TECHNICAL UPDATE

CRAY VALLEY
A BRAND OF TOTAL

BENEFITS

- Increased tear strength
- Increased tensile strength

TARGET MARKETS/ APPLICATIONS

- Automotive
- Home goods

ADDITIONAL INFORMATION

- **SDS:** Cleartack® W-85, W-100, W-110, W-120, and W-140
- **Technical Update:** Cleartack® W Aromatic Resins Improve Performance of SBC Styrene Butadiene
- Block Copolymers

Cleartack® W Aromatic Resins Improve Performance of Styrene Block Copolymer Based Thermoplastic Elastomers

By choosing the appropriate Cleartack® W resin for styrene block copolymer (SBC) based thermoplastic elastomers (TPE), formulators can increase one or more tensile properties and increase tear strength.

Styrene block copolymers have been effectively used in TPEs for many years. However, it is possible to enhance properties like tensile strength and tear strength by incorporating Cleartack W resins into TPEs. This technical update will examine the effect of Cleartack aromatic C9 type resins on the properties of styrenic TPE.

SBCs have a distinct two-phase (domain) structure. Each phase contributes unique properties. The styrenic domains provide a rigid cross-link type function while the low-T_g butadiene midblock will impart flexibility and toughness. These two phases also provide the opportunity to modify or enhance the performance of the entire polymer by judiciously selecting an additive to modify a target phase. For example, the hard polystyrene endblock can be modified by choosing additives that are compatible with the aromatic domains. In contrast, the softer, rubbery midblock can be modified by choosing additives that are primarily aliphatic.

In this update, the effects of five grades of TOTAL Cray Valley's Cleartack W series of aromatic resins will be presented. The resins chosen cover a wide range of ring and ball softening points from relatively soft to hard. Softening points are typically 50 °C higher than the T_g of the Cleartack resins as shown in Table 1.

Table 1: Ring and Ball Softening Points of Cleartack Resins.

Abbreviation	Grade	Ring and Ball Softening Point (˚C)	T_g (˚C)	Description
W-85	Cleartack W-85	85	35	Pure monomer aromatic hydrocarbon resin
W-100	Cleartack W-100	100	50	Pure monomer aromatic hydrocarbon resin
W-110	Cleartack W-110	110	60	Pure monomer aromatic hydrocarbon resin
W-120	Cleartack W-120	120	70	Pure monomer aromatic hydrocarbon resin
W-140	Cleartack W-140	140	90	Pure monomer aromatic hydrocarbon resin

Cleartack W-85, Cleartack W-100, Cleartack W-110, Cleartack W-120 and Cleartack W-140 resins were compounded into the TPE at 2% and 5% by weight. The styrene ethylene butylene styrene (SEBS) used was a commercially available product with a 30% polystyrene content and a mass flow rate of 5 g/10 minutes. The process oil was dispersed onto the SEBS block copolymer prior to compounding. Compounding was completed on a 20 mm co-rotating twin-screw extruder with an L/D ratio of 40:1. An increasing temperature profile from 165 °C to 180 °C was used. The single-strand extrudate was cooled in a water bath, dried, and pelletized. The pellets were then compression molded into sheets with nominal dimensions of 4" x 4" x 0.07" thick at 180 °C using a Carver press at 15,000 psi for 4 minutes. Samples were die cut and conditioned in a 23 °C and 50% relative humidity environment for 40 hours before being tested using ASTM D624 and ASTM D638. The TPE compounds are shown in Table 2.

Table 2: TPE Compounds

Compound	PPC 4481WZ (%)	SEBS (%)	Process Oil (%)	$CaCO_3$ (%)	Cleartack W-85 (%)	Cleartack W-100 (%)	Cleartack W-110 (%)	Cleartack W-120 (%)	Cleartack W-140 (%)	Antioxidant (%)
Control	39.9	30	15	15	—	—	—	—	—	0.1
2% W-85	37.9	30	15	15	2	—	—	—	—	0.1
5% W-85	34.9	30	15	15	5	—	—	—	—	0.1
2% W-100	37.9	30	15	15	—	2	—	—	—	0.1
5% W-100	34.9	30	15	15	—	5	—	—	—	0.1
2% W-110	37.9	30	15	15	—	—	2	—	—	0.1
5% W-110	34.9	30	15	15	—	—	5	—	—	0.1
2% W-120	37.9	30	15	15	—	—	—	2	—	0.1
5% W-120	34.9	30	15	15	—	—	—	5	—	0.1
2% W-140	37.9	30	15	15	—	—	—	—	2	0.1
5% W-140	34.9	30	15	15	—	—	—	—	5	0.1

By using either a low (2%) or a high (5%) amount of either the high (W-140) or low (W-85) softening point Cleartack resin, one can choose to harden or soften the styrenic endblocks of the SEBS block copolymer. Improving tear strength is one

of the primary benefits when adding Cleartack W Resins. For instance, tear strength improvement can be increased as much as 20% with Cleartack W-85. The lower softening point of W-85 softens the styrenic endblocks of the SEBS block copolymer, providing greater tear strength, as shown in Figure 1.

