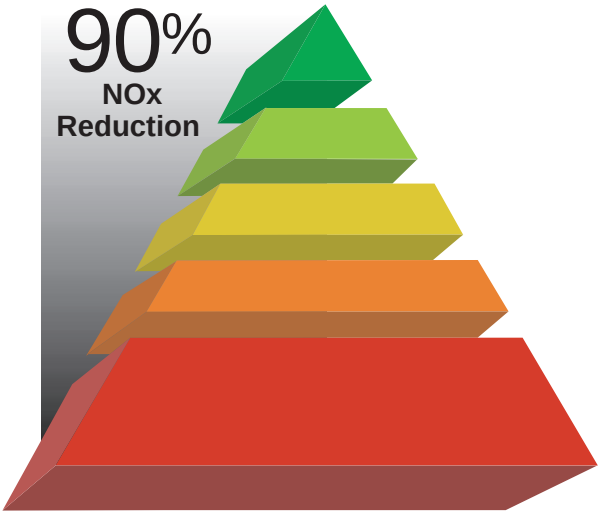
RJM-LT™

Does This New NOx Control Technology Obsolete SCRs?

- 90%+ NOx Reduction
- Lower Capital Cost
- Lowest Urea/Ammonia Consumption
- No Catalyst Required
- Shorter Plant Outages
- Custom Fit
- Select Only the Performance You Need

The RJM Layered NOx Reduction Process

90%+ NOx reduction at the lowest cost/ton



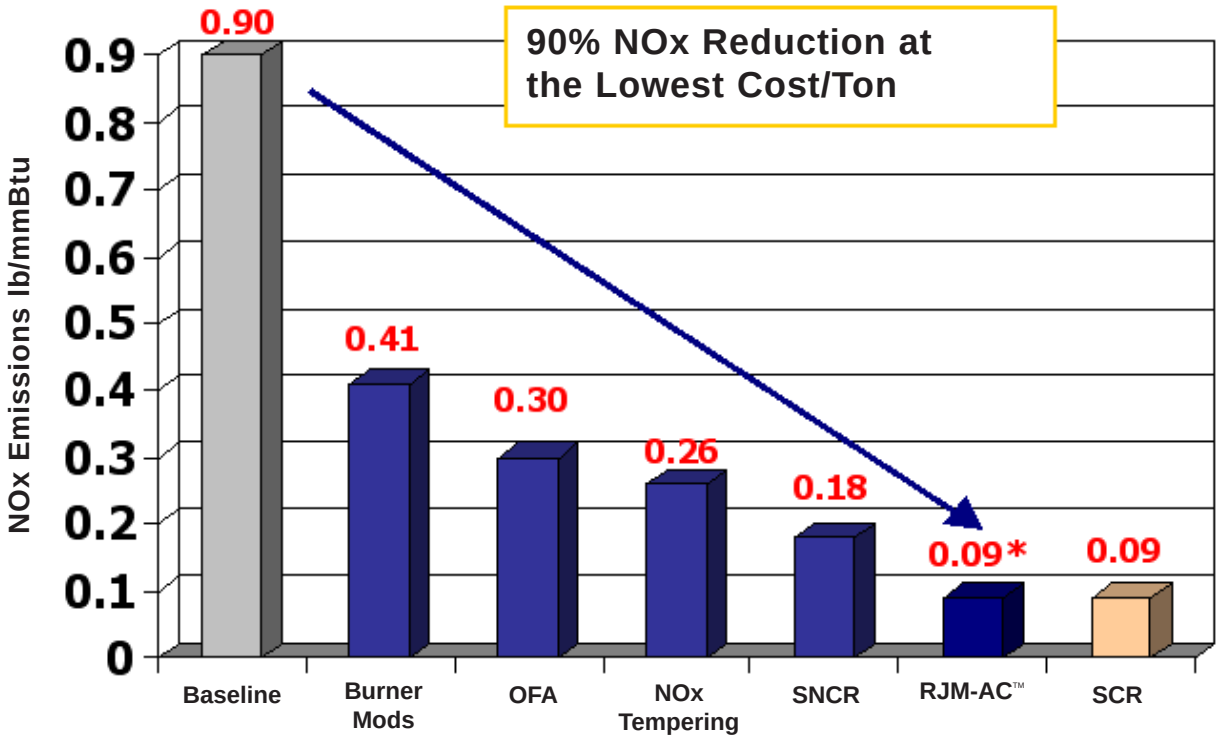
RJM
INNOVATIVE ENERGY TECHNOLOGIES

New NOx Performance Alternative Achieves 90%+ Reduction – *Are SCRs Obsolete?*

RJM Corporation uses a layered NOx reduction process to achieve up to 90% reduction in baseline NOx emissions from fossil fuel fired boilers. In North America, RJM's solutions have proved to be the least expensive route to complying with Environmental Protection Agency (EPA) and state mandated NOx regulations, typically saving customers 40%-70% in total installed cost when compared to alternative technologies like SCR or new low NOx burners. RJM's innovative solutions have consistently required less down time, usually one week, as compared to six to eight weeks for alternative approaches such as Selective Catalytic Reduction (SCR). Additionally, RJM's layered approach has saved power plants millions of dollars through lower capital and operating costs besides precious down time. These savings can lead to significant cash flow reduction for power generators to achieve compliance.

