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IEA CLEAN COAL CENTRE executive summary

Optimising fuel flow in pulverised coal and biomass-fired boilers

Poor pulverised fuel (PF) distribution to the burners in a coal-fired boiler has a significant, negative effect on combustion efficiency, wear of equipment and emissions, not to mention economics. For example, high coal flow to burners can create carbon-rich zones with a reducing atmosphere that leads to increased slagging and carbon monoxide (CO) emissions. Burners with too little coal flow can create oxygen-rich zones that may increase emissions of nitrogen oxides (NOx). In addition, a burner which delivers pulverised fuel at too high a velocity not only causes increased erosion of the system and high carbon-in-ash levels but can cause detachment of the flame within the boiler. Pulverised fuel which is delivered at too low a velocity can cause fall out of particulates and create pipe blockages which consequently can create dangerous fires and explosions.

In order to optimise pulverised fuel flow many aspects need to be taken into account. The major areas of a power plant where improvements can be made are the mills, air/fuel ratio, pipework and boiler. However, before any optimisation can be achieved, measurements, which are not only reliable and repeatable, but ideally in real time, must take place. Only then can accurate control and optimisation of the fuel flow be introduced. Optimisation is especially important in low NOx burners which require precise fuel control in order to maintain uniform and efficient combustion.

The majority of opportunities to enhance combustion performance by improving the performance of coal mills depend on reductions in coal particle size. Hence, fuel flow optimisation starts with work on fuel fineness/mill performance. Measurement of coal fineness is a useful diagnostic tool which can provide immediate performance improvement by adjusting mill settings. There are a number of new, non-extractive online particle fineness measurement systems. These are accurate and less labour intensive and above all can provide real time results in contrast to traditional systems based on manual isokinetic measurements. In most cases they can also determine additional parameters such as coal velocity or coal mass flow. Once the fineness is measured, the mills can be optimised. This includes adjusting various parts of the mill such as throat clearance, spring compression, alignment of classifier blades as well as supplying an adequate amount of primary air at the right velocity and maintaining the optimum mill temperature.

All air flows in a power plant must be measured and controlled in order to achieve optimum combustion at the boiler and avoid problems such as high furnace exit gas temperature, secondary combustion, overheating in the back-pass as well as slagging. Considerable progress has been made on measurement and control of all combustion air streams. New systems range from advanced pitot tubes through electrostatic based systems to virtual and optical sensors. Additionally, low NOx burners now have the option of individual burner measurement systems.

Fuel flow measurement is dominated by traditional isokinetic sampling in the majority of power plants, despite the fact that this type of measurement is the least accurate of currently available systems. New, online fuel flow systems are based on a number of techniques including laser, white light, acoustic emission, microwave, electrostatic and mathematical cross-correlation. As with any type of technology, there are a number of factors which can affect their performance such as instrument location, proximity to an

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Each executive summary is based on a detailed study undertaken by IEA Clean Coal Centre, the full report of which is available separately. This particular executive summary is based on the report:

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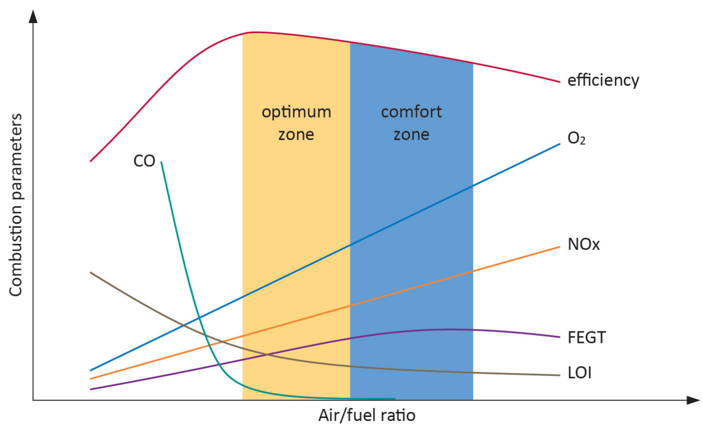
This report is free to organisations in member countries, £100 to organisations in non-member countries for six months after publication, and free thereafter.

orifice, flue gas temperature and velocity. Consequently, power plant operators need to consider several factors before choosing the most suitable instrument for fuel flow and control. These include: whether the equipment can be incorporated into the existing coal pipe geometry, and if not, what changes are required. Additionally, careful attention needs to be paid to calibration of the fuel flow measurement systems applied to biomass-fired boilers. This is because biomass particles are more heterogeneous than coal and their flow fluctuates considerably more than coal. Hence, frequent and careful calibration is required in order to obtain an absolute fuel flow mass measurement. If not, only relative fuel flow measurements can be obtained. Moreover, for dense biomass flows (above 2.5 kg of biomass per second) some fuel mass flow measurement systems may not be accurate.

Instruments for carbon-in-ash, oxygen and CO measurements have been developed further. These measurements are excellent indicators of fuel flow optimisation and can be used in online control of both excess air and coal flow to the individual burners. Currently available, online, non-extractive carbon-in-ash analysers are much more accurate and less labour intensive than extractive systems. Developments in oxygen and CO measurements enable simultaneous analyses of these emissions as well as other flue gas components. What is extremely important for all these systems is their sampling location, which determines the representativeness of the results. For example, oxygen and CO measurements should be performed in multiple locations by sensors deployed in a grid configuration.

The reviewed case studies make evident that, regardless of the chosen system and the scale of the optimisation, plant operators report clear benefits of using flow optimisation equipment. Apart from advantages such as improved efficiency, greater flexibility, lower NOx and CO emissions, reduced carbon-in-ash, lower overall operational cost and improved performance of various equipment such as PM control technologies, significant reductions in safety hazards and increased fuel flexibility are reported. Despite being highly effective and commercially available, these systems are not yet seen in the majority of power plants. However, this is starting to change as today's power plants need to be flexible and meet ever more stringent emissions limits while remaining economically viable.



The variation of key combustion parameters with air/fuel ratio, showing the potential efficiency improvements achievable with optimised combustion

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