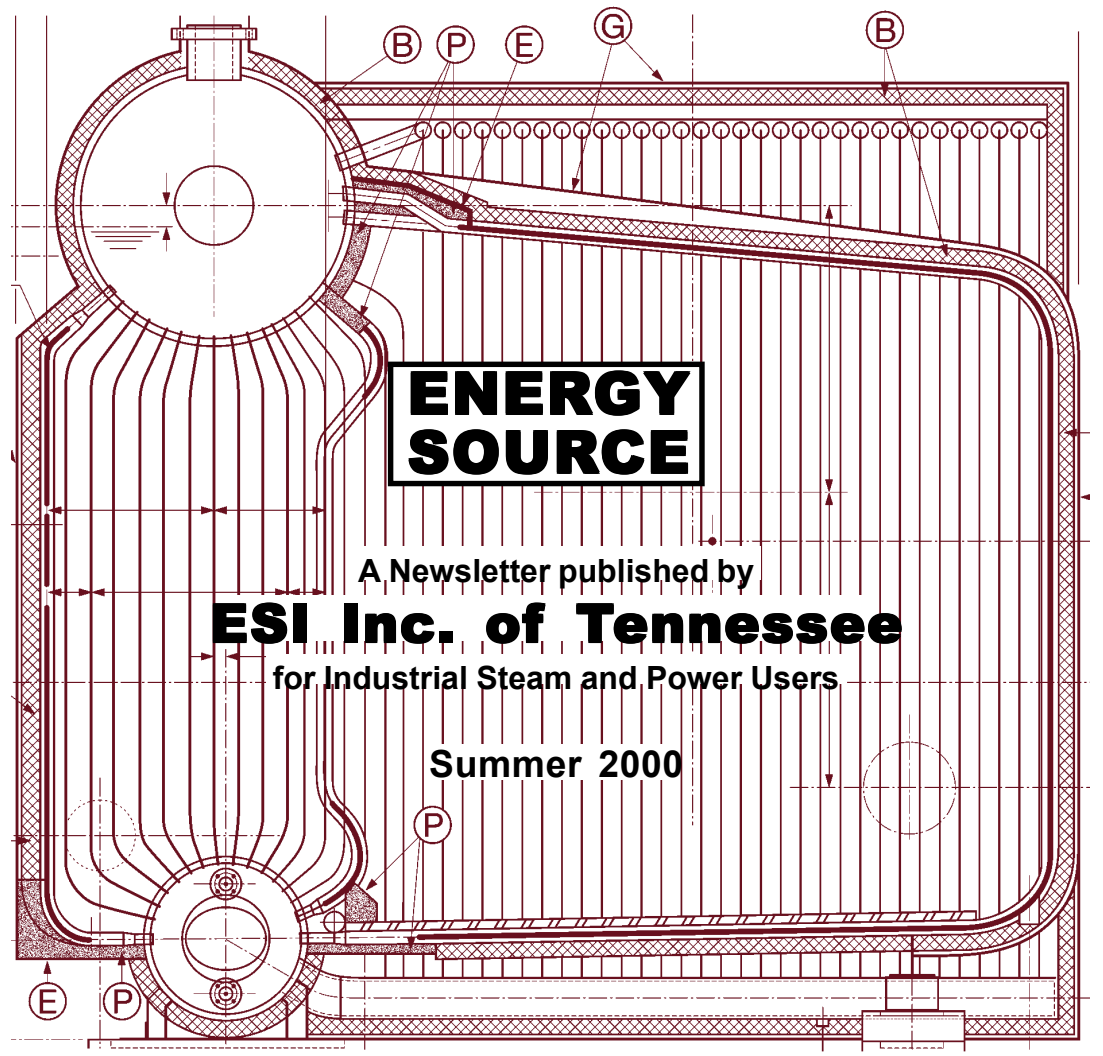

ENERGY SOURCE

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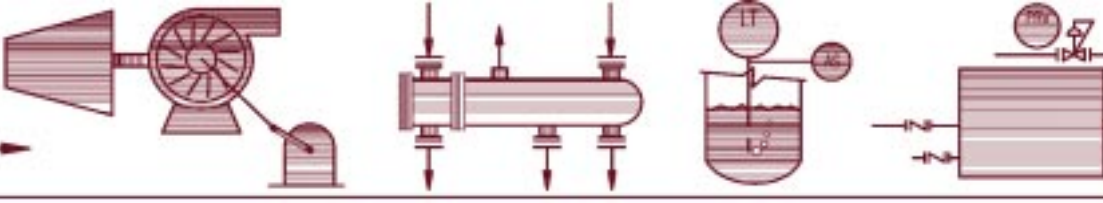
for Industrial Steam and Power Users

Summer 2000



NO_x NO_x - What's There?

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

So what's all the fuss about NO_x emissions?

