (ASR).

- The design criteria and burning behaviour of variable composition gas mixtures. Typical projects will include combustion stability in mixtures of carbon monoxide, hydrogen, methane and higher hydrocarbons.
- The application of liquid fuels in low emission burner systems. This will include by-products from the production of biofuels.
- Emissions associated with the products of combustion from renewable fuels. Low cost biofuels have the potential for having comparatively higher viscosities than refined fossil derived products, and hence quantification of particulate matter and NOx emissions are to be studied.

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