Co-firing of HTC bio-coals and coal in pulverised coal plant: The potential for HTC to overcome inherent biofuel limitations and utilise lower value biomass

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Co-firing is a near term, low-cost option for converting biomass to electricity by adding biomass as a partial substitute fuel in high-efficiency coal boilers enabling the utilisation of existing infrastructure. Issues however arise when you consider coal-fired power plants are built to burn a specific ‘design’ fuel specification, whereby the design fuel is usually a coal from the locality. These design fuels use parameters including ash content, grindability (HGI), volatile matter content, combustion behaviour, and slagging and fouling characteristics. The boiler is then optimised around these characteristics. Biomass is a very different fuel to coal and this brings about substantial challenges when co-firing. Failing to match the fuel parameters of the coal and biomass can result in technical issues such as an unstable flame, slagging, fouling and corrosion along with a host of fuel handling issues and limit the amount of biomass utilised. Hydrothermal carbonisation (HTC) could be a solution to this.

HTC is a tool developed by petrologists over the last century to understand coal formation and uses hot compressed water to simulate coal formation. Over the past 10 years, the process has undergone substantial development going from a technique that explains coal formation to an industrial application that can make bio-coal from biomass and wastes. Within 10 years, the technology has gone from TRL 2 and now widely considered TRL 6. Under correct operating conditions, the process can take a series of low value biomasses, including agricultural wastes, *Miscanthus*, AD digestate and even seaweeds and produce a high quality bio-coal within a few hours. For example, *Miscanthus* can be harvested and processed green, enhancing yields per hectare by over 40 %[1], and within three hours, start to finish, can be converted into a bio-coal equivalent to a high grade, high-volatile sub-bituminous coal. A bio-coal with a HHV of 29 MJ/kg and a carbon conversion in excess of 90% is currently possible under correct conditions. With an HGI of 150 the fuel will easily pulverise overcoming issues with flame stability brought about though larger particle diameters encountered in pulverised fuel applications with untreated biomass. Matched ‘coal like’ combustion profiles will result in good burn interaction, with potentially enhancing NOx reductions due to bio-coal reactivity. In addition removal of potassium, sodium and chlorine with the selective retention of silicon, calcium and phosphorous can ensure the fuels slagging, fouling and corrosion propensity is reduced and often overcome. The bio-coal is hydrophobic in nature and lends itself well to pelletizing and bracketing, properties favourable to haulage and outside storage; overcoming many of the limitations of premium white wood pellets currently used.

This presentation will overview HTC, covering aspects relating to the utilisation of HTC bio-coal co-firing in the context of pulverised coal application. The presentation will go on to address the current technology status. With a number of demonstration and commercial plants under construction, full commercialisation is likely within the coming years. When done correctly fuels can be made compatible with the design fuel specification and the resulting fuel could revolutionise both the co-firing and full biomass conversion of pulverised coal plants. The presentation should be both informative and interesting to the whole range of delegates present.

[1] : Aidan M. Smith, Carly Whittaker, Ian Shield and Andrew B. Ross "Potential for production of high quality bio-coal from early harvested *Miscanthus* by hydrothermal carbonisation." *Fuel* 220 (2018): 546-557