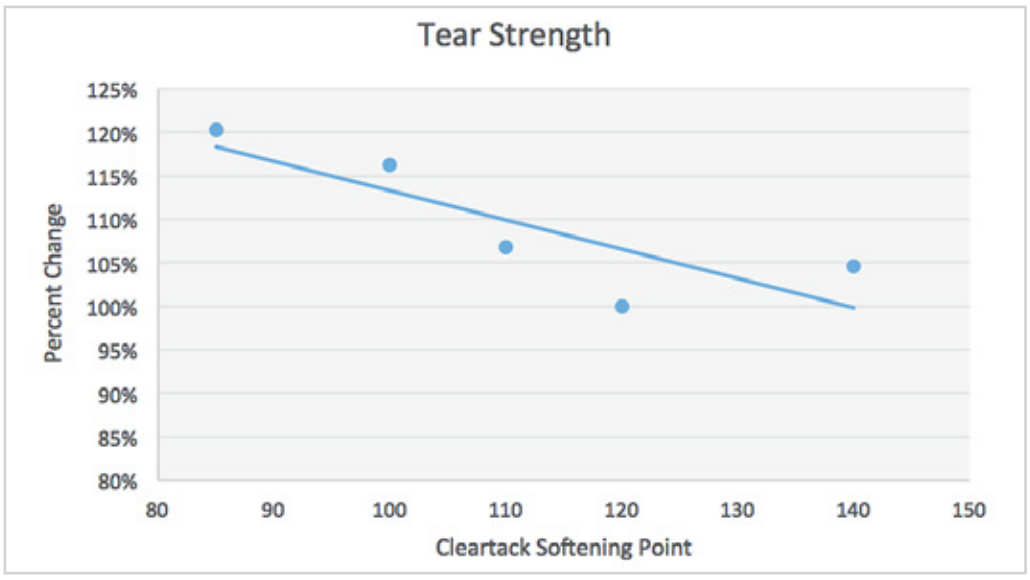

Figure 1: Tear strength of TPE using ASTM D624 Die C.

Adding Cleartack W resins to TPE can increase tensile strength and Young's modulus. Cleartack W-140 provided the greatest improvements in tensile strength and Young's modulus. The higher softening point of Cleartack W-140 hardens the styrenic endblocks of the SEBS block copolymer, resulting in an increase in tensile strength of up to 34% and an increase in modulus of up to 48%, as shown in Figure 2 and Table 3.

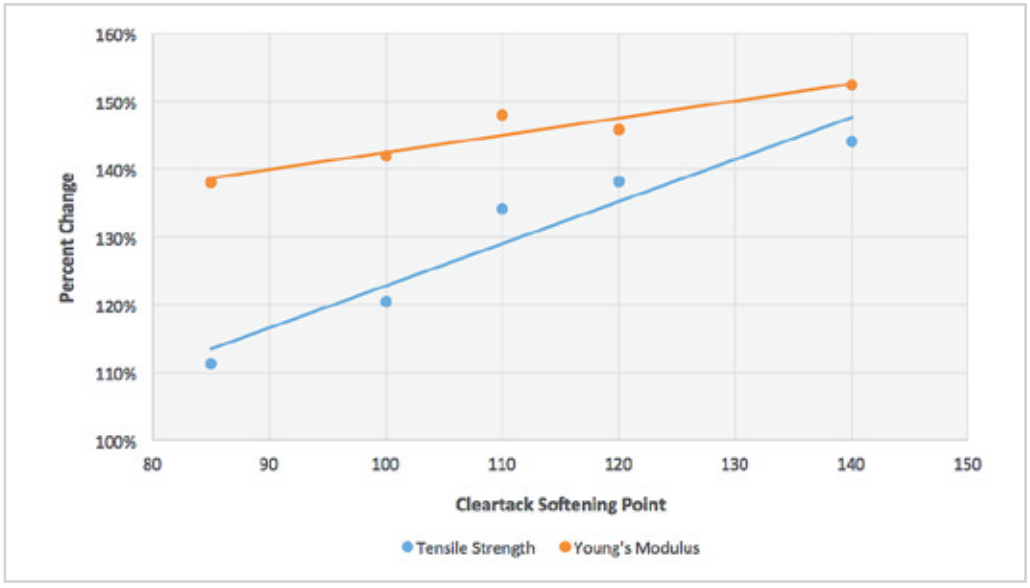

Figure 2: Percent change of tensile strength, tensile elongation and Young's modulus using ASTM D638.

Summary

Cleartack W resins can be used to harden or soften the styrenic endblocks of SBC-based TPEs. For increased tear strength, low-softening-point Cleartack W-85 provides the greatest benefit, while higher-softening-point Cleartack W-140 provides superior tensile properties. By choosing the appropriate Cleartack W resin for TPEs, formulators can increase tensile properties and/or increase tear strength.

Table 3: Actual Values of Physical Properties (ASTM D638, ASTM D2240, and D624 Die C)

	Tear Strength (psi)	Shore A (average)	Tensile Strength (psi)	Elongation (%)	Young's Modulus (psi)
Control	370	77	2200	115	5000
2% W-85	440	82	2400	290	6350
5% W-85	445	83	2450	345	6900
2% W-100	425	83	2300	205	7000
5% W-100	430	83	2650	240	7100
2% W-110	390	82	2700	190	7100
5% W-110	395	79	2950	215	7400
2% W-120	405	79	2900	190	6100
5% W-120	370	82	3050	275	7300
2% W-140	400	82	3100	215	6500
5% W-140	387	79	3200	220	7600

About TOTAL Cray Valley

TOTAL Cray Valley is the premier 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. 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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