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OR-1000™ Next Generation Liner Systems for Containment of Corrosive Chemicals

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Poly Processing Company (PPC) has recently commercialized the OR-1000™ next-generation liner system. This is the result of an initiative aimed at defining and addressing the short and long-term failure mechanisms associated with PE in the presence of strong oxidizers and other corrosive chemicals such as strong acids and bases over a range of solution concentrations such as encountered in commercial containment situations.

The improvement in long-term resistance of the OR-1000™ liner system to oxidative degradation is illustrated in Figure 1. This figure compares the tensile elongation of first and next generation of OR-1000™ liner polymer and Exxon-Mobil HDP8660 commercial rotational molding PE at monthly intervals when exposed to 12.5% sodium hypochlorite (industrial strength bleach) solution at 40^{o}C. Sodium hypochlorite is one of the strongest, if not the strongest known oxidizing chemicals in the presence of polyethylene. Over time, chemical oxidation results in discoloration, embrittlement and loss of ductility as measured by tensile elongation. Tensile tests were conducted at 2”/min. on are Type V compression molded specimens per ASTM D638. Exposure temperature was chosen to produce accelerated test results using conditions encountered during “real world” bleach manufacture. From Figure 1, the retention of tensile elongation of OR-1000™ has been improved from about 4X that of ExxonMobil HDP8660 to about 10X in the next generation system.

Figure 2 shows an example of a tank that failed after many years of service. Note the extreme discoloration and surface fissures resulting from loss of ductility. However, during examination of failed tank specimens, many failures were noted in tanks with relatively short service times, in some cases less than one year. Further, more failures were noted in tanks with bleach concentrations as low as 1%, much lower than the common 12.5% concentration of industrial bleach solutions. An example of this type of failure is shown in Figure 3. Note the liner is cracked despite retaining the original white color and showing no signs of embrittlement. This type of failure is called environmental stress cracking. Polymers such as polyethylene are especially susceptible to this type of failure, which is a result of breaking of polymer chains in stressed areas of a tank. Examples of this in practice would be normal heating and cooling of storage tanks in outside environments or pressurized filling and emptying of transfer tanks used in chemical manufacturing. The result at the physical level is micro cracks in the molded tank or liner. These grow into surface cracks as the heating and cooling continues, leading to catastrophic failure of the tank. The stress cracking process is accelerated by the presence of solutions of chemicals, particularly dilute solutions, in which the chemicals have increased mobility and can physically penetrate the polymer structure and increase the stress differences. High density polyethylene (HDPE) is the most susceptible to stress cracking due to higher levels of crystallinity as compared to medium density low density and linear low density PE’s.

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The most widely used and accepted test for environmental stress crack resistance (ESCR), especially in the rotational molding industry, is the bent strip method, per ASTM D1693. Ten rectangular test samples are severely bent, or stressed, and then immersed in the chemical of interest at elevated temperature. In this case the tests conditions were chosen to simulate conditions encountered in bleach manufacture- concentrations of 1% and 12.5% and temperature of 50°C. Figure 4 shows the time for 50% specimen failure, or F_{50}, for the ExxonMobil HDP8860 and next generation OR-1000™ liner polymer in the presence of 1% and 12.5% sodium hypochlorite solutions at 50°C. For ExxonMobil HDP 8660 at 1% bleach concentration, 50% failure occurs at 500 hours test time, while at 12.5% concentration 1200 hours are required for 50% failure. By comparison, the OR-1000™ polymer shows no failures in either solution after 2000 hours of testing. This would indicate that OR-1000™ offers decreased risk of short-term catastrophic cracking failures compared to conventional rotational molding PE resins such as Exxon Mobil HDP8660 in bleach containment applications.

To summarize, the data set forth in this document reveals the following:

1. Storage tanks using the next generation OR-1000™ liner system would be expected to provide lower risk of failure due to stress cracking than those manufactured from ExxonMobil HDP8660 or other similar conventional PE rotational molding resins in bleach chemical containment applications. Minimizing risk of such short term catastrophic cracking failures allows full advantage of the enhanced long-term antioxidant protection offered by the OR-1000™ system.

