

Environmental regulation of industrial and commercial boilers is getting tighter and more difficult to achieve without compromising operations. The implementation of environmental controls, either at the combustion source or post-combustion, has many undesirable limitations that impose considerable economic costs.

Operators of industrial boilers today must spend tens of thousands or even hundreds of thousands of dollars per boiler for NOx controls and then suffer an efficiency penalty, paying very high ongoing operating and maintenance expense to meet stringent US and European air quality regulations.

Many existing boilers are already out of compliance, forcing boiler operators to either buy credits to offset critical operations or, in some cases, shut down entirely.

Clearsign's Duplex Technology achieves low emissions levels without the use of external flue gas recirculation (EFR) systems which can reduce energy efficiency. This allows for substantial reductions in both energy costs and CO2 and NOx emissions as compared to currently available ULNBs.

Clearsign's Duplex Technology can reverse this trend and significantly improve boiler performance while meeting or exceeding regulatory demands.

NOx Reduction Strategy

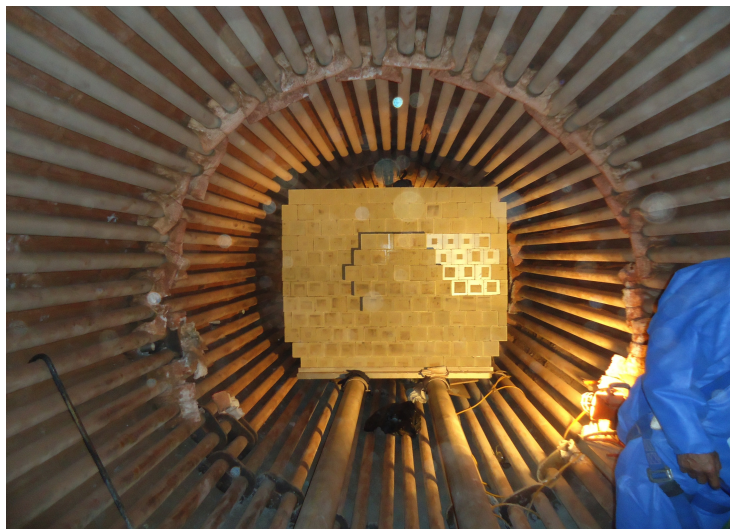
Ultra-Low NOx burners (ULNBs) are currently the technology of choice to meet ever more stringent regulations. For gas-fired applications, fuel staging and delayed mixing, combined with internal flue gas recirculation, ULNBs are the most common NOx control approach. NOx emission levels of 18-25 ppm at 3% O2 are typically guaranteed. (The range depends on fuel composition, furnace temperature and other parameters.)

Selective Catalytic Reduction (SCR) and Selective Non-Catalytic Reduction (SNCR) are post-combustion treatment technologies that many boiler operators are being forced to consider in order to achieve regulatory compliance. However, their higher capital and operating costs, combined with a reluctance to store ammonia-based reagents on-site and the large space requirements for these systems have limited their wide adoption.

Clearsign's Duplex Technology reduces NOx emissions to lower than 5PPM and improves process throughput without the need of prohibitively expensive ULNBs or impractical SCR systems.

Duplex Technology can be combined with existing ULNBs to eliminate the consideration of additional costly FGR or SCR solutions to achieve compliance with new, more stringent regulations.

Large Install (OTSG)



Maintenance Cost

ULNBs have several disadvantages (aside from decreased throughput) which result in increased maintenance cost. Boiler tube damage and decreased lifespan resulting from flame impingement and uneven heat distribution is the most common and noteworthy.

Flame impingement and uneven heat distribution caused by ULNBs and flame instability caused by external flue gas recirculation can result in catastrophic tube failure resulting in very costly repairs and personal injury or death.

Flame impingement can occur as a result of the increased flame length associated with ULNBs, or by flame instability caused by recirculating flue gas. If unchecked, this may eventually lead to tube bowing or can result in a pin-hole leak (requiring unplanned shutdown and tube replacement) and may lead to catastrophic tube rupture, which can cause collateral damage from the resulting steam and possible explosion.

Deposits can also occur on the boiler tubes due to soot and ash deposits. These deposits create an insulating barrier to heat transfer and lower heater efficiency. Cleaning of the tubes can be achieved by soot blowing (if fitted), or by mechanical cleaning or grit blasting of the radiant tubes requiring a shutdown of the boiler and entry to the firetube.

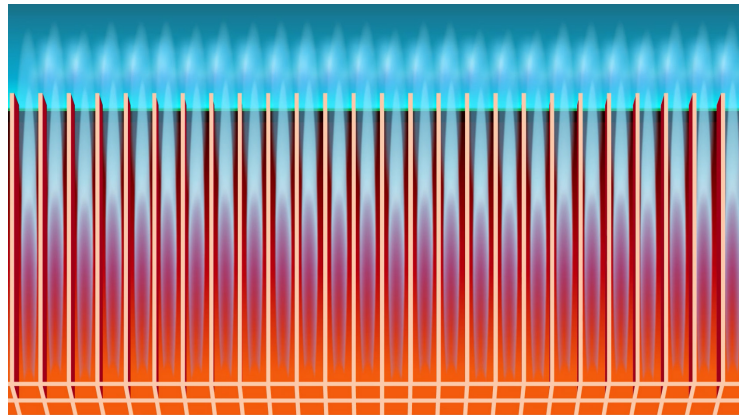
Clearsign's Duplex Technology eliminates the risk of flame impingement allowing for more even heat distribution to boiler tubes. This prolongs the life of the boiler tubes and reduces the frequency and occurrence of costly maintenance cycles and unscheduled shutdowns.

Performance

Ultra-Low NOx burners (ULNBs) lower potential process throughput as result of increased temperatures and uneven heat distribution within the firetube, which can stress boiler components. These systems not only require significant up-front capital cost but also add to the frequency of planned maintenance cycles and unplanned shutdowns due to flame impingement and fouling. These systems also suffer from inherent reduced fuel economy.

NOx can further be reduced by employing External Flue Gas Recirculation (EFGR), requiring power-hungry blowers and a costly retrofit which can further destabilize the flame and result in uneven heat distribution and fouling.

ClearSign's Duplex Technology shortens burner flames by up to 80% while reducing NOx to 5PPM or less and keeping O2 at 3% of volume or less. Our analysis shows that thermal efficiency gains on the order of 2-4% can be accomplished through lower levels of excess oxygen in the stack and enhanced radiant heat transfer, while offering fuel savings of 1 to 2%. **Duplex Technology is the only NOx reduction strategy on the market which can also offer the potential for increased process throughput and fuel savings.** The improved radiant heat transfer of the Duplex tile reduces stress on furnace components.



By adding a ducted ceramic tile above a standard burner, Duplex essentially turns a single large and unruly flame into thousands of tiny, more easily controlled flames. Duplex burner architecture reduces flame length by more than 80%

Summary

Clearsign's Duplex Technology completely revolutionizes the way boiler tubes are heated. With more stringent regulatory demands being placed on the boiler operators, Clearsign offers the world's only emissions reduction solution which can:

Meet or exceed current and foreseeable regulatory requirements without UNLBs, SCR or FGR

Offer a return on investment through:

improved fuel economy

improved radiant heat transfer to boiler tubes

increased process throughput

Reduce the capital cost of NOx mitigation

Offer a simple retrofit strategy

Eliminate flame impingement

Reduce stress on boiler parts

Reduce planned maintenance frequency and duration

Reduce the occurrence of unplanned shutdowns

Contact Clearsign now to find out more about how Duplex Technology can benefit your operation.



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