

The key to plant health

Jeff Bause and Steve Houghton, Groome, USA, use case studies to show that emissions catalyst maintenance is essential to refinery health and productivity.

rom an environmental standpoint, reducing atmospheric pollutants remains central for refineries across the US. Tighter restrictions on NO_x levels make high-performing emission control technologies such as selective catalytic reduction (SCR) catalyst systems even more critical, especially for large refineries.

A well-maintained SCR catalyst system helps achieve maximum NO_x reduction while minimising ammonia consumption and backpressure. These systems help buffer the overall balance of NO_x emissions using a dynamic reduction process in select sources to compensate for higher levels from others. However, efficient NO_x reduction is only possible with a properly designed, installed, and maintained SCR catalyst system, illustrating the need for skilled refinery maintenance services from trusted leaders in the industry.

AIG tuning: an essential element for SCR balance

The ammonia injection grid (AIG) is often overlooked when discussing NO_x conversion efficiencies, even though it is one of the keys to maintaining an efficient SCR system. AIG tuning allows for the most accurate ammonia dispersion across the face of a catalyst.

The value and importance of AIG tuning cannot be overstated. The service works to directly improve NO_X conversion, lower ammonia consumption, lower reagent usage, minimise ammonia slip, and increase the useful life of the catalyst.

It is essential that before any tuning work begins, a thorough cleaning first takes place. Plugged nozzles impede the tuning process, and a complete cleaning and unplugging allows a team to optimally tune the AIG system as a second step. Complete tuning services typically include all lift equipment, test port installation, valve adjustments, and stack testing.

A positive impact in the Gulf Coast

The management team at a refinery in the US Gulf Coast faced the challenge of a boiler at the facility operating at only 45% due to unknown issues with the SCR catalyst. The plant was exceeding NO_{χ} limits and was not generating enough steam to run at target efficiency.

The refinery needed to clean its SCR bed immediately to improve backpressure and meet its NO_x permit. Groome was brought in to conduct a thorough inspection, and determined that the SCR was plugged with refractory on multiple layers of SCR catalyst. It was necessary to quickly conduct a complete cleaning of the SCR layers.

The team developed a plan to clean the SCR bed, which included custom module fabrication, and completed this project on time, on budget, and with results that exceeded the plant manager's expectations. Following completion of the work, the plant reported the following before and after statistics: the average NO_x lb/million Btu for the days leading up to the shutdown of the economiser was

0.013058 lb/million Btu. The average NO_x lb/million Btu for the days following the start-up of the economiser was 0.009527 lb/million Btu. The unit was operating at similar firing rates for both durations. This translates to a reduction of approximately 27% NO_x lb/million Btu. The refinery



Figure 1. Foreman completing pre-job inspection.

experienced a 122% (US\$368 400) increase in daily revenue once the cleaning and maintenance work was complete. The payback period for the project was just under 10 days.

Cleaning before tuning: get the job done right

Tuning a dirty AIG system is akin to painting a dirty car. The results will not look right and the performance will not be optimal. A proper cleaning of the nozzles, lances, and vaporiser will promise much better tuning results by establishing a 'clean slate'.

Contaminants on the inside of the AIG lances are evacuated by using a vac truck. It is sometimes shocking to see blockage build up inside lances which can range from rust build-up to ammonia bisulfate. Proper maintenance will ensure blockage does not become a production hinderance over time.

The vaporiser is waterjet cleaned, which is an effective and environmentally friendly form of high-pressure washing that removes surface material and contaminants from the drip rings. This process uses only water and does not require any environmentally harmful abrasives or chemicals.

Fin tubes: different tubes, different cleaning process

It is also important to ensure that the system is not challenged with backpressure inefficiencies and cooling restrictions. There are two popular methods employed to resolve these issues for system flow and operating temperature balance: dry ice blasting and foam cleaning.

Dry ice blasting

Dry ice blasting is a fast, dry, non-abrasive, and non-toxic cleaning method. It uses a form of dry carbon dioxide (CO_2) that evaporates upon contact and does not release any harmful contaminants into the air.

This service is an excellent solution for finned tube cleaning. Finned tube bundles are CO_2 blast-cleaned and high-pressure air-lanced with this method to remove accumulated ammonia salts, rust, and other contaminants and debris. Once the tubes are completely clean, interior surfaces are vacuumed to recover any residue remaining inside the unit. The benefits of dry ice blasting include corrosion accelerant removal, prolonged



Figure 2. Before and after of common SCR cleaning project.





equipment life, improved heat transfer performance, decreased backpressure, and increased megawatts.

