BLENDED FIRING OF COAL AND LIGNITE

Globally, coal supplies nearly 30% of energy consumption. Many emerging economies depend on coal for secure, affordable and reliable electricity generation and supply. Therefore, it is vital to ensure that coal is used efficiently with minimum environmental impact. Centuries of active coal extraction have resulted in depletion of reserves of higher grade coals. The result has been the firing of more lower quality coals and lignites in power plants, which can create complications. The disadvantages of firing lignite may be reduced by blending it with higher quality coals. Conversely, adding some lignite to higher quality coals may reduce fuel costs. Blending coals is one way to use the poorer fuel while maintaining output from coal-fired power plants. Firing indigenous lignite with high quality coals in countries such as India, Pakistan and Bulgaria can help to cut the cost of energy generation and keep generating electricity at high efficiency and low emissions to provide energy at an affordable price.

COAL PROPERTIES

There are four main ranks of coal, in order of quality: anthracite, bituminous, subbituminous, and lignite. The characteristics of low quality coal, especially lignite, may include: low calorific value; high moisture content; high ash content; low ash fusibility; high alkali/alkaline content; low volatile matter content; high sulphur content; high mercury and nitrogen content; and low Hardgrove Grindability Index (HGI).

The top three producers of lignite in 2019 were Germany (131 Mt/y), Turkey (7.3 Mt/y), and the Russian Federation (82.2 Mt/y). As it is not economic to transport over long distances, most lignite is used close to the source.

COAL BLENDING

Many power plants have blended coals to adjust the composition of the fuel and to provide a consistent feedstock for power generation. Other reasons to blend coal include: a shortage of high quality coal; the cost of the fuel; to alleviate coal transportation problems; to reduce fouling and slagging; and to lower emissions of pollutants.

Coal blending is a physical process designed largely to impact fuel chemistry. Blending can be achieved at any point in the supply chain from coal mine to boiler, onsite or offsite to a power plant. Blending offsite at the coal mine, preparation plant, or transshipment point, can save capital investment for the power plant and the blend is handled as a single coal at the power plant. Blending onsite at the power plant yard or in the boiler provides flexibility to adjust the blend according to the characteristics of the coal. This approach can be cost-intensive and requires large amounts of space at the power plant. Blending methods include stockpile, bin, belt and furnace blending.

Some coal properties, such as proximate and ultimate analysis data and the heating value, remain additive after blending. The effects of some physical properties on blending, such as grindability, ash fusion temperature, swelling, and combustion characteristics, are harder to predict. The main issues related to firing lignite blends at power plants are the blending ratio, boiler and mill performance, combustion characteristics, and ash deposition.

Coal characterisation data can be coupled with pilot plant studies to formulate optimum blend ratios and design boilers' efficiency for blended coal firing. In theory, blending is a straightforward process. In practice, the process can be more challenging due to the vast amount of coal that has to be handled physically and the complexity of coal characteristics. The coal blend received at the power plant may not be the same as expected. Power plant operators' experience plays a large part in successful coal blending.

The blending ratio is important for ensuring the safe operation of a power plant and to improve emissions control. Firing low ratio lignite blends (less than 15%) can be carried out without plant modification at coal-fired power plants. When the blending ratio is greater than 15% or the volatile matter difference of the coals is greater than 15%, laboratory tests and field trials must be carried out first. To fire a high ratio coal blend, modifications to the boiler or burners may be needed. Many plants need to modify their coal handling system to accommodate onsite out-furnace blending processes.

COMBUSTION

Reactions taking place in the combustion zone become more complex when coals of different ranks are blended or cofired. Although blending lignite with higher rank coal can improve combustion behaviour, decrease gaseous pollutant emissions, and mitigate some operational problems, it does not always reduce issues with grinding, flame stability, heat absorption balance, ash deposition, and so on. A blended product that closely resembles the design coal specifications may not burn in the same way as single coals. Interactions can occur between the component coals, which may or may not be beneficial. Thus, the compatibility of the coals concerning their combustion performances should be evaluated. Generally, low rank coal influences the ignition temperature of a coal blend, whereas high rank coal influences the burnout temperature. The blending ratio plays a vital role in firing lignite blends. Blending less than 10% lignite into bituminous coal has almost no impact on the boiler and combustion efficiency, and vice versa. The effects of blending on emissions control are hard to predict due to the complex chemical contents of coals. Apart from sulphur and nitrogen contents, some coals have higher oxygen contents, which may contribute to the formation of oxides. Local combustion conditions and furnace operating conditions have impacts on the emission of NOx, SOx, trace elements, and particulate matter.

Lignite-fired plants may choose to blend in higher quality coals to improve combustion efficiency and to reduce slagging and fouling and other difficulties. Conversely, at bituminous coal-fired power plants lignite may be blended to reduce fuel costs and reduce emissions of SO_2 and NOx.

For developing countries, such as Pakistan and India where lignite resources are abundant and energy demand is growing rapidly, utilising indigenous lignite can also help create jobs and contribute to the local economy. In poorer countries with large lignite resources, a growing energy demand and a need to improve air quality cheaply and easily, the blending of lignite and coal is one way to provide cleaner energy to support rapid economic development and a growing population.

Each executive summary is based on a detailed study which is available separately from: www.sustainable-carbon.org. This is a summary of the report: Blended firing of coal and lignite by Xing Zhang, ICSC/316, ISBN 978-92-9029-639-3, 70 pp, October 2021.