

Keywords - Failure, Tubing, Degradation, UV

Problem

A section of tubing was submitted for evaluation as the material had failed while in service. The sample was identified as ¾ in. coiled tubing, assembled onto a water meter in an uncovered pit. Leaking from the tubing was observed after a relatively short period in service. The tubing was extruded from a poly(butylene terephthalate) (PBT) resin modified with polyether block amide.

Evaluation

The cracking was present on the end of the tubing that had been connected to the brass fitting associated with the water meter connection. A series of transverse parallel cracks, displaying brittle fracture features, was located exclusively on the exterior surface within the inner diameter of the tubing as it was coiled. At higher magnification an intersecting crack network was apparent. Distinct discoloration was exclusively evident within the general area of cracking.

Compositional analysis, including FTIR, DSC, and melt flow rate testing produced results indicative of a blend of poly(butylene terephthalate) (PBT) and a polyether block amide. No evidence was found to suggest contamination or bulk degradation of the failed tubing material.

Ultraviolet (UV) exposure per ASTM G154 was performed on the original tubing as well as an alternate resin with an improved stabilizer package. Through UV exposure the original material exhibited significant yellowing and cracking. The alternate material showed no signs of material alteration, including discoloration or cracking.

Conclusion

It was concluded that the tubing failed via brittle fracture through significant molecular degradation of the exterior surface of the tubing. The degradation was the result of ultraviolet (UV) radiation through exposure to sunlight. The mechanical stresses responsible for the cracking are thought to be associated with tensile loads created during bending of the tubing against the coiled direction. Significant improvement in performance could be achieved by the use of a resin with an alternate stabilizer package.

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Figure 1: The failed tubing exhibited a series of parallel transverse cracks on the exterior surface within the inner diameter of the coil.



Figure 2: At higher magnification an intersecting network of cracks was apparent, characteristic of molecular degradation.

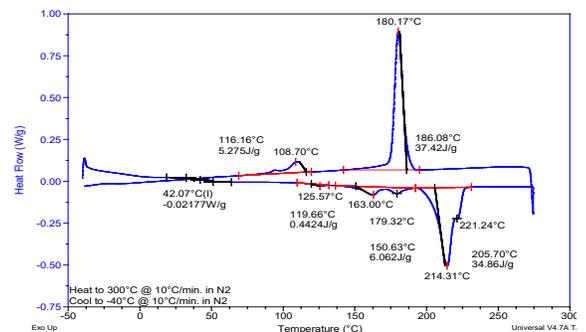


Figure 3: DSC test produced results characteristic of a PBT resin modified with polyether block amide.

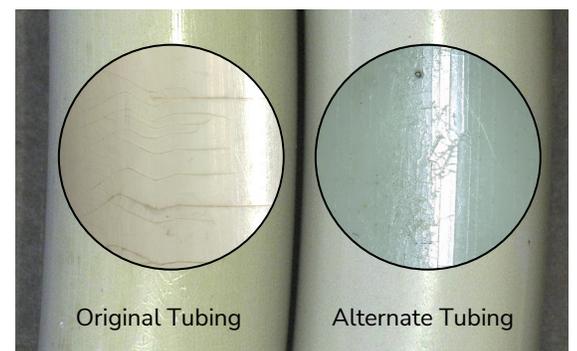


Figure 4: UV exposure testing showed significant performance differences between the original and alternate tubing materials.