Polymer Services Group
Innovation, Application, Evaluation

Polyethylene Regrind

Short-term “strength” tests are not the most reliable tests to perform when attempting to assess whether increased amounts of regrind affect the mechanical properties of a polymer in long-term service. Crystalline materials can increase in crystalline perfection over time, which will yield an increased modulus and strength. However, an increase in modulus and strength could also result from a reduction in molecular weight that could be occurring as a result of continuing oxidation.

Unfortunately people presume that loss of properties in a polymer is directly related to the amount of regrind used. In some cases it works out that way, and in others, it does not. The real thing that people should be concerned with is, how much damage has occurred in the reprocessed resin.

In most cases, if a resin is properly stabilized and is not mistreated during processing (no excessively high temperature or shear exposure), and is cooled properly, the resin will experience very little damage and can be reprocessed with little or no apparent loss of mechanical properties. To check this, first determine the melt flow rate. If there has been any significant degradation there will be a corresponding loss in molecular weight which will show up as an increase in the MFR. Melt Flow Rate is indirectly proportional to the weight average molecular weight to the 3.4 power --- making it a very sensitive indicator of molecular weight change.

Another test to perform, is Oxidation Induction Time (OIT) by Differential Scanning Calorimetry (DSC). Comparing the time to onset of oxidation for the processed material to that of the virgin material will give an indication as to whether or not additional stabilizer will need to be added. A significant reduction in OIT may indicate that oxidation of the polymer may have already been initiated. Have a lab perform an infrared spectrum to identify oxidation products (ketone carbonyl at 1720 wave numbers). Once significant oxidation has been initiated, the reaction is autocatalytic and will continue to accelerate exponentially with time --- and even faster at elevated temperature.

Another point to keep in mind is that during thermal processing there two competing reactions occurring simultaneously. The first, we mentioned, is related to chain scission which causes a reduction in the molecular weight. The second is recombination --- some people erroneously refer to it as “crosslinking” --- which actually increases the molecular weight of the resin during thermal processing, assuming the resin is properly stabilized. In polypropylene and polyethylene polymerized with Ziegler-Natta (Ti-Cl) catalysis, chain scission is more predominant which results in a general rise in MFR with processing time. However, polyethylene polymerized with Phillips chromium oxide catalysts, as well as many of the newer Ziegler-Natta catalysts, tends to experience an increase in molecular weight after processing and exhibits a noticeable “drop” in MFR. If properly processed, the reprocessed material can actually provide better long-term properties than the virgin compound.

The use of phosphite-based antioxidants tends to reduce the recombination reaction and therefore, limit the MFR drop after processing.

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