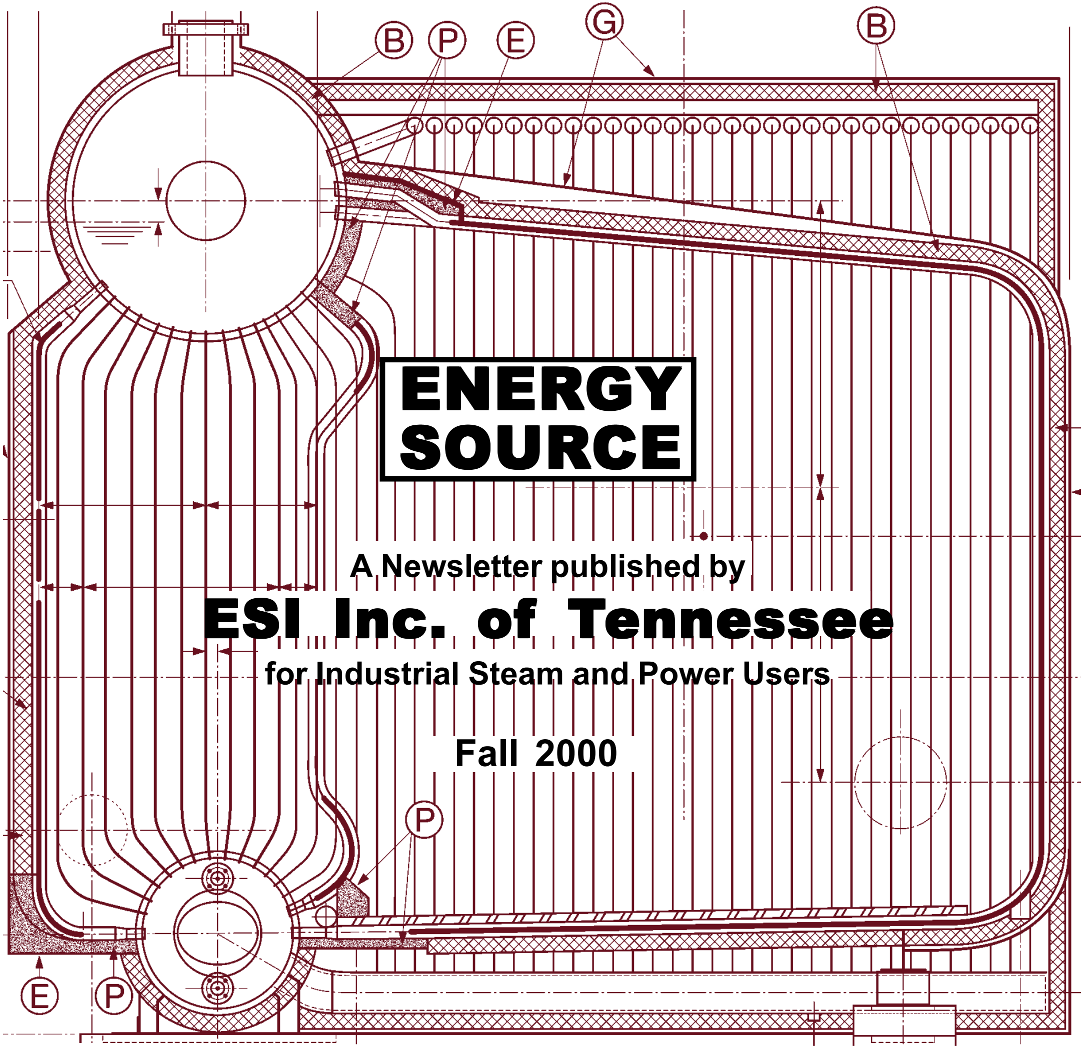

ENERGY SOURCE

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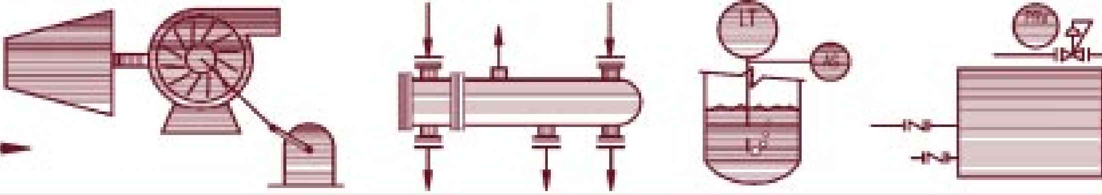

NO_x NO_x - What's There?