Did you know that nitrogen oxides are one of the primary pollutants emitted during the combustion process? Did you also know that NO_x has been identified as a contributor to acid rain and ozone depletion, visibility degradation, vegetation damage, and health concerns? Thus the big fuss!

The term nitrogen oxides (NO_x) refers to nitric oxide (NO), nitrogen dioxide (NO_2), and nitrous oxide (N_2O). Nitric oxide has no color, odor, or taste, and is non-toxic. In the atmosphere, it is rapidly oxidized to nitrogen dioxide. Nitrogen dioxide is a reddish-brown gas that has a pungent, irritating odor. It absorbs light and contributes to the yellow-brown haze sometimes seen hanging over cities. It is one of the main components of smog. Nitrous oxide is a colorless, slightly sweet-smelling, non-toxic gas which occurs naturally in the atmosphere. The most common NO_x emitted is nitric oxide, while nitrogen dioxide accounts for less than 10%, and nitrous oxide accounts for even less.

Nitrogen oxides occur both naturally and from human activities. In nature, they are a result of bacterial processes, biological growth and decay, lightning, as well as forest and grassland fires. The primary source of human-made nitrogen oxides is the burning of fossil fuels. Approximately 79% of air is composed of nitrogen and about 21% is oxygen. Fossil fuels also contain varying amounts of nitrogen. During the combustion process, NO_x is produced from two sources. There is thermal NO_x and fuel NO_x. Thermal NO_x results from the high-temperature oxidation of the nitrogen contained in the combustion air. Fuel NO_x, as the name implies, results from the oxidation of the nitrogen contained in the fuel.

So how did we get into this position?

During the late sixties and into the seventies, the impact of years of basically unrestricted pollution could be seen almost anywhere you looked. Then Uncle Sam stepped in and began one of the most wide-sweeping legislated clean-up actions undertaken in modern times.

The first air pollution control legislation with any real teeth was the revised Clean Air Act of 1977. By this time, it was becoming evident that the implementation of a national air pollution control program was going to be challenging to say the least. Just the assimilation of representative air quality data and understanding interrelationships between pollutants and the environment is a quest still being pursued today. National Ambient Air Quality Standards had been established for six criteria pollutants: 1) sulfur dioxide

Continued on Page 5

ENERGY SOURCE

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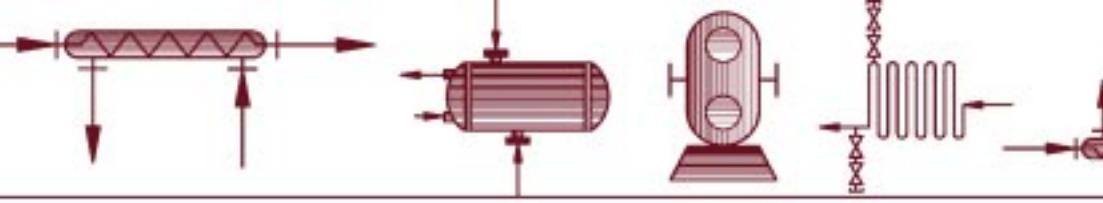
ESI is an engineering and construction firm that specializes in steam and power projects for industrial and utility clients.

Complimentary subscriptions to the *ENERGY SOURCE* are available by calling 770/427-6200 or visiting our web site at www.esitenn.com. If you have any suggestions or comments about the newsletter feel free to call us or e-mail us at energysource@esitenn.com.

Deanna White
Managing Editor



Cognis Adds New Demineralization Packed Bed Water Treatment System

By: Mitch Mason, Mechanical Engineer, ESI

Since most industrial facilities have water quality requirements which far exceed that of the incoming water supply, water treatment systems are a necessity. Depending on the quantity and quality of water required, the systems can be extensive and can be a major cost item, both from a capital as well as an operating standpoint. The more progressive companies make it a point to review their existing systems on a regular basis, both from an operating cost and from a current technology perspective. The Cognis Corporation in Cincinnati, Ohio is just such a company. ESI was contracted by Cognis to evaluate current water treatment technology and thereafter to design and build a new water treatment facility to serve the plant's needs.

Cognis produces steam at 1200, 800, and 300 psig for numerous chemical processes. Currently, the feedwater for the low pressure boilers is treated by a hot lime softening and zeolite softening system, and the feedwater for the higher pressure boilers is returned condensate which passes through polishing units.

Technology Selection

The review of the available technology directed both ESI and Cognis to standard countercurrent, packed bed, and reverse osmosis systems. However, due to the higher efficiencies (less waste water) and lower capital cost, Cognis decided to use a demineralization packed bed system. The new system was required because the existing hot lime and zeolite systems were more than 25 years old, and had become high-maintenance items.

