

Frontier innovates pressurized cleaning with NitroLance™

Conco Industrial Services

The use of pressurized liquid nitrogen (LN₂) as a safe and effective industrial cleaning tool achieved prominence in 2003 when the technology was utilized by NASA to clean components of the space shuttle. In a more recent (and down to earth) application, the cleaning benefits of LN₂ are being recognized as a highly effective means for removing tenacious fouling deposits encountered in petroleum refinery process equipment. As a result of the new technology, significant improvements are being seen in process flow rates and control, in process energy and pollution management, and reduction of equipment downtime associated with cleaning compared to high-pressure water blasting and other methods. On the subject of high-pressure water, an additional benefit of utilizing LN₂ is that it doesn't produce secondary waste streams, thus completely avoiding issues with cross-contamination and volatile reactivity with the process deposits being removed.



Before and after results using NitroLance™.

Heat exchanger cleaning evolved

Cleaning of refinery heat exchange equipment is traditionally performed using a variety of methods including high-pressure water blasting, hydro-drilling, grit blasting, acid cleaning and mechanical scrapers or brushes. These methods require disposal of deposits as well as the polluted water, chemicals or sand used in the cleaning process that can often reach hundreds of thousands of gallons. With this new method of LN₂ cleaning, no secondary waste stream is produced. The fouling deposits removed by the cleaning process are easily vacuumed up or blown out of the tubes and the unit is immediately ready to return to service, requiring no supplemental drying. This zero secondary waste stream benefit represents a significant savings in both time and money for refineries when compared to traditional cleaning methods, especially when considering cleaning of critical path components like crude pre-heat trains.

Introduction to LN₂ cleaning technology

The ultra-high-pressure LN₂ cleaning technology owned and operated by Conco Industrial Services of Deer Park, Texas, is marketed under the brand NitroLance™. The complete system is mounted on a mobile platform that is moved to close proximity of the heat exchangers being cleaned. The NitroLance hose and nozzle can extend up to 300 feet from the mobile platform while delivering LN₂ to the surface. NitroLance uses a controlled stream of LN₂ at variable pressures and temperatures to penetrate and break up just about any deposit. Using various nozzle configurations, NitroLance can clean both internal tube surfaces as well as external tube surfaces like those found on economizers, and can be configured to clean heat exchangers and process equipment encountered in sulfur recovery units and associated heat exchangers such as waste heat boilers, sulfur condensers and catalytic reactors to name a few.



LN₂ cleaning mechanism of action

The NitroLance cleaning system delivers pressurized LN₂ to the cleaning surface and rapidly removes deposits through three mechanisms of action: mechanical pressure, super cooling and volumetric expansion.

1. Mechanical pressure — The pressure exerted at the nozzle tip of the system is regulated from 5,000 psi to 55,000 psi based on the equipment being cleaned and fouling characteristics present.

2. Super cooling — The super cooled LN₂ (-160 F to -250 F at the nozzle) facilitates embrittlement fracturing of fouling deposits.

3. Thermal/volumetric expansion — As the high density liquid penetrates the cracks and crevices of



NitroLance™ mobile platform cleaning exchangers in place.

the fouling deposit, it rapidly vaporizes to a gas expanding nearly 700 times. This rapid expansion, combined with the delivered pressure and cold temperature, causes the fouling deposit to break apart and release its bond with the parent metal.

NitroLance at Frontier El Dorado Refining Co.

A NitroLance cleaning performed at Frontier El Dorado Refining Co. in El Dorado, Kan., provided insight into the speed achievable utilizing LN₂ in place of high-pressure water. In the case of Frontier El Dorado, it was a waste heat boiler that had significant deposits of iron pyrite. The deposits on the tube inner diameter ranged from 0.20 inches thick to 0.32 inches thick. Similar deposits were on the tube sheet. These deposits decreased the heat transfer



NitroLance™ cleaning Frontier's waste heat boiler.

and reduced the overall unit efficiency. Previous cleanings of this boiler were done by hydro-blast technique and resulted in many thousands of gallons of effluent that needed treatment by the plant's wastewater system.

The time to clean utilizing hydro-blasting often reached 12 shifts or more.

Cleaning process and results

Conco technicians configured the

NitroLance to an optimal pressure and nozzle temperature. Twenty-foot-long lances with specially designed rotating jet nozzles were used to clean each waste heat boiler tube. Feed rates of the rotating nozzles were evaluated by checking the internal tube's cleanliness with a borescope. Once the optimum cleaning rate was determined, the process of cleaning the unit's 308 tubes began.

"The cleaning effectiveness of the NitroLance was readily apparent," said Frontier's Turnaround Superintendent Rick Scott. "The entire waste heat boiler was finished in a single 12-hour shift compared to the previous method requiring 12 shifts."

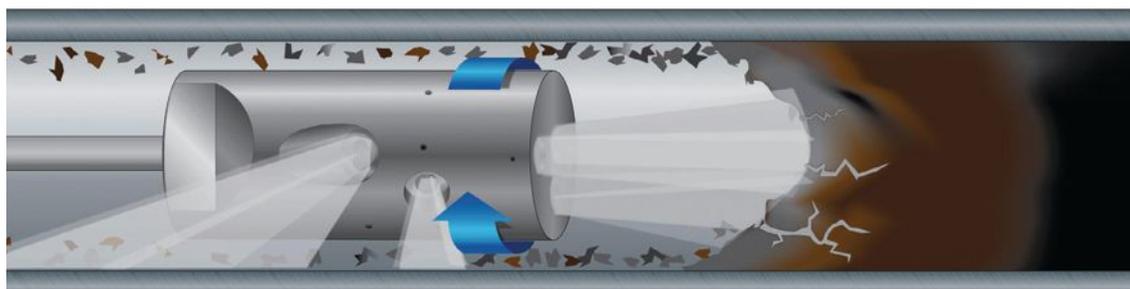
Performance results

After the waste heat boiler was brought back in service, immediate results showed the process gas side temperature was reduced from 800 F to 650 F, or the original operating temperature specification. Thus, the heat transfer performance of this unit was brought back to design conditions and the overall plant efficiency was improved. A calculation on the total iron pyrite deposits removed from this heat exchanger was approximately 19.7 cubic feet, weighing 6,202 pounds.

The cleaning of this waste heat boiler was so effective Conco's NitroLance is now being utilized to clean Frontier El Dorado Refinery's sulfur condensers.

"Other plant equipment will be considered, including catalytic reactors and any other fouled heat exchangers," said Scott.

For more information, visit www.concoindustrial.com or call (800) 569-5523. ●



The liquid nitrogen removes the deposit by mechanical pressure, super cooling and volumetric expansion.