By: Jackson A. Brown, P.E., Mechanical Engineering Manager, ESI

Editor's note: The following article discusses how the NO_x generated by fuel combustion can be reduced. The Summer 2000 ENERGY SOURCE discussed the characteristics of NO_x and how air pollution control legislation has gotten us to where we are today.

Ever-tightening boiler plant emission regulations have resulted in consultants, equipment designers, and process engineers working hard to determine the best strategy to control NO_x emissions. Burner suppliers are making steps towards understanding the mechanisms of NO_x production and the factors that affect these mechanisms in the combustion process, while air pollution control equipment suppliers have started looking for ways to remove NO_x from the flue gas downstream of the boiler (add-on technology). Both of these approaches have to consider the fact that acceptance by industry would necessitate the consideration of system economics, operational complexity, and system availability.

As was mentioned in the last newsletter article, combustion-generated NO_x primarily consists of nitrogen oxide (NO) and nitrogen dioxide (NO_2). These oxides are formed by the oxidation of fuel-bound nitrogen (fuel NO_x) and by the high-temperature oxidation of nitrogen in the combustion air (thermal NO_x).

Combustion Control Methods

There are several factors that affect the combustion process which can result in a reduction of NO_x generated. First, if the amount of nitrogen and oxygen available from the air (tightly controlled excess air) is reduced, the NO_x generated will be reduced. Also, if the amount of nitrogen in the fuel (usually only attained by changing fuels) is reduced, the NO_x generated will be reduced. After investigating the NO_x formation process, it became apparent that the extent of the oxidation is time and/or temperature-dependent. An increase in temperature and/or time resulted in an increase in NO_x generated.

To optimize the NO_x reduction effect of these factors, low NO_x burners were designed to operate efficiently with low excess air, while keeping the temperature and time in the combustion zone to a minimum. This design indeed proves that necessity is the mother of invention. Designing burners to do this basically violates two of the three T's of the combustion process which has been preached for years. The three T's of the combustion process are: 1) time, 2) temperature, and 3) turbulence. Therefore, controlling NO_x in the combustion process involves some basic design changes to previous conventional burner technology.

The two most common low NO_x burner modifications utilize: 1) staged combustion, and 2) flue gas recirculation. Both of these modifications are aimed at flame temperature reduction and lower excess air levels. Staged combustion involves burning the fuel in two or more stages. By supplying only part of the necessary combustion air in the first zone and then completing combustion in a second or even a third zone, the maximum combustion temperature is reduced significantly. Flue gas recirculation (FGR), as the name implies, involves the recirculation of some of the combustion products back to the burner where it is mixed with the combustion air. A schematic of a typical low NO_x burner with FGR is presented in Figure 1. From a nitrogen standpoint, this is basically an inert gas, so the production of more NO_x is not possible. The additional gas mass which must be heated by the combustion process results in lower combustion temperatures. This additional flow can also be used to enhance burner flow patterns and air/fuel mixing without introducing additional oxygen, as would be the case with

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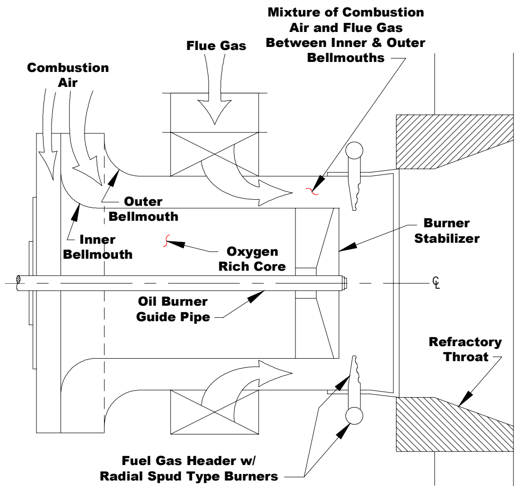

Figure 1. Typical schematic of low NO_x burner with FGR.