2. The fact that ESCR of the ExxonMobil material is significantly reduced in comparison to OR-1000™ at bleach concentrations as high as 12.5% indicates the potential for similar such short term catastrophic cracking failure when conventional rotational molding PE's are used to contain other corrosive chemicals such as acids and bases, even at concentrations greater than 10 percent. The combination of polymer design and additive system offered by the next generation OR-1000™ system presents a superior alternative designed to minimize both short term stress cracking as well as long term oxidation/embrittlement failure risks associated with containment of corrosive chemicals, whether in dilute or concentrated solution form.

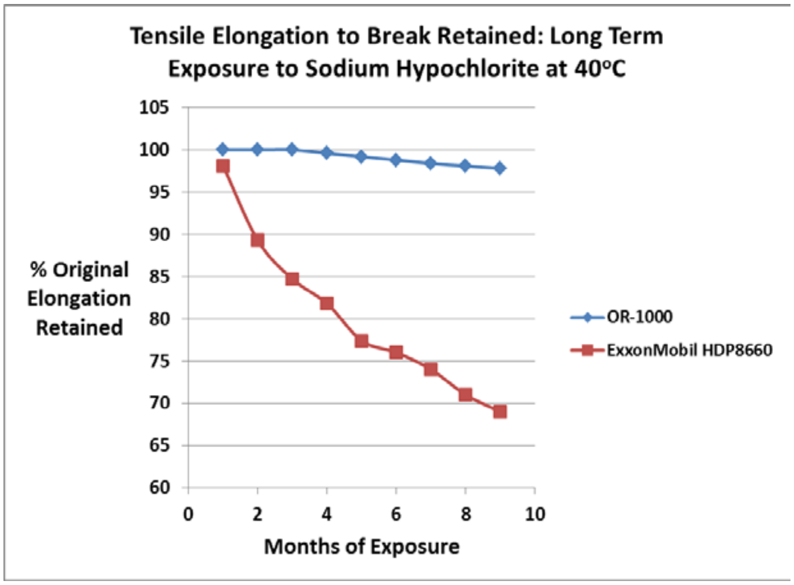

Figure 1: Tensile elongation retention on accelerated bleach exposure

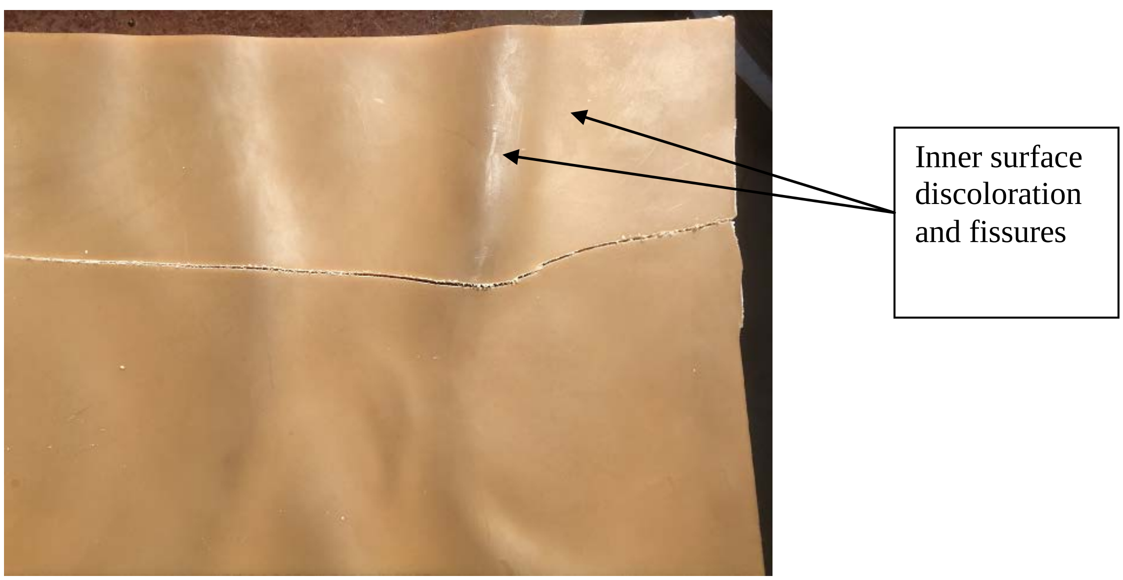

Figure 2: Crack in tank after long-term service in chemical containment-significant evidence of discoloration and embrittlement

