Difficult situations lead to lessons learned

Firetube boiler

Specifications for the fabrication of a firetube boiler indicate a partial penetration J-groove and fillet weld for the tube-to-tubesheet joint and QA inspection after welding by the boiler designer and engineering design company. The fabricator prepared the tubesheet according to the specifications and proceeded with welding the tube-to-tubesheet joint. The completed boiler passed inspections by the boiler designer and engineering design company. It also passed a hydrotest at the fabricator's shop. About 48 hours after startup of the acid plant, water level in the steam drum dropped and became difficult to maintain, so the plant was shut down. The firetube boiler had a leak and the cause of the leak was the tube-to-tubesheet joint. Forensic investigation revealed the tube-to-tubesheet joint was mostly fillet weld and the J-groove was bridged with weld and not completely filled.

Lesson Learned: Always place QA hold point for the inspection of the root pass weld and performance of non-destructive testing prior to deposition of successive weld layers.

Superheater

A steam superheater was specified by an engineering design company to be installed inside a converter for process gas cooling between catalyst beds. The design specifications called for the finned tubes at the header end to be fixed, while those at the rear end would slide. The steam piping was equipped with a by-pass line for process gas temperature control to the next catalyst bed. During commissioning and performance testing, the temperature of the process gas was higher than specified despite the by-pass valve already being fully closed. Review of the design and fabrication drawings for the superheater and converter revealed that process gas was by-passing the finned tubes through the tube holes of the return-end tube support.

Lesson Learned: Superheaters for installation inside a converter should be provided with a shroud at the return end of the finned tubes to prevent process gas from short circuiting to the next catalyst bed.

Gate valve bonnet gasket

During a five-year internal inspection of an oleum storage tank, the block valve at the outlet piping was replaced with a gate valve. The valve was bought as per best practices specifications from a valve manufacturer, then sent to a shop for actuator fitting. The valve was installed; a few days after filling up the storage tank with oleum, a leak with white smoke (acid mist) was noticed coming out of the newly installed gate valve. The storage tank was emptied and after investigated it was found that the leak originated at the bonnet gasketed joint and the gasket had been chemically attacked. Apparently, the valve manufacturer did not follow the best practices specifications and installed a grafoil gasket instead.

Lesson Learned: Never use gaskets with carbon or graphite filler as this will be chemically attacked by SO_3.

Acid pipeline

An acid pipeline transferring fresh acid from a storage tank to the barge loading area more than a mile and a half away was found to have sections of the pipeline dislodged from the pipe rack by maintenance on a daily inspection round. Fortunately no breakage of the pipeline resulted. The eight-inch pipeline is constructed from stainless steel and equipped with expansion loops to accommodate thermal expansion. The dislodged sections were mostly at the expansion loops located close to the transfer pump. The transfer pump piping from the floor of the storage tank is equipped with an internal plug valve and block valves in the discharge and suction lines, as well as a block-valve-equipped recirculation line back into the storage tank. The investigation indicates that thermal expansion did not cause the pipeline to dislodge; rather it was liquid hammer from improper start up of the transfer pump.

Lesson Learned: Always start a pump with the discharge block valve partially opened and the recirculation line block valve fully opened to prevent liquid hammer. Once flow is established and the pump is stable, open the discharge valve fully while closing the recirculation valve.

Precipitator explosion

Wet electrostatic precipitators are used in the gas cleaning section of spent acid regeneration and metallurgical plants. The precipitators remove essentially all of the sulfuric acid mist and ash particulates, preventing downstream corrosion and plugging, with low power consumption and pressure drop. Because of the high voltage charge, however, electrical sparks occur within the unit, making the equipment an ignition source. This can cause major fires and explosions if unburned hydrocarbon and oxygen are present.

Such an incident happened in a spent-acid regeneration plant during a cold startup. Multiple attempts to light a natural gas burner failed, with no air purging, accumulating unburned gas in the two precipitator cells. Because the precipitators were energized, a spark caused an explosion, destroying both precipitators and associated structures. Fortunately no injuries resulted, but the plant was out of commission for several months, until the unit was re-commissioned with new precipitators.

Lesson Learned: Use a PLC-based combustion safeguard system, with adequate purging between fuel lighting attempts. Keep the precipitators de-energized until furnace conditions allow complete combustion of hydrocarbon.

Watch that pressure drop

Contaminants such as particulates, mist, moisture and iron sulfate accumulate in acid plants, and increase pressure drop in equipment over time. Pressure drop increases power consumption in the main gas blower and may lead to reduced throughput for the plant. When the pressure drop exceeds the mechanical design, equipment damage can occur.

Pressure drop incidents have occurred in the acid industry, including:

—solids accumulation in the process gas side of waste heat boilers restricting plant throughpu

—solids accumulation upstream of tubular lead precipitators, collapsing tubes;

—plugging of candle mist eliminators atop drying towers causing tubesheet damage and/or ducting collapse (if main gas blower is downstream)

—pressure drop increase in fixed bed converters, causing partial damage or collapse of beds

—pressure drop increase in drying and absorbing tower packing causing excessive acid entrainment, if not bumping and shattering of ceramic packin

—pressure drop increase in cold heat exchangers causing restrictions in throughput and heat transfe

—blower suction and discharge increases, causing surges and equipment failure.

Lessons Learned: Establish a safe pressure drop and static pressure limit for each piece of equipment. Measure and trend the pressure profile in the acid plant routinely, at least once a month. Place an alarm or interlock in critical areas to prevent equipment damage.

The above Lessons Learned submissions were provided by OP & Associates - H_2SO_4 Consultants Ltd. For more information please contact Orlando Perez at (604) 807-2148 or orlando.perez@outlook.com. ❑