Packed bed systems are common in Europe, but much rarer in the United States. There are two distinct classes of packed beds: 1) upflow service with downflow regeneration, and 2) downflow service with upflow regeneration. Both upflow and downflow have several advantages and disadvantages.

Packed Bed Upflow Service with Downflow Regeneration

Advantages

- Floating resin bed offers less pressure drop which equals less pump horsepower
- With less pressure drop, the resin bed can be deeper which allows for a smaller vessel size
- With deeper resin beds, the regeneration efficiency increases which equals less wastewater
- Proven technology - widely used all over the world

Disadvantages

- Minimum flow is required to hold resin bed in place
- Limited turndown on the system

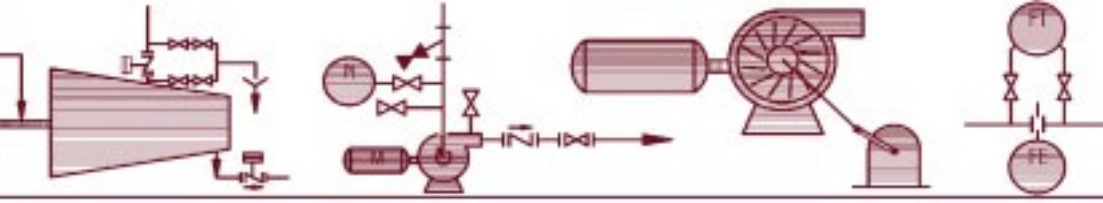
Packed Bed Downflow Service with Upflow Regeneration

Advantages

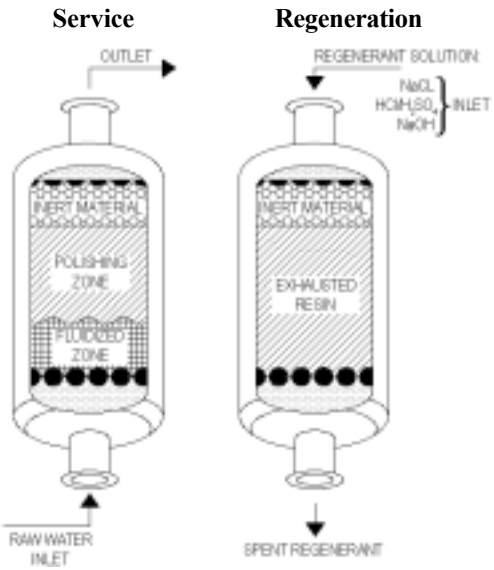
- Better turndown
- Ideal system for retrofitting vessels without the high capital cost

Disadvantages

- High flow rate required for regeneration which in turn produces more wastewater
- Weak and strong resins may get mixed together



Many factors influenced the decision of which packed bed to choose including: initial cost, facility layout, choice of sulfuric or hydrochloric acid, regeneration cycles, and wastewater. For this specific installation, the upflow service with downflow regeneration system was chosen. However, this decision might be different at another plant with different parameters.



Schematic of Demineralization Packed Bed System with Upflow Service Downflow Regeneration.

Water Treatment Facility

At Cognis, the water treatment process begins with well water being pumped at a rate of 1300 gpm to the raw water storage tank. Due to the quality of the well water, sodium hypochlorite is injected into the storage tank. The water is then pumped to the cation units, but before it reaches the cation units, the chlorine must be neutralized with sodium bisulfite to prevent destruction of the resin beads. The carbonic acids formed during cation treatment are removed by a decarbonator which is downstream of the cation vessel and upstream of the anion vessel. From the decarbonator unit clear well, the water is pumped through the anion unit and then to the appropriate boiler deaerators. The operating scenario for the plant is to utilize two of the cation/anion trains while the third train is in standby or regenerating. The regeneration process will occur when any of the following alarms activate: high pressure drop across the resin beds, high silica level, or water throughput. The cation train requires 93% sulfuric acid while the anion train requires 50% caustic for regeneration. The wastewater from the regeneration is collected in a neutralization tank and is pumped to a process sewer after the pH reaches an acceptable level.

The new demineralization water treatment facility will provide higher quality water to process, to all existing boilers, and to future facility expansions. The facility will be completely automatic and will operate 365 days a year. In order for this reliability to occur, pumps, tanks, vessels, and controls have the appropriate redundancy designed into the system. This facility is scheduled to start up in March 2001.

Conclusion

Depending on the quality of water required, water treatment can be as simple as a water softener or as complicated as the demineralization packed bed system with upflow service downflow regeneration. The design considerations required to select a water treatment process begins with an analysis of the available water source and the water quality requirements. ESI has extensive experience with respect to designing and building water treatment facilities as well as designing and building entire steam and power facilities. If you have a steam or power concern, contact the steam and power ***SPECIAL FORCES*** at 770/427-6200 or energysource@esitenn.com. Ask for Deanna.

ARE YOU A SURVIVOR?

