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Ultra-Low NOx burner technology vs integrated combustion and post combustion emission control

Today's rules regarding the emission of greenhouse gases from industrial sources are as tough as they have ever been and there is no easing off in sight. For operators of industrial boilers generating steam for process, heating or power generation the options have been limited. Although the technology continues to advance, growing experience with Ultra Low NOx burner systems have shown the technology to limit operational flexibility, increase electric power consumption and increase the complexity of instrumentation and controls necessary to keep the system within safe operating specifications.

A Brief History

As NOx emission requirements were reduced, burner manufacturers developed hardware to limit the formation of NOx through natural gas firing by manipulating the localized fuel and air ratios in the flame body to keep peak flame temperatures low. They also developed ways to maintain flame stability while introducing inert gas (flue gas recirculation) that also dampened peak flame temperatures for reductions in thermally generated NOx. These methods were successfully achieving NOx emission rates in the 25 – 30 ppm range without extraordinary controls or excessively high FGR flow rates.

The next round of lower emission limits pushed boiler operators in California, the Northeast and parts of Texas to NOx emission levels in the single digits. The 9 ppm "Ultra Low NOx" burner was developed to satisfy this market. With thermally generated NOx being reduced to theoretical limits by maximum flue gas recirculation and deep fuel staging, burners would now utilize pre-mix or simulated pre-mix combustion techniques to reduce "prompt NOx" which could not be affected by FGR or staging. The technologies for pre-mix combustion, very high levels of flue gas recirculation and advanced fuel and air staging have proven to lower NOx emissions below the 9ppm level, but restrict operation to within very tight parameters. With higher flue gas recirculation rates and deep staging of fuel and air, the limits of flammability become increasingly more narrow. Flame stability is dependent on operation within the limits of flammability making stable control of all input parameters critically important. An Ultra-Low NOx burner now comes with 30% or more flue gas recirculation, sensors for O2 in the windbox and at the boiler outlet, tight draft control sometimes incorporating ambient pressure sensing, tight limits on load ramping rates and restrictions on low load operation. Because fuel air staging and flue gas recirculation tend to extend the flame body, furnace geometry (length, width & height) becomes much more critical to successful operation.

If the process involves a set steam load that doesn't vary, an Ultra-Low NOx burner can be used successfully resulting in a very low NOx emission rate. Otherwise restrictions on load changes could affect the process or lead to steam venting and accompanying losses.

Alternative technology

During the development of the Ultra-Low NOx burner, another technology was being used to reduce NOx emissions to low single digit numbers behind gas turbine generators. Selective Catalytic Reduction systems or SCR has been used to convert NOx to harmless N2 and H2O using a reagent and a catalyst in the exhaust gas stream of a combustion source. In the early days, the catalyst

formulations were only effective at higher temperatures which made the technology ideal for HRSG applications. The catalyst could be "buried" in a HRSG where temperatures were most effective at reducing NOx.

The primary reagent used at this time was and still is for the most part, ammonia in either pure (anhydrous) or diluted (aqueous) form. Safety and permitting of ammonia was and remains of great importance to operators. On a utility level, the monitoring and reporting is tolerated in the cost of business. For smaller scale industrial applications however it has been one of the largest drawbacks for utilizing the technology.

As catalyst formulations have progressed, the effectiveness at reduced temperatures has been drastically improved making SCR a viable option in a cycling industrial boiler. In addition, alternatives to ammonia reagent are now available that eliminate the hazardous chemical handling, storage and reporting required with ammonia.

It is now possible to install an SCR system behind a package boiler upstream of the economizer using urea as the reagent to reduce NOx emissions well below 9ppm. There are many additional advantages to this option over conventional Ultra-Low NOx burner systems.

1. Provide reliable steaming capacity utilizing natural gas and liquid fuels
2. Guaranteed emissions of NOx, CO, VOC's and NH3 throughout the firing range
3. Reduced auxiliary power usage with zero FGR and smaller HP forced draft fan.
4. Reduced control complexity. Single point positioning, parallel positioning, full metering systems are all compatible
5. Improved load following capability over Ultra-Low NOx burner solutions. No steam venting or process restrictions required
6. True integrated solution for stack emission compliance with burner and SCR optimization, feed-back and feed forward.
7. Urea based reagent systems proven and available
8. Any OEM furnace geometry can be applied
9. Cost comparable to Ultra-Low NOx burner solution with reduced on going operational costs
10. Improved boiler efficiency with lower O2 levels and reduced mass flow
11. Potentially smaller boiler footprint available

By providing a combined solution for combustion and post combustion emission control along with a single integrated control system it is now possible to offer superior emission control, improved efficiency, unlimited operational flexibility and lower overall costs to supply steam for process, heating and power generation.

Joseph Richter is the principle owner of BMR Thermal Inc, a manufacturer's representative firm providing equipment for combustion, energy recovery and pollution control. Joe graduated with a BS in Mechanical Engineering from San Jose State University and worked as a project engineer for Coen Company in Burlingame, CA before representing Coen and then DeJong Combustion and CCA Combustion systems for burners, Peerless MFG for SCR systems along with other energy related equipment manufacturers. For more information or to submit a system inquiry, please contact BMR Thermal at: mail@bmrthermal.com or call (603) 929-0769