PPN
Poly Pipe News

SPECIAL FEATURE

PEX Pipe Failure Analysis by Fractography

Source: Jeffrey Jansen

29 August 2024

PEX Pipe Fractography

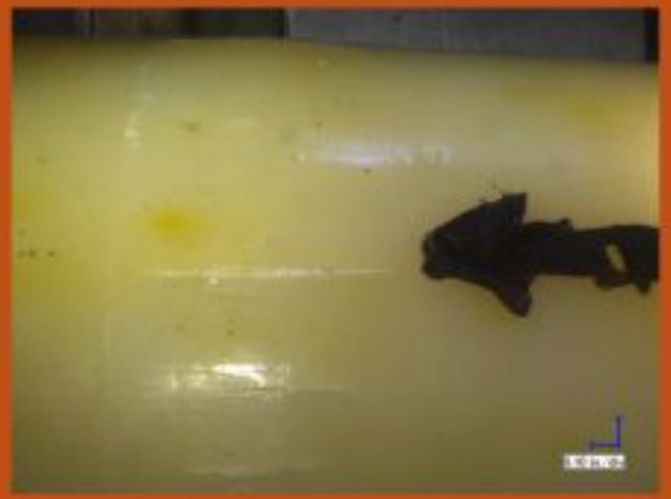
I recently conducted a failure analysis on a pipe that had ruptured during service. The pipe was manufactured from crosslinked polyethylene (PEX) and was in service for approximately 12 months prior to the failure. No other failures have been reported within that production lot of pipes.

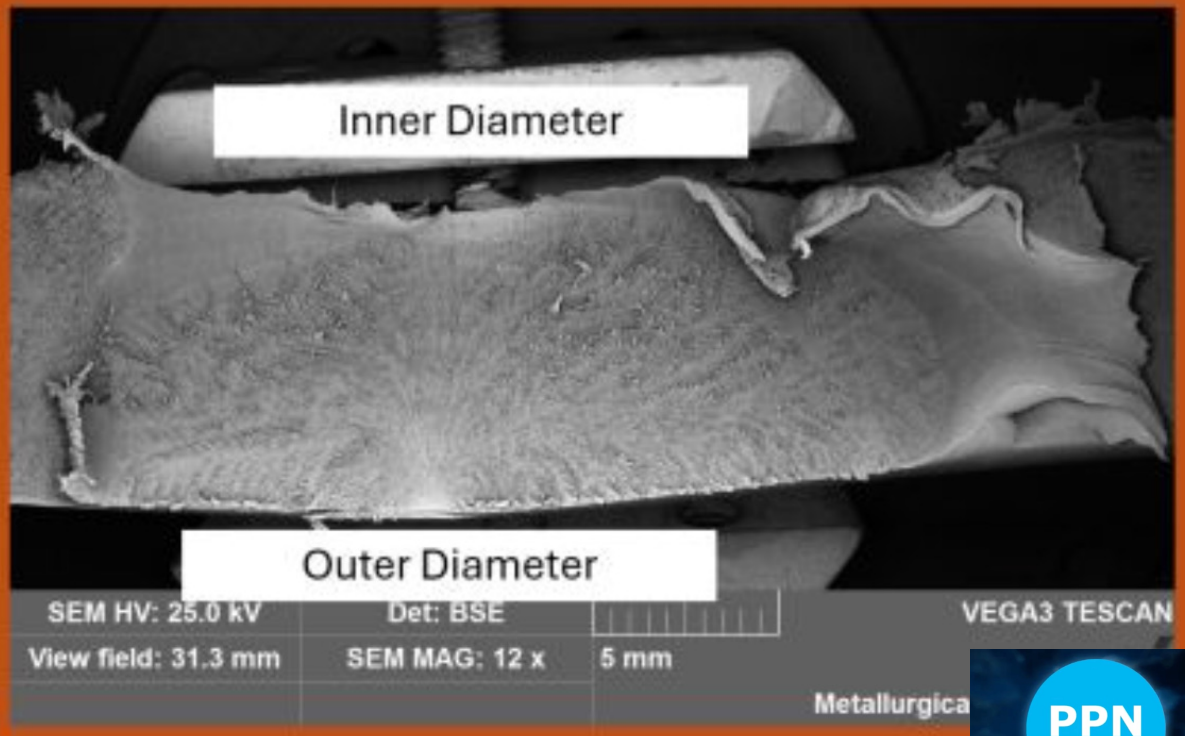
As is often the case in failure investigations, the fractographic examination provided key information to distinguish the mechanism of the failure, essentially how the pipe failed. In this instance, the initial visual examination identified the presence of a longitudinal crack on the outer diameter surface of the pipe. The longitudinal nature of the cracking was indicative of failure associated with internal forces. Internal stress, such as pressurization, typically produces a longitudinal crack as a result of the hoop stress present in a cylindrical component, such as the pipe.

The microscopic examination of the crack exterior showed evidence of stress whitening indicative of macro ductility. Further evidence of ductility was evident once the crack was completed in the laboratory. Continued microscopic examination revealed evidence indicating some stretching and deformation. This indicated stresses that exceeded the yield point of the material over some period of time.

