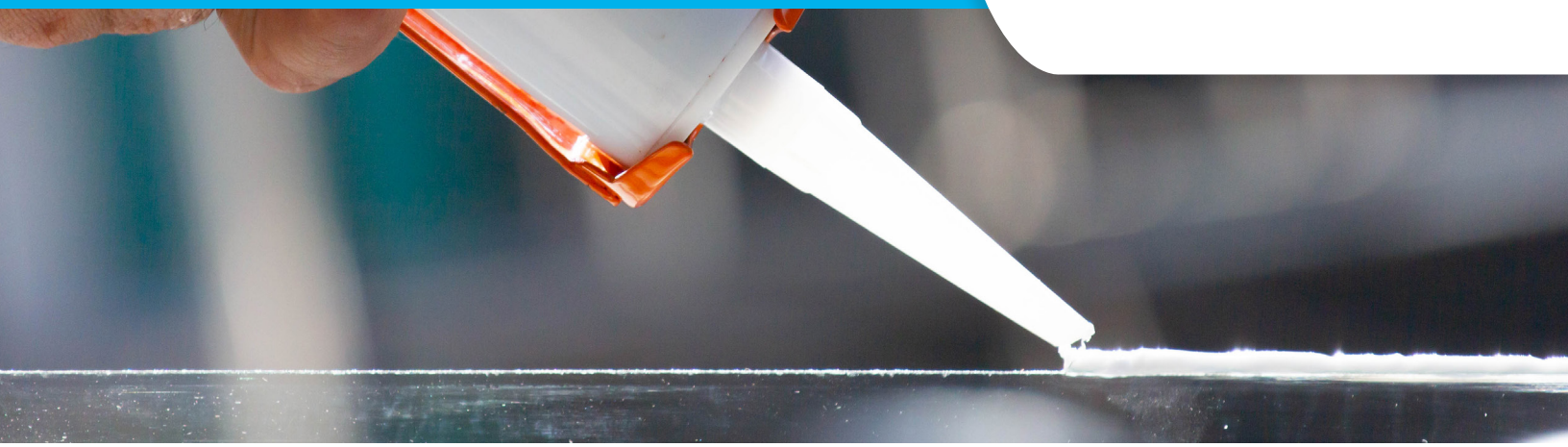
TECHNICAL UPDATE

CRAY VALLEY



BENEFITS

- Improved processing
- Increased melt flow index (MFI)
- Increased tear strength
- Increased tensile strength, yield strength, elongation and modulus

TARGET MARKETS/ APPLICATIONS

- Plastic modification
- SEBS (SBC) modification
- Soft touch

ADDITIONAL INFO

- SDS/TDS: Cleartack W85, Cleartack W100

Using Cleartack® W Resins to Modify the Performance of Styrene Butadiene Block Copolymers

Introduction

Cleartack® resins can increase tensile properties and tear strength in formulations with styrene-butadiene block copolymers (SBC).

Styrene ethylene butylene styrene (SEBS) is a thermoplastic elastomer belonging to the generic class of materials commonly referred to as "block polymers" (also, styrenic block copolymers or SBC). 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, compression set and environmental resistance. Thus, they have found their way into a wide variety of applications.

If a standard grade of SBC does not perform in an ideal fashion, it is possible to enhance properties like tensile strength, yield strength, tear strength and also melt flow index (MFI) with the addition of relatively small amounts of resin. This technical update shows the effects of aromatic resins on the properties of a widely used SEBS manufactured by Kraton Corporation, known as Kraton™ G1652M. The typical properties of G1652M are taken from literature and shown in Table 1 (on next page).

TotalEnergies

Table 1: Typical properties of Kraton G1652M.

Property	Value/Description
Structure	Linear Triblock SEBS
Tensile Strength, MPa	31
300% Modulus, MPa	4.8
Elongation @ Break, %	500
Styrene/Rubber Ratio	30/70
Diblock, %	<1
Melt Flow Index @ 230°C, g/10 min	5

SBCs have a distinct two-phase (domain) structure with each phase contributing to their unique properties. The styrenic domain provides a rigid crosslink-type function while the low-Tg mid-block imparts 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 enhanced by choosing additives that are compatible with the aromatic domains. In contrast, the softer, low-Tg, rubbery mid-block phase can be enhanced by choosing additives that are primarily aliphatic in their chemical composition or nature.

This technical update discusses the effects of two grades of Cray Valley's Cleartack W series of aromatic resins, shown in Table 2.

Table 2: Ring and ball softening points of Cleartack Pure Aromatic Hydrocarbon Resins.

