TECHNICAL UPDATE

CRAY VALLEY
A BRAND OF TOTAL

BENEFITS

- Improved processing (increase MFI)
- Increased tear strength
- Increase tensile, elongation, yield and modulus

TARGET MARKETS

- Thermoplastic elastomer modification
- Styrenic block copolymer (SBC) and styrene ethylene-butylene styrene (SEBS) copolymer modification
- Soft touch applications

ADDITIONAL INFO

- **Tech Update:** Additives and their effect on SEBS - Part 1: Cleartack® W Aromatic Resins
- **Tech Update:** Wingtack® Aliphatic Resins Improve Performance of SEBS Thermoplastic Elastomers

SMA® Resins Improve Properties of SEBS Thermoplastic Elastomers

Summary

By choosing the appropriate Total Cray Valley product for your styrenic block copolymer (SBC), the formulator can increase both tensile properties and tear strength. In this tech update two maleic anhydride functionalized materials are evaluated for their effect upon styrene ethylenebutylene styrene (SEBS) properties.

Introduction

SEBS is a thermoplastic elastomer belonging to the generic class of materials commonly referred to as “block polymers” (or SBCs). Specifically SEBS is a hydrogenated grade of styrene-butadiene-styrene (SBS) such that the unsaturation that was once prevalent in the mid-block, a mixture of 1,2- and 1,4- polybutadiene polymer, has been removed leaving a mid-block that now resembles a copolymer of ethylene and butylene (hence the name SEBS). These polymers offer improved heat resistance, improved compression set and improved environmental resistance so they have found their way into a wide variety of applications.

When a standard grade of SBC doesn’t perform in an ideal fashion it is possible to enhance properties like tensile strength, yield strength, tear strength and even melt flow index (MFI) with the addition of relatively small amounts of resin. In this tech update we will examine the effect of Styrene Malaic Anhydride (SMA®) resins on the properties of a widely used SEBS manufactured by Kraton Polymers, LLC, known as Kraton® G1652M which is a standard grade of SEBS and its properties are shown in Table 1. The typical properties of Kraton G1652M are taken from literature and were not independently verified.

SBCs have a distinct two-phase (domain) structure and each phase contributes unique properties. The styrenic domains function as a rigid crosslink while the low Tg butadiene midblock will impart flexibility and toughness. The two phases also provide the opportunity to "modify" or enhance the performance of the entire polymer by judicious selection of an additive to modify the targeted phase. For example the hard polystyrene end block phase can be can be modified by choosing additives that are compatible with the aromatic domains. In contrast the softer, rubbery midblock phase can be modified by choosing additives that are primarily aliphatic in their chemical composition or nature.

Table 1: Typical properties of Kraton® G1652M.

Property	Value/Description
Structure	Linear SEBS
Tensile Strength, MPa	31
300% Modulus, MPa	4.8
Elongation @ Break, %	500
Styrene/Rubber Ratio	30/70
Diblock, %	<1

In this tech update, two aromatic resins (SMA) were evaluated for their effects and their properties are shown in Table 2.

Table 2: Effect of two grades of maleic anhydride functional resins.

Abbreviation	Grade	Description	Tg (°C)
3000P	SMA® 3000P	Styrene-Maleic Anhydride Copolymer (approx. 25w% MA)	125
EF80	SMA® EF80	Styrene-Maleic Anhydride Copolymer (approx. 11w% MA)	104

Experimental

The additives were mixed into the SEBS at levels ranging from 2 to 5 percent by weight. All compositions were compounded on a 20mm co-rotating intermeshing twin screw extruder (Brabender TSE-20) with a L/D ratio of 40:1. Samples were bag mixed and feed at the feed throat with an increasing temperature profile from 200 °C to 220 °C. All compounds were extruded into a water bath, dried with an air knife and then pelletized.

All samples were pressed into sheets with nominal dimensions of 4" x 4" x 0.07" thick at 220 °C using a Carver press at 15,000 psi for 4 minutes. Samples were conditioned in a 23 °C and 50% relative humidity overnight before continuing.

Specimens were tested according to ASTM D412 in conjunction with a Type C die. All testing was completed in triplicate using a Thwing-Albert twin screw tensile tester.

Results

The numerical results are summarized Table 3. As seen in the data table, the maleic anhydride grafted liquid aliphatic additive increased the MFI significantly, especially at the addition rate of 5% by weight, with only a minor impact on the tear strength, tensile and elongation properties.

With a combination of higher molecular weights (for additives) and glass transition temperatures (Tg) higher than that of the styrenic domains in the SEBS it is not surprising that the SMA additives did not increase the MFI, but rather caused a slight reduction. The 12% increase in tear strength at a low 2% additive level for SMA 3000P is a positive result with mixed effects upon the tensile and elongation properties.

Table 3: Numerical Results.

Functional Additive	Percent Additive	Tensile Strength (psi)	Elongation (%)	Yield Strength (psi)	Modulus at 50% (psi)	Modulus at 100% (psi)	Modulus at 300% (psi)	Tear Strength (psi)	MFI (g/10 min)
Control	0	3588	667	2830	326	392	879	309	5.8
3000P	2	3399	646	3253	283	339	791	346	5.3
3000P	5	3975	687	3380	284	336	829	329	5.3
EF80	2	3766	669	2777	348	406	930	279	5.2
EF80	5	3994	691	3865	298	348	835	291	4.6

Summary

By choosing the appropriate Total Cray Valley product for the modification of SBC the formulator can increase tensile, yield and/or tear strengh, while improving the processability of the SEBS as measured by the melt flow rate (also melt flow index).

About Total Cray Valley

Total Cray Valley is the premier global supplier of specialty chemical additives, hydrocarbon specialty chemical, and liquid and powder tackifying resins used as ingredients in adhesives, rubbers, polymers, coatings and other materials. Total Cray Valley has pioneered the development of these advanced technologies, introducing hundreds of products that enhance the performance of products in energy, printing, packaging, construction, tire manufacture, electronics, and other demanding applications.

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