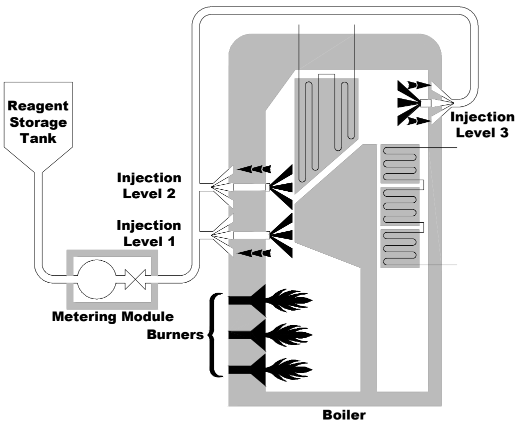

Figure 2. Typical schematic of the SNCR process.

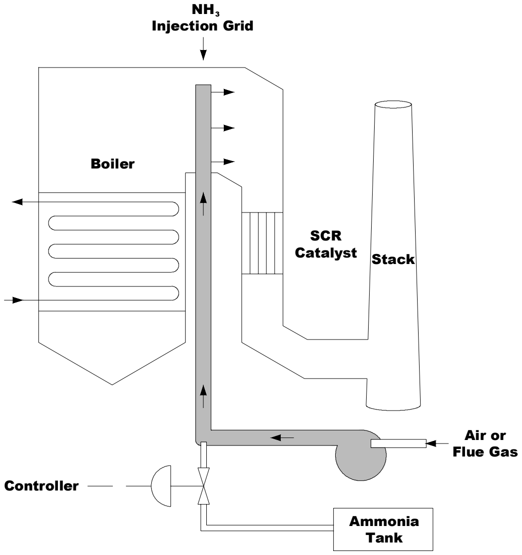

Figure 3. Typical schematic of the SCR process.

additional excess air. It is common now for low NO_x burners to achieve NO_x reduction of 40-60% when burning natural gas without FGR. To achieve lower emission rates, FGR is added. Increasing the FGR usually corresponds to a decrease in thermal NO_x, but flame instability and heat input requirements for the boiler limit the recirculation rate. Typical limits are 15-18% on natural gas and 12-15% on fuel oils. Emission reductions of 60-70% are common when burning natural gas and utilizing 15% of FGR. Obviously, achieving these emissions on a consistent basis requires the proper specification and purchase of the burner, proper mating of the burner with a boiler, design and installation of a dependable and accurate control system, and an extensive start-up and tuning procedure.

Current Post-Combustion Control Methods

When combusting solid fuels such as coal, wood, solid waste, etc., it is usually not possible to follow the same NO_x design modification philosophy as on gas and liquid fuel burners. These units, and in some cases conventional burners, can incorporate some sort of in-furnace treatment (SNCR), or a back-end treatment (SCR). SNCR stands for selective non-catalytic reduction, and SCR stands for selective catalytic reduction.

SNCR is a post-combustion control method utilizing the injection of ammonia or a urea-based reagent. A schematic of the SNCR process is presented in Figure 2. This process is very temperature-dependent, requiring high temperatures

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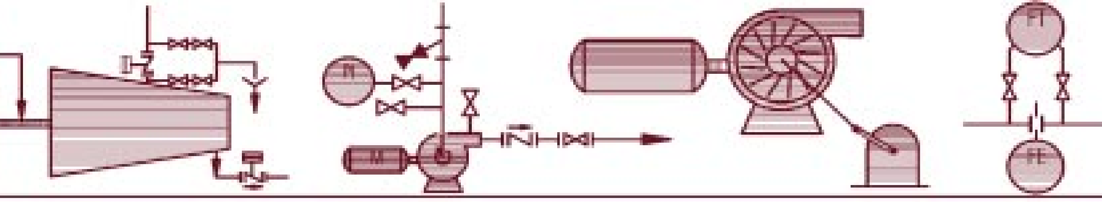