Grade	Softening Point
Cleartack W85	85°C
Cleartack W100	100°C

Experimental

The resins were mixed into the SEBS at levels ranging from 2 to 10 percent by weight. All compositions were compounded on a 20 mm 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 102 x 102 x 0.2 mm^3 (4" x 4" x 0.07") thick at 220°C using a Carver press at 103 MPa (15,000 psi) for 4 minutes. Samples were conditioned in a 23°C and 50% relative humidity environment overnight before testing.

Tensile properties were measured according to ASTM D412 while tear strength was measured according to ASTM D642. All testing was completed in triplicate using a Thwing-Albert twin-screw tensile tester.

Results

The physical properties are summarized in Table 3.

Table 3: Physical properties.

Cleartack Resin	% Added	Tensile Strength (MPa)	Elongation at Break (%)	Yeild Strength (MPa)	Modulus at 50% (MPa)	Modulus at 100% (MPa)	Modulus at 300% (MPa)	Tear Strength (N/m)	Melt Flow Index (g/10 min)
Control	0	24.7	667	13.1	2.25	2.70	6.06	1.76	4.8
W85	5	30.3	698	24.0	2.30	2.74	6.19	1.89	6.2
W85	10	32.0	687	24.9	2.59	2.99	6.40	1.52	8.3
W100	2	29.7	693	19.8	2.74	3.16	6.63	1.81	6.1
W100	5	31.4	706	28.3	2.33	2.74	6.35	1.91	7.3
W100	10	31.2	702	32.7	3.74	3.67	6.62	2.06	9.0

With 5% addition, both grades of Cleartack W provide an increase in tensile and tear properties, with significant increase in tensile, yield and tear strength. The higher softening point resin Cleartack W100 provides slightly higher increase in properties compared to Cleartack W85. Melt flow increases significantly as well.

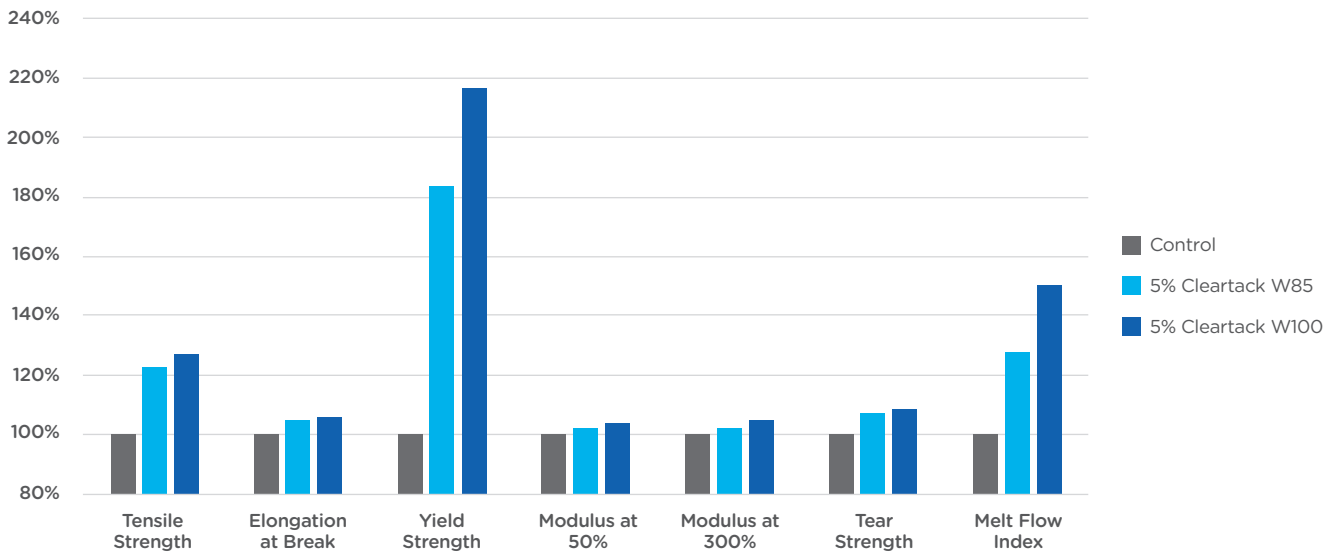


Figure 1: Relative effect of 5% of Cleartack on SEBS properties.

Tear strength of SEBS increases significantly with increasing amount of Cleartack W100 as shown in Figure 2. With 10% loading there is 20% increase in tear strength.

