TECHNICAL UPDATE

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BENEFITS

- Improved processing (increase MFI)
- Increased tear strength
- Increased 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

Wingtack® Aliphatic Resins Improve Performance of SEBS Thermoplastic Elastomers

Summary

By choosing the appropriate Total Cray Valley product for your styrenic block copolymers (SBC), the formulator can increase both tensile properties and tear strength.

Introduction

Styrene ethylene butylene styrene (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 in a wide variety of applications.

Kraton® G1652 is a standard grade of SEBS and its properties are shown in Table 1. The typical properties of Kraton G1652M are taken from the literature and were not independently verified. In a previous Tech update, the effect of Cleartack® W aromatic resins on SEBS was discussed. In this Tech update, Kraton G1652M will be blended with four grades of Wingtack aliphatic resins, and the properties of these resins are

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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

shown in Table 2. 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.

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 block 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.

Table 2: Effect of four grades of Total Cray Valley's Wingtack® series of C5 hydrocarbon resins.

Abbreviation	Grade	Description
WT-10	Wingtack 10	Liquid aliphatic hydrocarbon resin with a 10 °C softening point (SP)
WT-98	Wingtack 98	C5 Aliphatic hydrocarbon resin with a 98 °C SP
WT-Extra	Wingtack Extra	C5/C9 Aliphatic/Aromatic hydrocarbon resin with a 98 °C SP
WT-STS	Wingtack STS	C5/C9 Aliphatic/Aromatic hydrocarbon resin with a 94 °C SP

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 fed 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 further testing.

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 in Table 3.

Summary

By choosing the appropriate Wingtack resin for modification of SBC, the formulator can increase tensile, yield and/or tear strength, while improving the processability of the SEBS as measured by the melt flow rate (also melt flow index). As viscosity is decreased, melt flow increases.

The largest increase in melt flow index (MFI) was observed when adding Wingtack 10, a liquid C5 resin, to the SEBS. All of the resins increased the MFI but a 5% addition of Wingtack 10 more than tripled the MFI while only marginally impacting the tensile and elongation properties. If a dramatic increase in MFI is needed for easier processing, then Wingtack 10 is a great addition to the compound.

Table 3: Physical properties of SEBS modified with Wingtack resins

Wingtack 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
Wingtack 10	2	3896	710	3743	298	363	784	322	8.2
Wingtack 10	5	3421	752	2952	246	306	651	329	15.6
Wingtack 98	2	3947	728	3626	287	348	754	337	6.9
Wingtack 98	5	4167	715	4021	310	371	851	303	10.0
Wingtack Extra	2	4061	765	3414	259	314	677	347	6.6
Wingtack Extra	5	4362	731	3046	287	338	717	350	8.8
Wingtack STS	2	3463	710	3323	321	397	816	307	6.3
Wingtack STS	5	3896	710	3743	298	363	784	322	6.5

All of the Wingtack resins increase the MFI to various extents. If it is desirable to increase the tear strength of SEBS then both Wingtack 98 and Wingtack Extra can provide more than a 10% increase with as little as a 2% addition by weight and only a slight decline in modulus.

Future Work

The next Tech update on modifying SEBS will include the investigation of the effects of functionalized resins.

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.

For more information, please visit **www.crayvalley.com**

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