Modelling the emissions from a fuel flexible power plant and the impact on NOx emissions of coal with biomass ash in co-combustion

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NOx is a harmful emission that can lead to acid rain, tropospheric ozone and increased particulate matter in the atmosphere. A 600MW coal power station, fitted with efficient control measures still emits approximately 3.3k tonnes of NOx each year. Emissions levels brought in under the Industrial Emissions Directive (EU), has set targets for large scale combustion furnaces of 150-175 mg Nm-3 by 2020 for existing plants. These values are similar to the US of 117-160 mg Nm-3, and the values of 100-200 mg Nm-3 for existing power stations in China. The BREF report and using the BAT (2017), suggest current power stations will struggle to reach these targets. The current technologies for NOx abatement, such as Low NOx burners, advanced overfire air and SNCR/SCR, required large capital investment and therefore are not always economically viable for legacy power stations. Many stations are being converted to fuel flexible operations focussing either on biomass or co-combustion of coals and biomass. Biomass fuels tend to be lower in sulphur and iron but have increased levels of alkali an alkaline metals such as potassium. Particles such as iron and potassium may act as catalysts to alter the nitrogen partitioning of the coal during co-combustion and consequently result in reduced NOx emissions.

A study carried out on three bituminous coals, a low reactivity coal and 2 types of biomass ash additives from the same fuel feed stock. The study evaluated the impact of the ash additives (at 15% w/w) on the emissions during combustion in a drop tube furnace at Northeastern University (USA). This was carried out in an air atmosphere at 1373K. Gas emissions of CO, CO2, SO2, NO and NO2 were monitored. Devolatilisation was carried out at the University of Leeds in a drop tube furnace at 1373K in an N2 atmosphere with 2% O2. The combustion experimental work showed that there were decreases in the nitrogen retained in the char when the coals were tested with the biomass ash additives. During devolatilisation higher percentages of nitrogen was released as volatiles with the blending of the coals with the additives. The retention of nitrogen in the char and increased devolatilisation are advantageous for NOx reduction in a low NOx burner with overfire air. Working with a previous combustion model, the experimental work is being carried forward to evolve the model taking account of the catalysis brought about by the additives. The modelling will take the form of two models, a drop tube furnace model and a furnace slice model. The drop tube

model will be used to calculate the nitrogen partitioning and carbon conversion during devolatilisation. The furnace slice model, will deconstruct the furnace into sections calculating the reaction pathways within each section. The final output will focus on predicting the emissions output from a known furnace design for a given coal type and fuel additive blend.