

WHITE PAPER CASE

RCA of an investigation of a product failure

Situation: A flexible container used outdoors to hold-in a liquid, presented blisters without fluid leakage. The failure presented itself in around 5% of the containers and affected about 2% of their surface area.

1. Inspection of the sample indicated an interlayer separation without rupture of either side of the separated layers. A whitish sediment was found inside the blister.
2. The flexible container was made off a 9-layer polyethylene structure with nylon 6, in layers 4 and 6.
3. The conditions of use indicated the containers were permanently full, outdoors, and periodically cleaned in place with cleaning and disinfecting agents introduced independently. All cycles were In/Hold/drain each chemical was preceded and followed by a clean water wash. Chemicals used in series: NaOH, NaOCl (bleach) and H₂SO₄ at proprietary concentrations.
4. The separated surfaces were cleaned, and their thicknesses measured. The result indicated the delamination occurred probably at layer 4 (the Nylon layer closest to the liquids).
5. Analytical tests of the whitish residue found elements N and C in proportions like polyamide.
6. An FTIR on one of the separated surfaces identified an absorbance peak associated with polyamide.
7. It was concluded the structure failed at layer 4.
8. A process was initiated to identify the cause for a PE-mah/PA interfacial delamination failure:
 - a. One of the paths attempted to recreate the failure was to seal pouches containing individual and mixed chemical aqueous agents, placing them under heating lamps to recreate day temperatures and letting them cool at night for 30 days.
9. Not a single agent (acid, alkali, hypochlorite) pouch showed a failure, but a delamination was found in pouches containing both acid and hypochlorite (a combination not used on the field).
10. If the suspect hypochlorite did not cause a delamination how did the mixture with acid do it?
 - a. When in contact these chemicals react and liberate chlorine gas Cl₂.
11. Cause: Due some installation variations some bleach solution remained inside the containers and was not removed by the wash water cycle. During the acid cycle and in the pockets of leftover bleach the acid attacked it with evolution of chlorine gas. Chlorine gas diffused through layers 1,2 and 3, dissolving parts of the nylon layer causing partial delamination in some areas that under liquid loads appeared as blisters.

