TIP SHEET:

Many facilities today seek to reduce their NOx emissions as a part of a sustainability initiative or to meet stricter government regulations. There are a number of options available to meet a low-NOx requirement.

- Reducing the amount of oxygen available during the combustion process is the least expensive strategy
- Induced flue gas recirculation is commonly used to reduce NOx emissions
- Selective catalytic reduction is a post-combustion NOx cleanup technology

Strategies to Reduce NO_X Emissions

In the boiler-burner industry, most experts agree that NO comprises about 95% of total NO_X, with NO_2 making up the remaining 5%. But, more recent studies have shown that NO_2 can make up an appreciable amount of the total NOx formed, particularly at very low NO_X levels. Many areas of California, for example, require sub-9 ppm NOx operation. Therefore, accurate NO_X measurements require both NO and NO_2 cells. Before investing a combustion analyzer that measures NO_X, ensure that it includes both NO and NO_2 cells.

NO_X control technologies vary widely across burner and boiler manufacturers, and can also depend greatly on the required emissions standards in different air quality management districts (AQMD). Permitted NO_X levels can and do dictate the most cost-effective strategy available for NO_X reduction. Here are a few:

- **Reducing the amount of O2** available to bind with nitrogen during the combustion process is probably the least expensive strategy to implement. This entails the use of a combustion analyzer to adjust the fuel/air mixture such that the amount of O_2 as measured in the flue gas sample is minimized (and still within the manufacturer's specifications).Tuning up the boiler in this manner can potentially reduce the NO_X production by as much as 10%. Generally, this method is insufficient to achieve NO_X levels that are required today.
- **Burning low nitrogen fuel oils** that contain significantly less fuel-bound nitrogen (FBN) can reduce NO_X emissions by more than 80%. However, this low FBN fuel oil can be very expensive.
- **Injecting water or steam into the flame** reduces flame temperature and thus lowers overall NO_X production by as much as 80% for gas. However, this technique can result in lowering boiler efficiency by 5% or more, depending on the amount of steam or water injected. Increasing the amount of moisture in the flue gases may also lead to condensation and consequently cause damage to boiler and flue passageways.
- **Induced Flue Gas Recirculation (FGR)** is one of the more commonly used methods to reduce NO_X emissions and involves pulling relatively cool combustion gases from the vent system and mixing with combustion air. Flue gases are composed of inert gases such as water vapor, carbon dioxide and nitrogen, which take heat away from the combustion process and lower flame temperatures. Flue gas recirculation is capable of reducing NO_X emissions by as much as 80%.
- **Stage combustion** entails running either a fuel-rich or fuel-lean primary zone followed by a fuel-rich or -lean secondary combustion zone, and can be very effective for modest NO_X levels reduction. However, incorporating FGR with staged combustion can reduce NO_X levels by more than 90%.
- **Premixed combustion** involves premixing the air and fuel prior to introduction into the combustion zone. This method can also yield modest- to high-level NO_X reductions (single-digit NO_X), but carries the inherent potential for flashback and the need for elevated excess air levels, leading to lower combustion efficiencies.

- **Selective catalytic reduction** is a post-combustion NO_X cleanup technology involving injecting the flue gas with ammonia or urea and passing the gases over a catalyst. This technology is very effective in reducing NO_X levels to 3 ppm or lower. However, the initial system capital costs, the annual operating costs and potential environmental issues surrounding issues such as ammonia "slip" can be substantial.

There are other technologies and technology combinations used to reduce NO_X emissions; however, the aforementioned strategies are most prevalent today.

To find out which NO_X-reducing strategy is best for your boiler system, watch the Strategies to Reduce NOx Emissions webinar or visit cleaverbrooks.com or contact your local Cleaver-Brooks representative.