Converting Fly Ash To A Valuable Resource

By: Jeffrey H. White, Vice President - Sales, ESI
Thomas C. Hendrix, President, SEFA

ESI is proud to announce that it has been selected as the EPC Contractor for Southeastern Fly Ash Company's (SEFA) Carbon-Recycling Plant to be located at Santee Cooper's Winyah Electric Generating Station in Georgetown, South Carolina. This high-tech carbon-recycling plant will convert approximately 200,000 tons/year of fly ash from a waste material to a product that is ready for use as partial replacement for cement in ready-mixed concrete.

Currently, the fly ash is collected in electrostatic precipitators and is sluiced away to an ash-collection pond, where it is stored prior to landfill. This has been the procedure since Santee Cooper retrofitted their boilers with burners to reduce NO_x emissions. This retrofit caused the carbon content of the fly ash to increase from less than 6 percent to as much as 18 percent which is unacceptable for use in ready-mixed concrete, its traditional market.

The new facility will receive up to 200,000 tons/year of low-quality, high-carbon fly ash by-product when burning coal to generate electricity in Units 1, 2, 3, and 4 at Winyah Station, and Units 1 and 2 at the Grainger Electric Generating Station in Conway. A fluid-bed combustion process will burn out the high levels of carbon, reducing the ash content to less than three percent. There is a strong regional market for the high-quality fly ash. Approximately one-third of the fly ash will go to ready-mixed concrete suppliers in the Charleston area and a similar amount to suppliers in the Myrtle Beach area.

This project has several benefits over the current method of handling the fly ash. First, Winyah's operating and maintenance costs will be reduced by eliminating the need to transfer, store, and recover fly ash from collection ponds. Second, the heat recovered from the carbon-recycling unit will be returned to Winyah's turbine cycle. This will result in a slight reduction in coal consumption. Also, this project has several economic and environmental benefits which have many locals very excited. In a prepared statement, South Carolina Governor Jim Hodges said, "This $13.5 million is an investment in South Carolina's economic and environmental future. SEFA's announcement clearly demonstrates that keeping our state clean is a priority for Santee Cooper and an investment that will keep on giving for future generations."

This technology is currently employed at the Wateree Power Station of South Carolina Electric & Gas. This first-of-a-kind facility, which was designed, procured, and construction-managed by ESI, has been in operation since January 1999. For additional information about this technology, visit ESI's Newsletter Archives (Summer 1999 Issue, article titled "A New Technology For Enhancing The Value Of Fly Ash" and Fall 1999 Issue, article titled "Case Study - Carbon Burn-Out Plant For South Carolina Electric & Gas") on-line @ www.esitenn.com.

ESI and SEFA are excited to begin the design and construction of a facility which will have such a tremendous impact both environmentally and economically on the local area. Preliminary engineering is underway and plant construction is expected to start in January of 2001.

For additional information, please visit us on-line (ESI @ www.esitenn.com and SEFA @ www.SEFAflyash.com) or call Jeff White at 770/427-6200. We look forward to hearing from you!

ESI Supplies 432,000 PPH Rental Steam System

By: Deanna White, Marketing & Rental Sales Manager, ESI

After a year of planning, anticipating, and hard work, Potlatch Corporation in Cypress Bend, Arkansas began a 30-day shutdown of their recovery boiler on September 5, 2000. During this shutdown, Potlatch converted their two-drum recovery boiler to a single drum unit. This was the first single drum conversion in North America; however, five have been performed in Europe.

While the recovery boiler was shut down, 432,000 pph of rental steam was supplied by ESI. Six 72,000 pph trailer-mounted rental boilers arrived on-site the first week of August and then the task of installing this rental steam system began. On August 22 when start-up personnel arrived on-site, installation was nearing completion. Even though record-breaking temperatures were recorded in nearby Little Rock, Arkansas, start-up remained on schedule and was completed on August 30.

