Understanding Ultraviolet Inhibitors

Common misnomers in the plastics industry are that ultraviolet inhibitors (UV) prevent colorants from discoloring and that resins with poor exterior durability can be amended to give them good exterior qualities. UV inhibitors are frequently asked to prevent the premature failure of poorly designed polymer or colorant systems. UV inhibitors are designed to prevent oxidation of the polymer and have little effect on the inherent degree of permanency of the pigments or dyes used to color that polymer. The addition of UV might slow but not stop most pigments and dyes from fading. Adding UV will not give a resin, which is unsuitable for exterior use good exterior durability, but again only slows down the degenerative process. The addition of UV to a resin-pigment system that starts with good or excellent exterior durability is the most rational, cost effective use of these chemicals.

Information about the chemistry and expectations of the part must be provided before specific combinations of pigments, UV inhibitors and anti-oxidants are formulated. Synergistic combinations of UV inhibitors or anti-oxidants might perform better, and with better economy than a single UV inhibitor. UV inhibitors have been blamed for discoloration or polymer failure when anti-oxidants, metal deactivators, or anti-microbial should have been used.

We recommend the addition of UV inhibitor when the non-stabilized life span of the product (usually 1 to three years) is not sufficient. Low levels of hindered amine light stabilizers (HALS) can add 2 to 3 years to the life span at $.02 to $.03 per pound. P/E or copolymer P/P stadium parts might use as much as $10.00 of UV per 100 pounds resin to attain a 10-year guarantee. Resin-coloration packages with excellent exterior durability can last much longer than a warranted three-year period without the use of any UV inhibitors. Opaque colors impart some ultraviolet protection by blocking out UV radiation and may require less UV inhibitor to attain the same functional life span than transparent colors. Dark colors that absorb infrared may cause extreme fluctuations in temperature, expansion and contraction, and accelerated oxidation.

Many resins with impact modifiers will discolor with or without the addition of UV inhibitors although the rate of discoloration is slowed with the addition of UV. Impact modifier (butadiene) in styrene and ABS is the primary source of “yellowing” and is extremely difficult to inhibit. High doses ($5 to $10 per 100 pounds) of HALS and benztiazole incorporated synergistically will keep the resin structurally sound outdoors for 3 years and will slow but not stop discoloration. Additives such as flame-retardants and fillers dilute the polymer and accelerate discoloration and polymer oxidation. Painting, coating or laminating is the best solution for most styrenics.

Poly vinyl chloride (as in vinyl siding) is less affected by ultraviolet rays, but is susceptible to degradation from infrared and the high temperature. Titanium dioxide and other infrared reflecting pigments are the most effective way of slowing the degenerative process in PVC as opposed to UC inhibitors.

Current technology has recently developed “nano-particle” versions of titanium dioxide and zinc oxide that show promise in weather testing. There is no significant economic advantage of the inorganic TiO2 and ZnO2 over UV chemicals, although they are more durable in longevity. Potential exists in the combination of these technologies.

The conclusion is that when plastic parts are designed to withstand the harsh environment outdoors, the processor, designer, compounder, resin and chemical suppliers all need to be consulted in order to produce a durable part at the lowest cost.