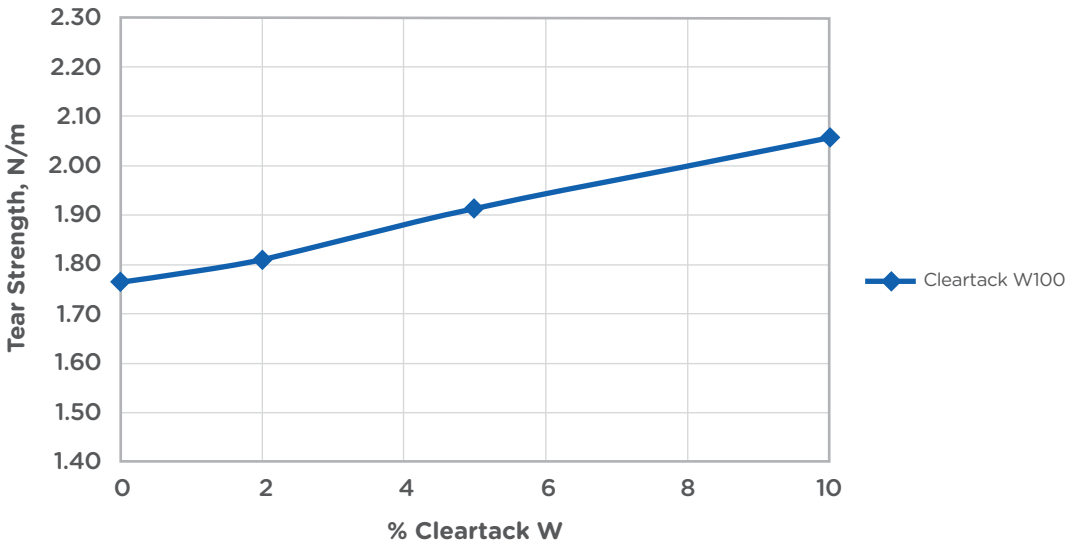


Figure 2: SEBS tear strength with respect to % Cleartack

In addition to physical property enhancement, the processability of SEBS is critical to compounders and end users. The melt flow index (MFI) increases with addition of Cleartack as well, as shown in Figure 3, indicating Cleartack can improve processing of SEBS while increasing physical properties.

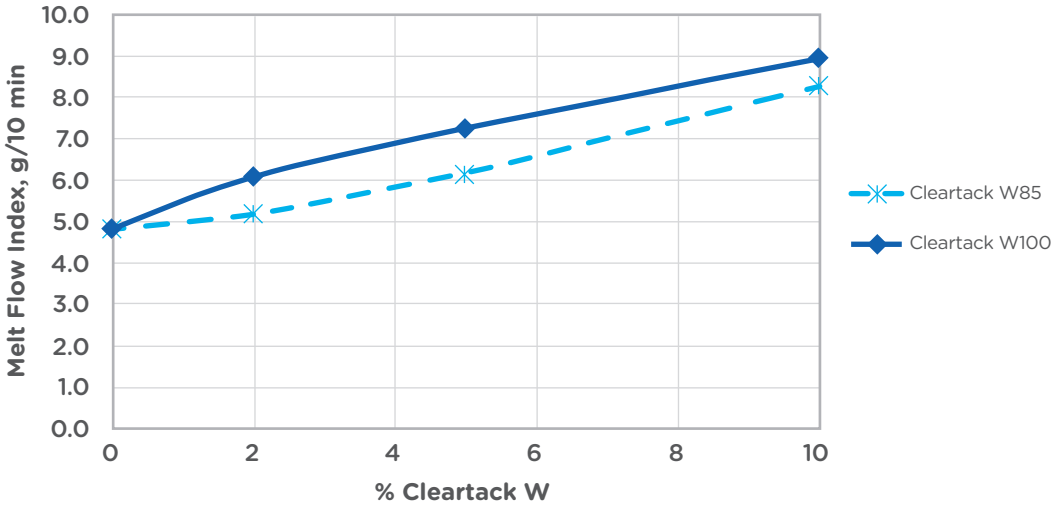


Figure 3: MFI of SEBS at various loading levels of Cleartack.

Summary

With the addition of Cleartack W resin to SBC, formulators can increase tensile properties and tear strength, while improving the processability of the SEBS as measured by the melt flow index (rate).

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

About Cray Valley

As part of the TotalEnergies family, Cray Valley is a global supplier of specialty chemical additives, hydrocarbon specialty chemicals, and liquid and powder tackifying resins used as ingredients in adhesives, rubbers, polymers, coatings and other materials. 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 or to contact us, please visit **www.crayvalley.com**.

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