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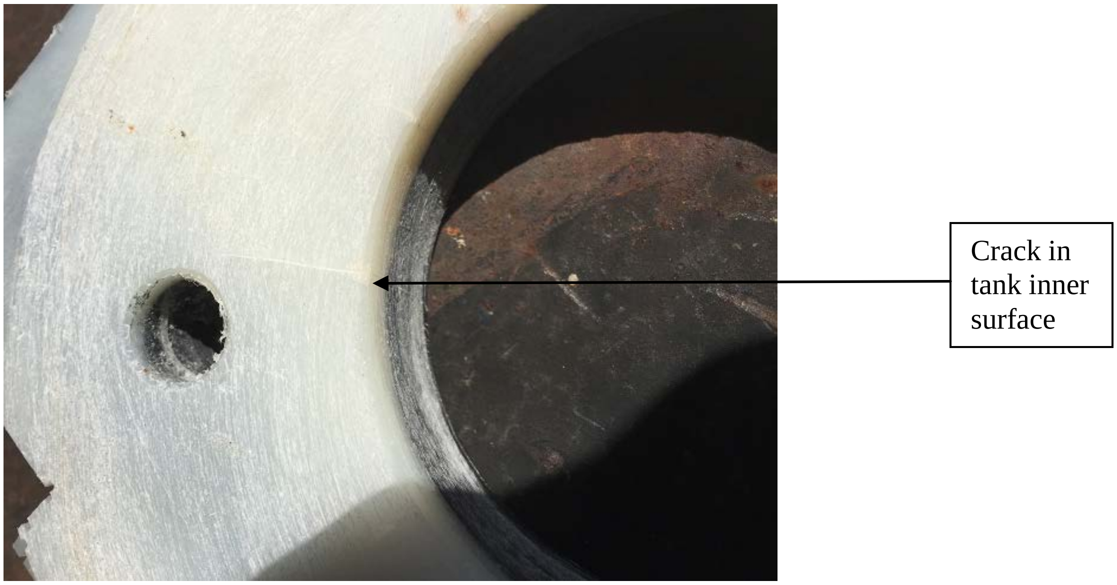

Figure 3: Crack in tank used in hazardous chemical containment-little or no evidence of long-term discoloration or embrittlement

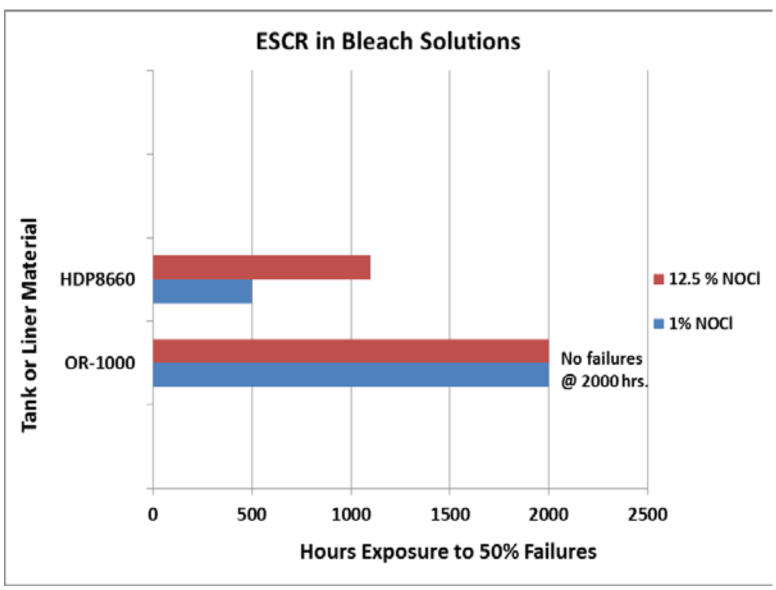

Figure 4: ESCR Comparison of PE's in Sodium Hypochlorite Solutions