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NOx CONTROL FOR HIGH ASH COAL-FIRED PLANT

Many countries have strict emission limits for nitrogen oxides (NOx) and so NOx controls are widely used. India has introduced new emission standards and has coal with a high inherent ash content. This has created concerns that some NOx controls may not be suitable for such an environment.

INDIA – NEW NORMS AND CHALLENGES

The new standards in India are broadly similar to those in the EU and the USA. They regulate particulate matter (PM), sulphur dioxide (SO_2), NOx and mercury (Hg) emissions as well as water consumption. For NOx, they stipulate that plants installed before the end of 2003 emit no more than 600 mg NOx/m^3, plants installed after 2003 and before the end of 2016 emit no more than 300 mg/m^3 NOx, and plants installed from 1 January 2017 limit their NOx emissions to 100 mg/m^3. New norms are obligatory from 1 January 2017 for new plants. Existing units have two years in which to comply. Revisions of the norms and delays in implementation are expected.

As with all retrofits and the introduction of technologies to markets, there are challenges. In India, these include: high ash, highly erosive coals; technical difficulties including space constraints; financial issues as it is costly to introduce multiple technologies at the same time; lack of local suppliers and a subsequent need to import technologies as well as all materials and reagents; lack of local skills and expertise; and the utilities have no experience in continuous emissions monitoring.

NOx CONTROLS

There are several NOx control technologies. They can be broadly divided into primary and secondary measures. Most controls can be used alone or in combination depending on the rate of NOx removal required.

Primary measures include: low NOx burners (LNBs), overfire air (OFA), fuel biasing, low excess air, fuel reburning, flue gas recirculation and combustion optimisation. In general, these controls reduce NOx by controlling coal combustion. Many boilers in India have OFA and deploy fuel biasing, but only a few have LNBs. Several power plants will have to install LNBs and/or OFA. These are relatively quick to install but can adversely impact the boiler's operation leading to increased NOx and CO emissions, carbon in ash and changes in the burners' flame geometry. Hence, careful design and the measurement and control of various combustion parameters are vital. The latter can be achieved by using advanced sensors and controls. Retrofits can take place during planned outages, so many will take place during 2017 and 2018.

Secondary NOx control measures include: selective catalytic reduction (SCR), selective non-catalytic reduction (SNCR) and a combination of the two. Generally, they are applied to plants which need to reduce NOx limits beyond the capability of primary measures.

SCR achieves the highest NOx removal rates of all NOx controls at 80–90%, but it is also the most expensive option. In India, over 300 units may require SCR. In coal-fired power plants an SCR unit is generally installed between the economiser and the air heater, where the temperature of the flue gas is

optimal for an SCR reaction. However, in this configuration, known as hot-side, high-dust, the SCR is exposed to the fly ash and chemical components of the flue gas, which can cause excessive wear on: the ductwork; large particle ash screens; ammonia injection grid (AIG) nozzles; flow distribution devices; and the SCR catalyst. The ash also leads to poor distribution of velocity into the catalyst, accelerates its deactivation, and increases costs of catalyst management. These issues can be mitigated by appropriate design, such as the use of abrasion resistant coatings, erosion resistant wear plate, and wear shields on AIG lances, proper reactor sizing, catalyst module shape and pitch size. Pilot tests are currently underway (2017-18) on NTPC units to find the best solutions.

On its own, SNCR reduces NOx by 30–50%, while SCR levels of performance can be achieved if it is applied in conjunction with other combustion controls. Historically, the effectiveness of SNCR has been limited, especially in utility-scale boilers, due to a lack of accurate real-time tools to measure the temperature and CO profile within the boiler – parameters which are important for an effective NOx reduction reaction. However, recent developments in measurement systems allow the effective use of SNCR even on large furnaces (>400 MW). In India, an SNCR would have to cover a greater area and not all types of spraying nozzles will be applicable; this can be verified with CFD modelling and field tests. In Indian applications it would be preferable to use urea as the reagent rather than ammonia, as urea is non-toxic and its use would avoid various environmental and health hazards. Also, urea is much more effective than ammonia on large furnaces, according to some experts. Current tests on NTPC units will ascertain the applicability of SNCR.

As India is introducing emission standards for more pollutants, and pollution controls are expensive and time consuming to install, which disrupts power generation, it would make sense to co-ordinate installation of pollution control systems and to focus on multi-pollutant control systems. There are a few multi-pollutant controls which can remove NOx. Some of them, such as ReACT™ have been used in coal-fired power plants for several years. Some are deployed in non-coal applications but have the potential to be applied to coal-fired plants and are in various stages of testing and demonstration.

CLOSING REMARKS

Choosing appropriate methods of NOx control for a power plant requires a site-specific strategy which considers cost, performance and safety, and also water requirements.

NOx controls for high ash coals are broadly the same as for ‘normal’ boilers, but they must be customised to local requirements as has already happened with LNBs.

There is a lack of SCR and SNCR commercial installations in India. However, the experience from high ash lignite-fired plants and from high dust industries such as cement kilns indicates their potential, and vendors have confidence their systems will be applicable to Indian plants. However, utilities are not expected to make decisions about SNCR and SCR until the test results from NTPC units are clear.

The IEA Clean Coal Centre is a technology collaboration programme of the International Energy Agency (IEA). The objective of the IEA Clean Coal Centre is to provide definitive and impartial information on how coal can continue to be part of a sustainable energy mix worldwide.

Each executive summary is based on a detailed study which is available separately from www.iea-coal.org. This is a summary of the report: NOx control for high ash coal-fired plant by Malgorzata Wiatros-Motyka and Herminé Nalbandian-Sugden, CCC/285, ISBN 978-92-9029-608-9, 87 pp, April 2018