> *"The RJM layered approach for NOx reduction tailored to our specific needs, has enabled us to achieve our NOx emissions objectives at the lowest cost per ton ratio in the industry."* — Reggie Horton, Austin Energy Power Magazine, Sept/Oct 2001

RJM-LT™ – RJM's Layered NOx Reduction Process



The RJM-LT™ System uses a layered approach to NOx reduction using a combination of technologies. The above chart illustrates typical performance on an uncontrolled unit with baseline emissions of 0.9 lb/mmBtu. RJM's layered approach can enable the unit to achieve a 90% reduction in NOx emissions. The above example assumes 55% reduction through burner modifications. Additional incremental reductions include 25% through OFA, 16% through NOx tempering, 30% through SNCR and 50% through the RJM-AC™ System.

*Projected performance based on field and CFD results.

Burner Modifications Process (up to 70% NOx Reduction)

Air Distribution Analysis (ADA)

RJM's proprietary Air Distribution Analysis (ADA) is the fastest, accurate and most cost-effective technique for balancing secondary air between burners. This technique uses actual data taken from burners, rather than information inferred from downstream data or drawn from simulated conditions. RJM pioneered the use of massive, Airflow Balancing datasets, collected from inside the burner throat, at the critical fuel-air interface to create definitive diagnostic performance results. Typically over 2,400 individual data readings are taken for each burner. As a result, this proprietary technique provides reliable, accurate results to ±1.5%. Results identify airflow differences between burners, differences within the burner itself and the precise nature and location of any inefficient windbox air distribution for each unit.

Fuel Balancing

Balancing the fuel flow from burner-to-burner coupled with airflow balancing (RJM's ADA) ensures that the minimum furnace excess oxygen level is achieved. Fuel balancing and reduced furnace excess oxygen are beneficial to unit heat rate, boiler thermal efficiency, superheater temperature profiles, flame stability as well as NOx reduction.

For coal firing, RJM utilizes a RotorProbe and Dirty Air Pitot tube to measure the existing burner primary air and coal flow deviations. The RotorProbe is an effective measurement technique of coal flow distribution deviations and "roping" in the coal pipe runs, prior to the burner. This enables RJM to recommend changes to existing pipe orifices to correct the fuel distribution to ±10%. Alternatively, in order to limit outage time, RJM supplies balancing dampers for each coal pipe, which facilitates the on-line adjustment of the fuel balance. The balance of fuel and air is confirmed by measuring LOI, $\%O_2$ and CO across a sampling grid at the boiler or economizer outlet flue. RJM also supplies a coal distribution device to eliminate the coal "roping" in the burner.

CFD Modeling

RJM uses CFD combustion modeling to verify the baseline burner NOx and CO emissions and to design the burner modifications. The final burner configuration, including the flame stabilizer is modeled to ensure complete burnout of the fuel with low CO and NOx emissions. The difference between the baseline and modified burner emissions determine the percent NOx reduction from the burner modifications.

Flame Stabilizer

RJM adds a patented flame stabilizer to each burner to stabilize the combustion process and allow the unit to be operated at lower excess O_2. In addition, it radially and circumferentially stages the secondary air zone of the burners to reduce NOx emissions. This design creates the minimum swirl necessary to maintain a stable fire. The remaining secondary air is injected in a low or non-swirl mode outside the primary combustion zone. The application of the flame stabilizer allows the air doors to be set in a full open or nearly full open position, removing any inconsistencies between burners caused by the air doors. The quantity of air is effectively controlled in the primary combustion zone where the majority of the NOx emissions are formed. To enhance the NOx reduction capabilities of the burner modifications, the flame stabilizer is designed with internal air/fuel staging. This sets up fuel rich and lean zones downstream of the stabilizer in the primary combustion zone. This provides additional staging, flame stability and, lower NOx emissions.

Overfire Air (up to 25% Incremental NOx Reduction)

NOx emissions can be reduced an additional 25% through the use of RJM's advanced OFA ports. An OFA system can be supplied and installed to divert secondary air above the top burner rows. The ports are designed to inject air at the proper velocity to complete combustion prior to the furnace exit.

NOx Tempering System (15% - 30% Incremental NOx Reduction)

The patented NOx Tempering technology is another layer that can be added to incrementally reduce NOx. This technology injects micronized water droplets into high NOx production zones in the near burner region. This technology can achieve up to an additional 30% NOx reduction.

SNCR System (up to 40% Incremental NOx Reduction)

In this process, an aqueous solution containing a reagent (urea-based with chemical enhancers) is injected into the lean fuel zone above the furnace. The reagent reacts chemically with the NOx in the combustion gas to form nitrogen, a harmless gas, which comprises 80% of the earth's atmosphere.

RJM-AC™ System (30% - 60% Incremental NOx Reduction)

The final technology layer, the Absolute Compliance™ System involves amine reagent injection in the primary combustion zone. The reagent uses combustion turbulence for complete dispersion and targets specific zones where optimum chemical kinetics achieve maximum NOx reduction.

The Electric Power Research Institute (EPRI) and Reaction Engineering International (REI) are co-developers of the Rich Reagent Injection (RRI) Technology. The RRI technology has been successfully demonstrated by RJM, REI and EPRI on cyclone furnaces and is utilized as part of the RJM-LT™ System under license from REI.

With the RJM-LT™, total NOx reductions ranging from 25% to 90% can be achieved on fossil fuel fired units. These layers can be selectively combined to achieve specific NOx reduction targets for any given boiler. The layered approach to NOx reduction results in lower capital and operating costs (no catalyst replacement costs) compared to Selective Catalytic Reduction (SCR). These factors enable the RJM-LT™ system to achieve the lowest cost/ton of NOx removed when compared to competing NOx control technologies. Additionally, using the first three layers of the RJM-LT™ approach also works in conjunction with an SCR to achieve lower operating costs (reduced urea or ammonia consumption) and an extended catalyst life.

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