Thermal fatigue led to gas plant fire and explosion, CSB says

David Wagman | April 03, 2019

A major loss of containment in a heat exchanger at a gas processing plant in Mississippi led to a release of methane, ethane, propane and several other hydrocarbons, which ignited and touched off a series of fires and explosions that shut down the plant for almost six months.

The root cause, according to an incident report from the Chemical Safety Board (CSB), was thermal fatigue at the Enterprise Products Pascagoula Gas Plant in Pascagoula, Mississippi.

The CSB said that more than 500 gas processing facilities operate across the U.S. and the use of similar heat exchangers is common. (Read "Heat exchangers and their applications.")

Thermal fatigue was a root cause of a 206 fire and explosion at a gas processing plant. Source: CSB The Enterprise Plant receives raw natural gas and separates the material into two products: natural gas liquids, which serve as a feedstock to the chemical industry, and a natural gas fuel stream, primarily composed of methane.

A piece of equipment used in the process is a brazed aluminum heat exchanger, which allows for the transfer of heat between two different process streams while keeping the streams separate. The CSB investigation determined that the probable cause of the incident was a

failure of the heat exchanger due to thermal fatigue. The report said that as the exchanger is heated or cooled, its tightly connected parts expand or contract.

If the parts change temperatures at sufficiently different rates, the expansion and contraction can be disproportionate. Over time, this process weakens the metal, and ultimately causes cracks, which can lead to the escape of hydrocarbons. Typically, when a leak is found, it can be repaired before a major loss of containment occurs. The CSB said that thermal fatigue is a known factor to brazed aluminum heat exchangers and industry guidance offers recommended limits for maximum cyclic temperature fluctuations during operation and rates of cooling or heating during start-up and shutdown. However, the CSB found in its investigation that this guidance was not robust for the diverse operations and environments where that type of heat exchanger operates.

At the Enterprise Gas Plant, process data for the exchangers show that the equipment was repeatedly subjected to temperature changes that exceeded industry-recommended practices. That increased stresses on the connections within the heat exchangers as the aluminum parts pushed against and pulled apart from each other. At Enterprise, over a 17-year period, four different brazed aluminum heat exchangers were repaired nine times, the accident report found.

The 2016 accident, along with four other failure events at other facilities, suggest that relying on a so-called leak-before-failure assumption is not adequate, the CSB said. "Operators of midstream gas plants need a more robust assessment and risk management plan that considers thermal fatigue to prevent the risk of sudden and catastrophic rupture" brazed aluminum heat exchangers, it said.

Investigator William Hougland said, “A number of midstream gas plant operators have reported that the limits and rates in existing industry guidance may not be realistic. The CSB concluded that more realistic and updated guidance is needed to improve the safe use of BAHX.” (Learn more from IEEE Engineering360 about standards related to heat exchangers.)The CSB issued recommendations to two trade associations, the American Petroleum Institute and GPA Midstream Association, to share information related to failure hazards of brazed aluminum heat exchangers from thermal fatigue.

In a separate action, the CSB said in March that it will investigate a fire at the Intercontinental Terminals Company site in Deer Park, Texas. The fire, which began on March 17th, engulfed 11 above-ground storage tanks containing a variety of hydrocarbons

To contact the author of this article, email david.wagman@ieeeglobalspec.com

Case Analysis
What could be considered possible root causes of these problems?
Would special inspection schedules have helped to avoid this problem?