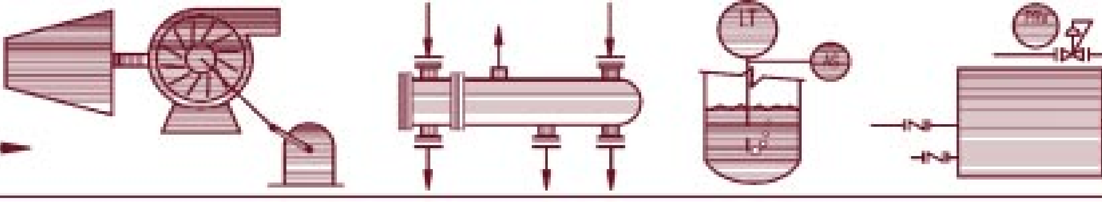
The recovery boiler project, led by Marc Stokeld of Potlatch, was performed to increase both the capacity and the efficiency of the unit. The project consisted of converting the two-drum recovery boiler to a single drum boiler with new long-flow economizers, long-flow generating bank, cross-furnace screen, superheaters, and numerous other modifications. These modifications cost a third of the cost of a new unit and were performed with just a 30-day shutdown of the recovery boiler.

432,000 PPH Rental Steam System

Arlon Ward and Doug White of ESI relax a minute while verifying the proper operation of the burner manangement system.

If you are planning a boiler shutdown and need temporary steam, call Deanna White at 1-800-990-0374 today! I will be glad to send you a proposal for review and assist in the planning stages of your project. Potlatch called ESI in January to schedule our equipment and begin planning for their shutdown. Thanks to Marc Stokeld, Darrell Wrobel, John Woodall, and Rhonda Finley of Potlatch for making this job such a great one!

Visit us on-line @ www.rentalboilers.com



NO_x NO_x - What's There ? *Continued from Page 2*

such as those found in the furnace. Typical optimal temperature ranges are 1,600°F to 1,750°F for ammonia, and 1,000°F to 1,900°F for urea. Temperatures outside of these limits can result in higher NO_x emissions (higher temperature) or ammonia slip (lower temperatures). Typical NO_x reduction rates are 50-60%. Careful monitoring for ammonia slip and NO_x levels is critical to insure that the system performs properly, thereby eliminating potential problems which are possible with these type systems.

SCR systems typically involve the injection of anhydrous or aqueous ammonia into the flue gas upstream of a catalyst bed. A schematic of the SCR process is presented in Figure 3. The NO_x and NH_3 react at the catalyst surface to form a salt that then decomposes into elemental nitrogen and water. Since the catalyst encourages the reaction, it can occur at lower temperatures than the SNCR reactions. Typical temperature ranges are 500-900°F depending on the type of catalyst, and typical reduction rates are 60-90%. As with SNCR systems, operation outside of the design temperatures can result in excessive NO_x emissions, ammonia slip (emissions), and damage to the system. Catalysts are available in a wide variety of shapes and materials. Each configuration presents various advantages and disadvantages in terms of allowable operating temperatures, catalyst fouling, and pressure drop.

Like the application of low NO_x burners, proper selection, installation, and operation of these add-on systems should involve properly qualified personnel. Only in this manner can the proper design parameters be considered so an appropriate system is selected and meaningful system guarantees are obtained.

Newly Emerging Technology

Although refinement of the NO_x control technologies previously mentioned continues, there are some new devices on the horizon. These technologies are in various stages of development, from R&D to market introduction. Generally these devices depend on oxidizing NO_x to NO_3 and even SO_2 to SO_3, which is then easy to capture in a wet scrubber or a wet precipitator. These devices normally depend on phasers or lasers to drive the reaction, which adds a minimal amount of temperature to the flue. Full-scale performance data is still being assembled; however, it should be available in the near future.

Conclusion

With the NO_x reduction requirements that exist today and the technologies that have been developed to meet these requirements, we should all benefit from the associated cleaner, healthier environment. If your plant needs to reduce their NO_x emissions, please contact ESI at 770/427-6200 or info@esitenn.com to discuss the appropriate solution. ESI is ready to help with all your steam and power needs!

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