Phillips on XLPE

Phillips Petroleum Company developed crosslinkable polyethylene for the rotational molding market 30 years ago and has continuously provided this high performance product since that time. Certainly over the years there have been changes, modifications and improvement to the crosslinkable polyethylene product line. These changes have typically been associated with a polyethylene feedstock change either from an improved polymerization process or catalyst enhancement. However, the crosslinking reaction remains similar. Basically a peroxide crosslinking agent is compounded into a high-density polyethylene which is then activated during the rotational molding of the part providing a finished product which offers excellent part toughness, stress crack resistance and other performance characteristics. The current Marlex® CL-200Y crosslinkable polyethylene grades, which have been available since the rebuilding of our Houston Chemical Complex polyethylene plant in 1992, have offered excellent overall performance in the rotationally molded tank market. Phillips is continuing to look at developments and improvements in the product line to ensure that it remains a viable product in the future.

Once properly cured during the rotational molding cycle, the peroxide is completely utilized and is not present in detectable amounts in the final part. While there have been attempts by Phillips and others to utilize other types of peroxides or alternative processes for crosslinking, the results have indicated that the current peroxide is optimum for this rotational molding polyethylene process. With proper precautions and procedures crosslinkable polyethylene can be safely molded and handled. We have reviewed EPA restrictions and regulations and do not find any EPA items, which restrict Phillips as the material producer or the rotational molding processor as fabricator of crosslinked tanks.

Without getting into details concerning specific applications, let's address the general advantages and disadvantages of crosslinkable polyethylene (XL) versus linear medium density polyethylene (MDPE) or high-density polyethylene (HDPE).

Crosslinking provides superior environmental stress cracking resistance (ESCR) or sometimes referred to more generally as resistance to slow crack growth (SCG). Two tests which clearly show this difference are bent strip ESCR (ASTM D1693) with 10% Igepal where crosslink does not fail in over 1000 hours compared to typical values for LMDPE of <100 hours. Another test which shows the slow crack growth difference with no surfactant (in air) is the polyethylene notch test (PENT) described in ASTM F 1473 and crosslink again does not fail in over 1000 hours and LMDPE grades fail in <10 hours. Even though linear grades with improved ESCR have become available over the past 10 to 15 years they still do not match crosslink in SCG performance. Slow crack growth resistance is an important property that can affect the long-term performance of tanks.

Other advantages of crosslink include long-term hoop strength properties which are key to providing the strength necessary for tanks. This performance is especially important in field applications where tanks can see elevated temperatures approaching 140^0F and crosslink offers a real advantage over linear. Phillips has developed over 50,000 hours (over 5 years) of hoop strength data on CL-200Y at both 73 and 140^0F. Design calculations should take into

account both temperatures and not be based solely on 73^0F if the actual application sees higher temperatures. Due to the crosslinking, which takes place during the rotational molding cycle, larger and/or thicker-walled tanks can typically be fabricated out of crosslink compared to linear. The higher flow of crosslink material prior to crosslinking provides improved molding around details such as molded-in threads or metal inserts. The high flow along with the specific Phillips crosslink formulation also provides a material that is highly resistance to bubble formation in tank walls during rotational molding.

The primary disadvantages of crosslink are the higher cost of the resin and precautions needed during molding. The cost can often be offset somewhat by typically faster cycle times. Processing of crosslinkable materials does require some differences compared to linear, but many rotational molders have successfully handled this product for years with good success as long as proper procedures are followed.

Perhaps the dividing line between crosslink and linear applications has shifted somewhat over the years, but the key decision is still typically based on cost-performance analysis given the requirements of each application. Is linear suitable for many applications? Certainly. Is crosslink superior in many applications? Certainly. Many rotational molders have provided crosslinked polyethylene tanks into a wide variety of high performance applications for years and field performance can often provide the best justification for use. Our recommendation is that each application be reviewed in light of the specific performance criteria needed and the proper resin choice made. We believe that crosslinkable polyethylene is often the best choice to provide the high performance desired for many demanding services.