



Failure Analysis of Extrusion Blow-Molded PVC Bottles

Dr. Duane Priddy, Plastic Failure Labs

Summary/Conclusions

Five PVC bottles were submitted for forensic failure analysis to determine the root cause of failure of the bottles during use. Fourier transform infrared spectroscopy (FTIR) confirmed the material as PVC. Optical microscopy and scanning electron microscopy (SEM) were used to evaluate the fracture surfaces. The crack locations do not appear to be related to the mold position. The appearance of etching on the fracture indicates chemical interaction of the contents with the PVC bottle material. Thinning and orientation of the bottle wall during molding create regions that are weaker and more susceptible to failure. There are two key factors that are the root cause of failure:

- 1) environmental stress cracking due to chemical incompatibility with the bottle contents;
- 2) too great wall thickness variability.

Variation of wall thickness from 0.3 to 1.0 mm is too large (>3). When wall thickness variations are too large, the thinnest regions are under high stress and allow chemicals in the formulation inside the bottle to be absorbed into the stressed material leading to failure by a failure mode known as environmental stress cracking (ESC). Since the failures occurred where the bottle wall thicknesses were low, we suggest that the wall thickness variation specifications be decreased bottle requiring the bottle to have a more consistent wall thickness (or minimum thickness in all regions of the bottle wall). Further we suggest changing the bottle material to a material that is chemically resistant to the chemical formulation being shipped in the bottles. Chemical compatibility testing (ASTM D543) should be performed to confirm compatibility.