The fracture surface was further inspected using scanning electron microscopy (SEM) to allow examination at high magnification with relatively great depth of field. The SEM examination revealed fracture surface features indicating that the cracking initiated along the outer diameter edge of the pipe wall and progressed principally radially through the wall. Multiple individual sites of crack initiation were present.

Fractography of PEX Pipe





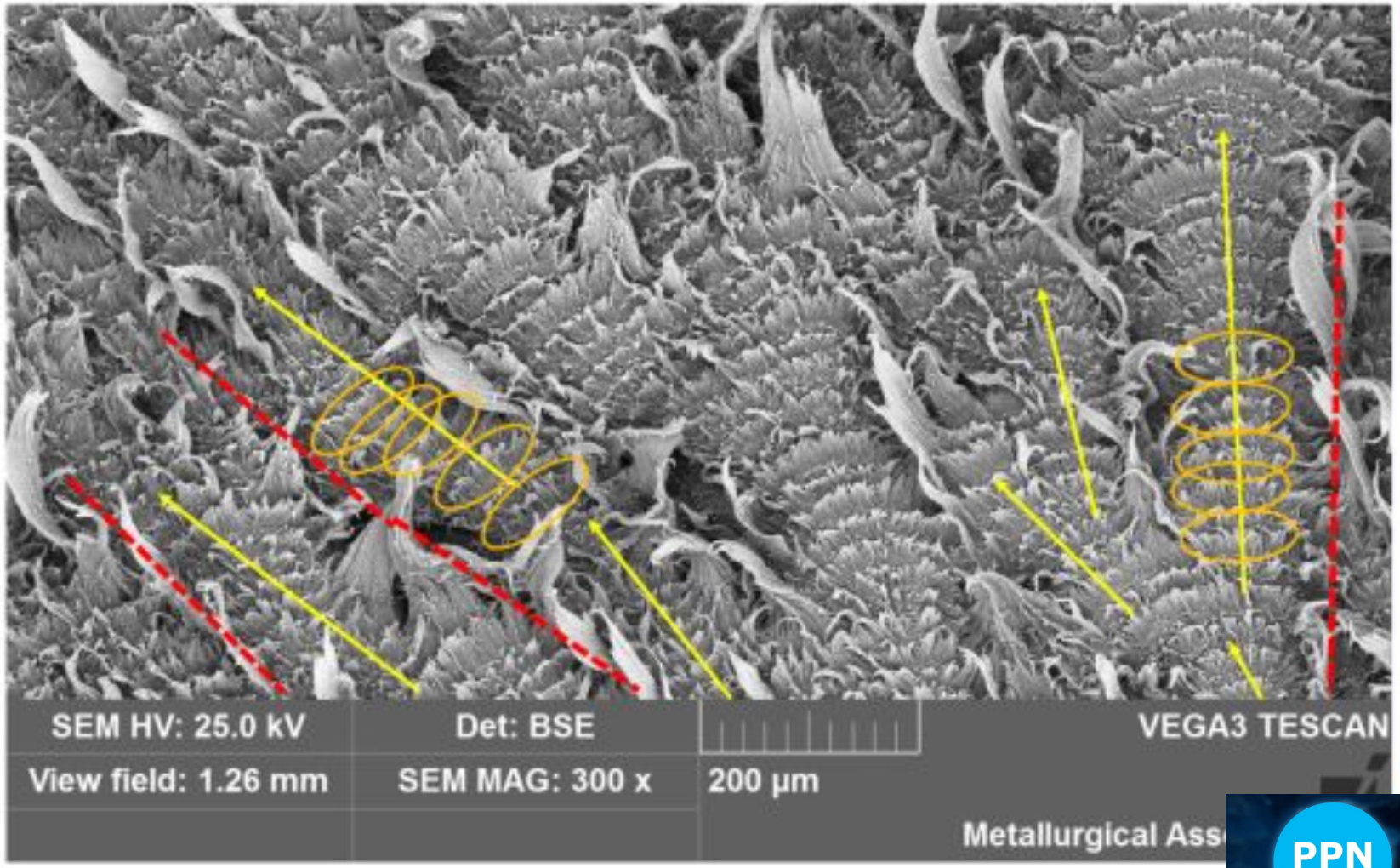
PPN
Poly Pipe News

The outstanding feature on the fracture surface was the presence of striations extending out from the origin locations associated with alternating cycles of cracking and arrest. The number of striations and their relative spacing were consistent with low cycle fatigue. This, coupled with the substantial stretching within these striations, indicated that the pipe had been exposed to relatively high cyclic stresses. Fatigue failures often initiate at multiple distinct sites, which propagate and coalesce into a unified crack front. Linear features representing these crack unions were evident on the fracture surface. In metallurgical failures, these are often called ratchet marks.

Crack propagation

Crack unions

Fatigue striations



In summary, the fractographic examination indicated that the pipe had been exposed to cyclic internal stress while in service, which resulted in the initiation of multiple individual cracks. The cracks subsequently propagated and coalesced to form a crack that extended through the complete pipe wall, resulting in rupture. The observed macro ductility together with the significant micro ductility of the fatigue striations indicated that the magnitude of the internal stresses was relatively high.