

Cross-Linked PEX Plumbing Pipes

Evaluation and Materials Testing of Oxidative Failure | AL



CLIENT

Law firm representing homeowner's insurance company

BACKGROUND

Cross-linked high density polyethylene (PEX) tubes used to carry potable water typically contain antioxidants in the formulation to increase in-service durability. Components of potable water, particularly those used as disinfectants, can lead to oxidation of PEX that may result in pipe failure.

The failed pipes at issue in this project had markings indicating that they were DURAPEX 1006 products and exhibited through-thickness perforations consistent with the observed leaks.

WJE conducted laboratory studies to investigate the cause of the leaks reported in PEX potable water carrying pipes. WJE's studies confirmed that the observed cracks that formed due to oxidative degradation of PEX pipes were the cause of the leaks. The study also indicated that the oxidative degradation was caused by the depletion of the antioxidants, leading to a severe reduction of oxidative resistance (>90%).



SOLUTION

The following techniques were used in the investigation of the causes of pipes failure:

- Microscopical examination showed that the through-thickness cracks had initiated on the interior wall. The presence of crack initiation points on the interior of the pipes indicated that failure was not the result of damage due to installation or handling.
- FTIR spectroscopy results showed that the tested samples exhibited oxidation of the polyethylene polymer, especially on the inner wall of the pipes.
- Oxidative Induction Time (OIT) by differential scanning calorimetry (DSC) is an indicator of the effectiveness of antioxidants added to the polymers. The testing results indicate that antioxidant concentrations were very low causing little to no oxidative resistance.
- Degree of Crystallinity (DOC) by DSC is an indicator of the resistance of PEX to thermal oxidation. The results of this testing indicated that the observed changes in the DOC of the inner walls of the pipes occurred as a result of the oxidative degradation. These findings were consistent with the results of the OIT testing.
- Compositional analysis by TGA confirmed the presence of contaminants on the interior surface of the most severely damaged PEX pipe. The presence of contaminants may have altered the physical properties of pipes such as thermal resistance and mechanical strength resulting in the reported pipe failure.