

Piping Failure – External Corrosion Problem
Art Jensen
Sunoco Inc.

Here are the basics regarding the event and what we have learned:

- At one of our Sunoco Philadelphia, PA area refineries we had a failure on a 10" high pressure (475 psig) process gas line in a high volume process system. This event took place in May of this year (2009).
- The line is carbon steel material and uninsulated. It has had minimal internal or external corrosion over the ~48 year life of the system (thickness readings at many locations as recently as March 2009 showed the pipe wall was approximately original nominal).
- The process line operates at ~60F (15C) year-round.
- Although the line would tend to "sweat" during the hot summer months there was only light external corrosion (rust staining) on the line exterior.
- At one pipe support location there was a loose-fit sleeve under the line. The sleeve dimensions were approximately 10" (254 mm) long x 10" (254 mm) circumference (about 1/4 of the circumference at the bottom of the pipe).
- The sleeve was likely installed during original construction in 1961 or shortly after.
- We were not aware of the sleeve being loose on the pipe, and it is in an overhead pipe rack approximately 20 ft (3 meters) above grade. From this observation point it would have been difficult to tell if the sleeve was loose or seal welded to the pipe. It is common in our refineries that pipe "wear sleeves" at support locations would be seal-welded to the pipe.
- Over the many years of operation (and moisture entrapment from rain and summer sweating) the pipe external corrosion rate in the crevice area between the sleeve and the pipe was ~10 mils per year, with irregular pitting corrosion within this crevice area.
- Original nominal wall thickness of the pipe was 0.625" (~16 mm), but the remaining "average" (high spots averaged with deeper pits) thickness of the pipe in the area under the sleeve was probably 0.050" (~1.25 mm).
- The deepest pits were probably also 0.050" (~1.25 mm), below the average, such that the pipe was very close to a pinhole leak at localized spots under the sleeve.
- Unfortunately the pipe did not leak - instead it ruptured over the large area under the sleeve. We experienced a large ~10" x 7" rupture-disk type of opening suddenly and unexpectedly at the bottom of the pipe.
- Since this was a high-pressure and high-volume process pipe, the hydrocarbon release was similarly very large. The vapors found an ignition source almost immediately, resulting in a large and intense initial fire.
- There were secondary line failures from short-term overheating during the first several minutes of the event (while emergency responders were preparing to put fire water on the area and surrounding equipment).
- The large rupture-type failure from external corrosion is specific to systems with large external contact areas and high operating pressure. For a lower pressure system the average wall thickness would need to be much lower than 0.050", such that the deepest pits almost certainly would have leaked at multiple pin-holes many years before the line was at risk of a large rupture. Our experience with pipe support contact area corrosion has been exactly this - small leaks at areas of deep and localized pitting.
- Our piping inspection practices conform with API-570 requirements. With regard to this specific corrosion scenario and combination of risk factors we have learned that we need to impose more specifications and requirements to our inspection practices at pipe support locations.
- Fortunately no people were injured as a result of the failure or subsequent emergency response, but this was a very close call to say the least. There was significant damage to the pipe rack and surrounding equipment in the area of the initial release. The fire burned for many hours until systems could be depressured, and there was a significant amount of press coverage of the event.
- Our desire is to share this Sunoco experience with others in industry so they can learn this lesson and avoid a similar failure at some other facility.