Feature

Liquid nitrogen removes tube deposits when other methods fail

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In the 1990s, the United States Department of Energy developed the use of high-pressure, super-cooled liquid nitrogen as a tool for cleaning and cutting into metal storage tanks that contained radioactive material. Liquid nitrogen was an ideal agent because it is not an accelerant that could spark and potentially ignite the contents of the tanks. In 2003, NASA used high-pressure liquid nitrogen to clean the Space Shuttle. Wearing a facemask and protective suit, a NASA technician at Kennedy Space Center aimed a nozzle at the Shuttle's surface. A controlled stream of liquid nitrogen flowed out of the nozzle and sandstone rubble flew off the surface of the vehicle like powder, leaving the valuable components clean and intact. Because liquid nitrogen evaporates into the atmosphere after use, cleanup requires only the removal of the dry powdered deposit. The benefits of using liquid nitrogen for the Department of Energy and NASA were its safe and effective cleaning action, no risk of explosion, and no secondary waste stream or cross contamination because liquid nitrogen cleaning does not use water.

Like other important technologies, liquid nitrogen cleaning has trickled down and found utility in unintended industries. The benefits of liquid nitrogen for cleaning are now well established in the petrochemical industry, where highly effective removal of tenacious fouling deposits in petroleum process equipment has been achieved. A good case in point is an application at Dow's St. Charles Operations (SCO) in Hahnville, La. The 2,000 acre site north of New Orleans is a vast and bustling petrochemical manufacturing complex that produces a wide variety of industrial products from pharmaceuticals to fabric softener.

The heat exchanger tubes in one of Dow's butanol units were coated with a hard varnish-like substance that had built up over time and become significant enough to impact heat transfer. Plant engineers had tried hydroblasting, abrasive blasting, and mechanical tube cleaners to remove the fouling but the hard deposits proved to be too tenacious for all of these methods. Abrasive blasting provided some removal of the tube deposits, but resulted in tube damage that required the replacement of numerous tubes with each application. In the wake of multiple unsuccessful cleaning applications, the plant understood that the difficulty of the deposits might require a next-level cleaning solution like liquid nitrogen.

NitroLance™ Cleaning Tubesheet.

In liquid nitrogen cleaning, there are three basic mechanisms of action that enable the super-cooled nitrogen to remove fouling: mechanical pressure, super-cooling, and thermal/volumetric expansion. Mechanical pressure is the pressure exerted at the nozzle tip of the NitroLance™ and is regulated from 5,000 psi to 55,000 psi, based on the equipment being cleaned and characteristics of the deposits that are present. Super cooling is the essential feature that enables liquid nitrogen to be highly effective. NitroLance™ technology employs liquid nitrogen from -160 degrees F to -250 degrees F that facilitates the fracture of semi-porous fouling deposits. Thermal/volumetric expansion occurs when the high density LN2 vapor penetrates the cracks and crevices of the fouling deposit, rapidly converting to a gas and expanding to nearly 700 times its volume. This rapid expansion, combined with the mechanical pressure and super cooling, causes the fouling deposit to rapidly break apart and release its bond to the parent metal.

NitroLance™ is the leading liquid nitrogen cleaning technology and the system that Dow SCO employed. To determine if liquid nitrogen would be effective at removing the hard varnish deposits, two of the Dow unit tubes were removed and tested with NitroLance™ at the Conco lab in Deer Park, Texas. The lab test found the flow of liquid nitrogen turned the hard varnish deposit into a powder, leaving the tube surface like new. These results confirmed the value of the method for Dow and the cleaning of the vertical heat exchangers proceeded and was very successful. Moving forward and based on unit performance, maintenance cleanings will take place every two to three years.

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