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

Sure your boiler plant may be operating okay and you are not getting any heat from the big boys upstairs; but unless you are continuously looking for ways to improve your operation, you may be the spoke in that proverbial wheel that causes the wagon to stop moving, or in other words, you may be responsible for the plant's failure.

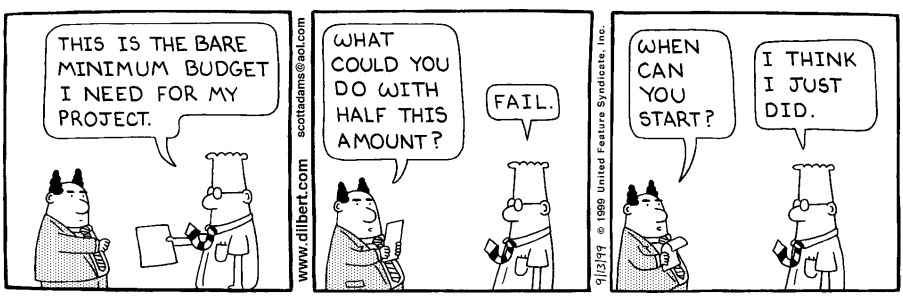
Competition in the marketplace is becoming tougher every year, especially since we are now in a global market. The survivors will be those who continuously assess their position and try to improve it. Since the boiler plant operation is usually a significant portion of a plant's operating cost, improvements in that area can go a long way. Obviously, preventive maintenance, operating efficiency, and fuel costs are of paramount importance. However, this article is aimed toward getting power plant personnel to look at the big picture, select a main course of action, and then move on to the details.

If you do not already have a written procedure to insure that equipment and system preventive maintenance (lubrication schedule, vibration readings, critical temperatures and pressures, etc.) is recorded and attended to, you should instigate one immediately.

Operating efficiency improvements are quite often better carried out by a qualified outside company which specializes in boiler plants. Since some areas for potential improvements are not apparent, these type of companies can usually more than earn their keep.

Fuel cost is of major concern. This item is not only affected by operating efficiency, but also by fuel flexibility. If natural gas prices are escalating and your only fuel of choice is natural gas, your only option is to pay the price. However, if you have made provisions to burn other fuels, you can shift back and forth to the most economical one at the time. This flexibility could justify a significant capital expenditure; however, a thorough investigation and analysis should be conducted prior to making such a decision. ESI has performed several projects that utilize unusual plant "opportunity fuels", thus providing a low cost energy source while disposing of a waste product.

If any of these areas have not been optimized in your plant, steps should be taken to do so. ESI is very familiar with these types of analyses and would be glad to discuss your particular situation. Please contact Jeff White at 770/427-6200 or energysource@esitenn.com for additional information. By making sure that the operating costs of your boiler facility are minimized, you will be helping to insure that your plant will be one of the survivors.



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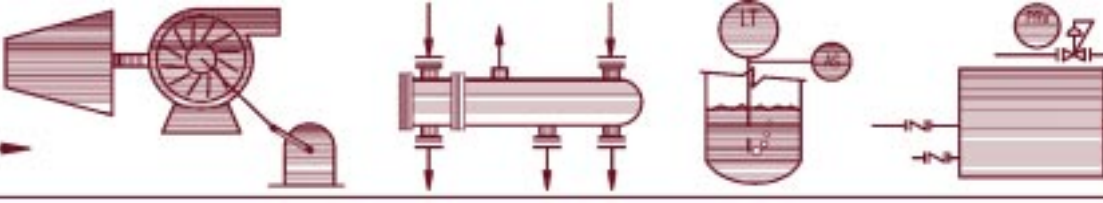

NO_x NO_x - What's There? *Continued from Page 1*

(SO_2), 2) nitrogen oxides (NO_x), 3) carbon monoxide (CO), 4) ozone (O_3), 5) particulate matter, and 6) lead. Needless to say, there has been considerable controversy as to what constitutes safe concentrations. Also, New Source Performance Standards had been adopted to require the application of Best Available Control Technology (BACT) on many new facilities. The amendments of 1990 put pressure on states, cities, etc., by identifying "Nonattainment Areas", or those areas which still did not conform to the National Ambient Air Quality Standards. By classifying these areas and issuing deadlines for compliance, pressure was exerted on the emitters in those areas. A special emphasis resulted on NO_x emissions since it was now understood that NO_x is a precursor to ozone formation.

So how are we going to reduce the NO_x generated by fuel combustion?

As a result of this legislation, new equipment has been installed, existing equipment has been modified, operational procedures have changed, legal action has been taken, and fines have been levied, all in the interest of cleaning up the environment. Although the results are slow in becoming evident, progress is being made. Look for our next newsletter where we will discuss the technologies available to help reduce the NO_x generated in fuel combustion.

Just A Reminder

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