Foam cleaning

Foam cleaning is growing in popularity. This eco-friendly method is an excellent option to minimise cost and downtime during the cleaning, while over the long-term improving refinery reliability. Foam cleaning procedures effectively clean exterior finned tube exchangers and boilers while the unit continues to run: a small amount of low-pressure liquid is paired with foam to clean and ensure refinery equipment returns back to peak performance, with the ultimate result of improving energy efficiency.

There are additional benefits with foam cleaning: the cleaning of the tube exteriors does not require entry into the shrouds so there is no damage by a team walking on the aluminium tubes; damage does not occur due to high-pressure water; and this method of cleaning enables deep cleaning of interiors of the tube banks, which often cannot be accomplished via other methods.

A Gulf Coast project

A recent project involved a refinery located south of Houston, Texas, US. This refinery looked to boost operational efficiency and reduce cost, as well as find innovative solutions to optimise plant performance, productivity, and its bottom line. Groome was tasked to determine what services the client needed to ensure equipment was functioning at optimum capacity. After meeting the client, observing plant operations and identifying areas that needed attention, a scope of work was tailored for this client, taking into account the unique needs of the plant.

The recommended solution was to thoroughly clean the furnace and surrounding equipment using the ice blasting method. When plant conditions required that the professional cleaning services take place offsite, a smooth and streamlined adjustment to the change was required. The team bundled all of the required services and ensured work took place during the plant's scheduled downtime.

In this particular project, the refinery realised an impressive 37% increase in production due to cooler running conditions, via a 9 in. decrease in backpressure (from 29 in. to 20 in.). This resulted in improved performance that maximised the furnace's efficiency and lifespan, thereby improving both plant operations and the return on investment (ROI).

With this project and others, the time-sensitive nature of refinery work and the need to minimise plant downtime must be accounted for. The team bundles services and simultaneously completes different projects for a plant, offering attention to efficiency and productivity that enables the plant to be up and running on schedule.

Tackling issues in the Midwest

Meanwhile in Midwest US, Groome was contacted by a refinery that was looking to improve its efficiency and determine a solution for its ongoing problem that had no obvious solution: the facility was continuously operating at temperatures above design. As the internal refinery engineers were not able to solve the problem on their own, they looked for outside support to determine a solution. A thorough inspection and review of the facility was conducted and it was determined that targeted maintenance was required to bring the refinery back to its intended operating level. Customised foam cleaning was used to clean the internal finned tubes, removing accumulated ammonia salts, rust, and other contaminants and debris.

After the cleaning was complete, the heater stack was reduced by 100°F, back to the original design temperature. This led to an increased annual production revenue of US\$14.6 million and saved the company approximately US\$100 000/yr in burner fuel.

The importance of safety

Safety must be at the cornerstone of every maintenance project and should be of paramount importance from management to field members of every team working on any type of refinery maintenance work.

Operators should partner with companies that have a continuous and evolving safety programme – one that can adapt with the changing world. As has been seen with the onset of the COVID-19 pandemic, companies needed to pivot and adapt to rapidly changing environments. The companies that have best survived the recent health crisis are the ones that have managed to quickly comply with new safety guidelines.

In addition, companies should ensure employees receive extensive annual safety training, with it a 'given' that all team members comply with the standards set forth by the Occupational Safety and Health Administration (OSHA) and other oversight organisations.

The best companies will start every project with a review of the working conditions and will both identify potential hazards as well as complete an in-depth analysis of how risks can be mitigated or eliminated – via a 'top-down' approach to safety. They will look to ensure projects are continuously assessed and re-assessed to identify hazards and preventive measures that will help minimise potential for injury. A focus on safety will translate to lower insurance costs, stronger employee commitment, and higher productivity that translates to an improved bottom line.

Searching for the right partner

As refineries continue to seek the best options to efficiently reduce atmospheric pollutants and abide by restrictions on NO_x levels, maintenance providers must look to raise the standard within the refining sector through the work of highly-trained teams, strategic alliances with catalyst manufacturers, and a philosophy of providing quality and innovative services at a reasonable cost.

With a variety of cleaning methods and technologies available, refineries should aim to partner with a turnkey service provider who can complete the job in the most effective way based on facility and management needs. In-house expertise with strong oversight procedures and a turnkey solution will help ensure high-quality work performance with every project. It is important to look to a partner with a track record of efficient and streamlined communications, which will help ensure the refinery returns to normal operations in the shortest amount of time while delivering a positive ROI on the project.

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