Overflow of an Ammonia Storage Tank

Leakage in the floor of an ammonia storage tank was caused by numerous pinholes which were attributed to construction and testing activities conducted during the cold, winter months.

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Hill Chemicals, Inc. operates a complete anhydrous ammonia fertilizer system with manufacturing facilities in the Southwest, and distribution operations in the middle American conrbelt states. This system consists of a 1,000 ton/day ammonia plant, a common pipeline carrier system, automated pipeline terminals, and a storage facility.

At the storage point here is a 1,300 ton/day refrigeration system, and two 40,000 ton storage tanks. During the initial filling of one of the 40,000 ton low pressure storage tanks it was noted that ammonia vapor was issuing from the under tank insulation drain. Corrosion was occurring on galvanized conduit mounted on the foundation, and the concrete was spalling in areas near ammonia vent points.

As the level in the tank was increased, the leak appeared to correspondingly increase until the tank became nearly half full. As the tank was filled further, the leak began to lessen until it nearly stopped. This phenomenon is thought to be due to fine iron oxide or rouge, less than 15μ in size, settling to the bottom and plugging the pinhole leaks. A seven-point under-tank thermocouple system indicated the leak to be in the SW quadrant of the tank bottom which also corresponded with the venting vapor.

The existence of the numerous pinholes is attributed to the construction and testing activities conducted on the tank bottom during the cold, winter months of December and January. The method for testing floor and corner weld seams is with a vacuum box. If a soap solution is applied and partially freezes, the test is void.

Drainage operations

The tank was emptied in the normal manner through the side-mounted eductor nozzle until no more liquid was available. By virtue of design, 6 in. of liquid remained in the tank bottom. At this point the tank pressure was allowed to rise to 0.92 lb./sq. in. gauge, and liquid was pressured through a side-mounted siphon line into a companion tank which was also nearly empty, but was only pressurized to 0.25 lb./sq. in. gauge. The undertank heating setpoint was then elevated from 36- to 125°F in an effort to increase the boiloff rate by heat leakage. The tank was determined empty by observation of the following:

1. The tank level tape gauge movement had stopped; when the float was lifted and dropped, the stop was sudden rather than the usual soft feeling.
2. There was no pressure rise in the tank when blocked in; taking in consideration for barometric pressure changes.
3. All frost had melted from the tank base, from around the manway head, and also from other lower connecting nozzles.

The tank pressure was lowered to nearly zero, the lower manway was removed, and a system refrigeration compressor with 1875 cu. ft./min. capacity was used to remove vapors from the top of the tank. It was calculated that the tank vapor equaled nearly 44 tons of ammonia and that it would require 17 hr. of compressor operation, assuming perfect interface, to replace the ammonia with air. After 12 hr. of operation, the evacuation was stopped due to the high air content which, in turn, overloaded the system inert purger and prohibited future compression due to excessive condensing pressure.

The two 10 in. relief valves on the tank top were dismantled and the purging continued by forcing air into the lower manway with a 11,500 cu. ft./min. fan. The initial NH_3 concentration in the air at this point was 45%. After 2 hr. of pressure purging the concentration fell to 5%. The top 22 in. dia. manway cover was then removed and pressurized purging continued over the weekend, with extreme care being taken as to wind direction and the location of farm families in the surrounding area.

It was noted, when the lower manway cover was removed, that a few puddles were on the tank bottom. They appeared to be water or slightly aqueous ammonia, as no boiling action could be noted and the pools appeared stagnate.

The discharge gas was sampled, and indicated 25 ppm on several samples. The fan was shut off and the tank was entered by an individual wearing a MSA Chemox self-contained breathing apparatus and lifeline connected at the manway outside the tank with personnel standing by for safety precautions. It was determined that the highest concentration in the lower portion of the tank was 10 ppm. An appreciable natural purge occurred on the tank with upper and lower manway covers removed.

Repair operations

The tank was then deemed safe for workmen to enter; no pools existed on the floow plate. The first order of business was to install temporary lighting and then to begin cleanup. Welding rod stubs, 2,700 lb. of fine reddish heavy powder in the partially reduced state (presumably pipeline rouge), 5/8 in. dia. wire rope 50 ft. long, and 12 ft. of 24 in. wide galvanized chicken wire were removed. The sump under the siphon pipe was filled with welding rod stubs, mill scale, and general trash.

After the tank bottom was swept clean all weld seams were power brushed and vacuum box tested. Eleven pinhole leaks were found and repaired; some were in the corner weld, some in floor seams, and others occurred at points where anchor lugs had been removed during construction.

While the tank was empty and open, a contour profile was obtained to determine the bottom distortion due to loading, and a new cable tape was installed on the tank gauge. The old tape was badly bent where it connects to the float. The new system utilizes a stainless steel cable inside the tank which withstands the boiling fluid action on the float. The cable is attached to a perforated tape outside the tank for conventional gauge head accommodations.

While the tank was open the following general observations were made:

1. There were several cartoons painted on the walls with yellow spray paint which remained in perfect condition.
2. All of the manufacturer's stencil marks were still complete and legible.
3. The only oil spot in the tank was located near the top, in the area of the liquid induction and vapor suction nozzle, forming a circle of approximately 20 ft. dia.
4. Rust a accumulated on the side walls, particularly in the weld seams, as a result of exposure to the atmosphere while the tank was open. Aside from this, there was no evidence of any type of corrosion within the tank proper.

Venting stopped

After the tank was put back into operation, it was noted that small amounts of aqua ammonia accumulated in the suction line and drained from the compressor suction knockout pot. Ammonia vapor issued from the under-tank insulation during the initial filling, and was assumed to be a result of volume reduction and insulation compaction of the under-tank media. After the tank reached a 10 ft. liquid level the venting stopped and it has not been detected since.

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