Ammonia Pipeline Rupture

A brief case history reviewing a failure in a line between an ammonia manufacturing facility and a nearby customer in the Texas City area.

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A 6-in. diameter ammonia pipeline between the Amoco Oil Co. ammonia plant complex, Texas City, Texas, and an adjacent chemical plant ruptured on September 3, 1975. The rupture occurred while the pipeline was being purged with nitrogen to allow a portion of the line to be rerouted.

The cause of the failure was external corrosion of the pipe due to mechanical damage of the pipe coating and an interference in the cathodic protection. The metallurgical quality of the pipe was satisfactory and did not contribute to the failure.

Amoco Oil's two plants at Texas City, Texas, produce 2,150 ton/day of ammonia. Part of this is pumped to an adjacent chemical plant through an underground 6-in. pipeline, 3.17 miles long. The line was constructed in 1961 using new API 5L, Grade B, electric-weld pipe. It was originally used to transport butane and was converted to ammonia service in 1965. The line is located in a right-of-way with several other pipelines. Nominal dimensions are 6⅝-in. diameter and 0.219-in. wall thickness. The pipe is coated with polyethylene using an adhesive mastic, and it is cathodically protected. Normal operating conditions are 200 lb./sq.in. gauge and 40°F. The ammonia is agricultural grade, containing 0.2% to 0.5% water.

Construction of two new tanks in the Amoco Texas City refinery required that a section of the line be rerouted. On September 3, 1975, it was removed from service. Nitrogen was injected into the customer end of the line to displace the liquid ammonia and move it back into atmospheric storage tanks at Amoco Oil.

During the displacement operation the line ruptured, releasing about 50 tons of ammonia to the atmosphere. The rupture was in the tank farm area of an adjacent refinery, almost three miles from the ammonia plants, and near a city street. Escaping ammonia vapors drifted into adjacent chemical plants and residential areas. More than 60 people were sent to local hospitals due to ammonia inhalation. Fortunately, no fatalities occurred.

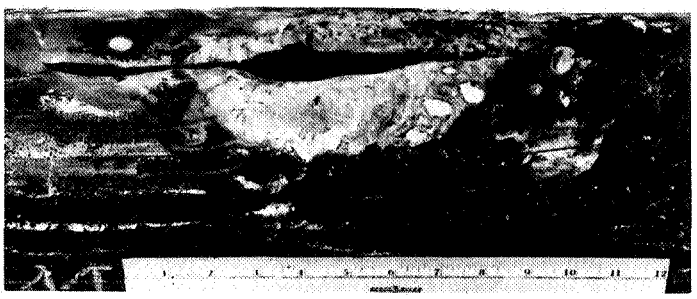

Figure 1. The 12-in. long rupture in the ammonia pipe line.

The Texas City police and fire departments and civil defense authorities responded immediately to the emergency. Police evacuated nearby residents and sealed off the area. Firemen sprayed the leak with water to contain the ammonia vapors. Amoco Oil fire department personnel relieved the Texas City crew and maintained a watch while repairs were completed.

When the line was depressured, a split in the pipe wall about 12 in. long could be seen. It is shown in Figure 1. A clamp was installed so that the purging could be completed. Mechanical damage to the pipe coating was then discovered at several locations in a length of 70 ft., including the leak location. The line was repaired by replacing 90 ft. of pipe. A hydrostatic test confirmed that the remainder of the pipe was satisfactory for continued use.

At the rupture location extensive pitting corrosion was found in an area 12 in. long covering a third of the pipe circumference. The pitting had reduced the wall thickness of a 2-in. diameter area to about 0.05 in., and the rupture initiated at this location. The fracture was arrested after it penetrated a few inches into the full wall thickness at each end. The inner surface of the pipe was not corroded.

The chemical composition of the pipe was determined to be in conformity with the API 5L requirements. Tensile

properties of the pipe were fully satisfactory. Flattening tests met the API requirements. The weld was sound and was located about 60° away from the rupture. Metallographic examination indicated no stress corrosion cracking; and the steel had a normal ferrite-pearlite microstructure.

Two deposit samples were taken from the pipe near the rupture. Both contained primarily SiO_2 and $CaCO_3$ (quartz and calcareous material). Water solutions were slightly alkaline with pH's of 8 and 7.5. The presence of calcareous deposits indicated that the cathodic protection was apparently effective recently.

Conclusion

The coating of the pipeline had been damaged by earth moving equipment at some time after it was laid. In 1969, a cathodic interference was found; this was corrected by a bond to the interfering line. Subsequent surveys recorded satisfactory cathodic potentials for the ammonia line. The calcareous deposits on the line indicate that cathodic protection was effective at the time of failure.

During the nitrogen purging, the pressure apparently exceeded the normal operating pressure at the point of failure and the pipe ruptured in the pitted area. The quality of the pipe and pipe weld was satisfactory and did not contribute to the failure. #

STERLING, M. B.

DISCUSSION

Q.: Do you routinely inspect this line and what are the procedures to monitor the condition of the line?
STERLING: The procedure to monitor the condition of the line is that a periodic survey is made to make sure that the cathodic protection is in service. We had no other inspection of the line.
KEES VAN GRIEKEN, UKF: Why did this rupture occur during that rerouting of the pipeline? Has it anything to do with it?
STERLING: It has nothing to do with it other than the operating pressure at that time was higher than normal. That's all.
VAN GRIEKEN: You said somewhere in your paper that your local corrosion was around ⅓ of the circumfrence, isn't it?
STERLING: Correct.
VAN GRIEKEN: Has that anything to do with interference on your cathodic protection? What was this type of interference?
STERLING: The problem was that the area of pipe which was corroded no longer had any coating. And therefore when there was a cathodic interference by another pipeline, that particular area was attacked. No other area could be attacked because the line was protected by the coating. So very severe corrosion occurred at the point of damage of the coating.