Eastoflex Amorphous Polyolefin Extension of Styrenic Block Copolymers in Asphalt Roofing Blends

Styrenic block copolymers (SBCs) are thermoplastic elastomers used as base polymers in a variety of hot-melt applications such as pressure-sensitive adhesives, sealants, and modified bituminous roofing. These elastomers include styrene-butadiene-styrene (SBS), styrene-ethylene-butylene-styrene (SEBS), and styrene-isoprene-styrene (SIS). They are sold under several trademarks such as *Kraton*, *Europrene*, *Vector*, and *Stereon*. Of the three types of SBCs mentioned, only SBS and SEBS are widely used in the modification of roofing asphalt.

Eastoflex amorphous polyolefins (APOs) from Eastman are characterized by consistent quality, low odor, good heat stability, low color, and good resistance to water and ultraviolet light. *Eastoflex* APOs P1023 and E1200 are effective replacements for up to half of the SBS and SEBS used in asphalt blends. Other *Eastoflex* polypropylene homopolymers (APPs), propylene-ethylene copolymers (APEs), and blends thereof can be expected to perform similarly. The use of these materials as extenders for selected SBCs can result in lower raw material costs because of their relatively low selling price.

Eastman has conducted an extensive study to determine the feasibility of replacing a portion of selected SBCs with *Eastoflex* amorphous polyolefins in asphalt roofing blends. The two series of SBCs selected for this study were *Kraton* D-1101, D-1102, and D-1116 SBS block copolymers and G-1652 and G-1657 SEBS block copolymers from Shell Chemical Company. The SBS polymers were chosen to represent a typical SBS-modified bitumen roofing formulation, and the SEBS polymers were chosen to represent a polymer-modified built-up-roofing/mopping asphalt formulation.

Blend compatibility was examined by first conditioning the modified asphalt compounds at 163°C in test tubes for 120 hours. Samples were then cooled and cut into thirds, and the ring and ball softening point (RBSP) of the top and bottom thirds were recorded. The closer the RBSPs, the more compatible were the blends.

Other properties examined were *Brookfield Thermosel* viscosity at 175°C and 190°C, RBSP of the unaged samples, needle penetration, low-temperature flexibility, tensile strength, and percent elongation. Table 1 lists the physical properties of the SBS-based blends studied.

EASTMAN

Table 1 Physical Properties of SBS-Based Blends Extended With *Eastoflex* APOs

Ingredients	% by Weight									
Exxon AC-5 Asphalt	68	68	68	68	68	68	68	68	68	68
Eastoflex E1200 APO	—	3	—	4	—	3	—	—	4	—
Eastoflex P1023 APO	—	—	3	—	—	—	3	—	—	4
Kraton D-1101 Linear SBS	12	9	9	8	—	—	—	—	—	—
Kraton D-1102 Linear SBS	—	—	—	—	12	9	9	—	—	—
Kraton D-1116 Branched SBS	—	—	—	—	—	—	—	12	8	8
Calcium Carbonate	20	20	20	20	20	20	20	20	20	20
Physical Properties										
Viscosity, cP @ 190°C	2,200	610	1,485	1,090	925	685	710	4,890	2,190	1,510
175°C	3,540	950	2,300	1,680	1,410	1,090	1,095	7,640	3,215	2,455
RBSP, °C	110	93	109	107	88	88	88	102	98	97
Needle Penetration, dmm	43	48	43	47	46	41	40	36	37	42
Low-Temperature Flexibility, °C	−33	−18	−21	−15	−9	−18	−6	−33	−12	−21
Tensile Strength, psi	33	11	65	24	17	9	14	44	22	25
Elongation, %	1,040	690	890	1,150	750	1,030	810	1,010	1,015	1,030
Test Tube Compatibility										
RBSP, °C										
Top Section	110	106	98	109	87	87	90	99	96	92
Bottom Section	103	104	93	102	87	94	84	101	96	100

As shown in Table 1, as much as one-quarter to one-third of the SBS can be replaced with APO while the resulting blends remain moderately to highly compatible. In most cases, the addition of APO causes a reduction in blend viscosity and increases the low-temperature flexibility. Other physical properties show little change.

Attempts made to extend *Kraton* D-1184 branched SBS with APO in asphalt roofing blends met with little success. The D-1184 would not blend into the asphalt using a high-speed disperser blade at 2,000 rpm and 200°C. Unsuccessful attempts were also made to blend D-1184 into roofing flux.

Physical properties of the SEBS-based blends that were studied are reported in Table 2.

Table 2 Physical Properties of SEBS-Based Blends Extended With *Eastoflex* APOs

Ingredients	% by Weight								
Exxon AC-5 Asphalt	68	68	68	68	68	68	68	68	68
Eastoflex E1200 APO	—	4	—	—	—	4	6	—	—
Eastoflex P1023 APO	—	—	4	6	—	—	—	4	6
Kraton G-1652 Linear SEBS	12	8	8	6	—	—	—	—	—
Kraton G-1657 Linear SEBS	—	—	—	—	12	8	6	8	6
Calcium Carbonate	20	20	20	20	20	20	20	20	20
Physical Properties									
Viscosity, cP @ 190°C	925	510	450	330	1,845	1,095	795	915	620
175°C	1,560	865	765	555	2,815	1,555	1,145	1,355	890
RBSP, °C	92	88	89	86	75	71	70	72	71
Needle Penetration, dmm	25	30	31	31	36	41	49	45	47
Low-Temperature Flexibility, °C	−24	−18	−18	−6	−36	−30	−27	−30	−27
Tensile Strength, psi	66	20	23	12	10	15	6	9	13
Elongation, %	795	800	1,005	730	825	345	155	355	295
Test Tube Compatibility									
RBSP, °C Top Section	90	93	91	92	75	77	80	84	80
Bottom Section	86	87	89	84	80	75	72	76	76

Table 2 suggests that excellent properties are maintained when up to 50% of the SEBS polymer is replaced with an APO. As in the case of the SBS blends, the addition of APO reduces blend viscosities and increases low-temperature flexibility. APO addition also increases the needle penetration values of the SEBS-based asphalt blends. Asphalt blends containing *Kraton* G-1650 linear SEBS were also tested, but these were deemed incompatible since the RBSPs of all the blends differed by more than 10°C, including the blend containing no APO.

Conclusions

The partial replacement of a styrenic block copolymer with APO in asphalt roofing blends can result in the following benefits:

- Reduced raw material costs
- Reduced viscosity
- Reduced mixing time and energy
- Improved resistance to ultraviolet light

For additional information concerning *Eastoflex* APOs, contact Eastman Chemical Company at the address shown on the back cover of this publication.

Information

Eastman Chemical Company
World Headquarters
P.O. Box 431
Kingsport, TN 37662-5280
U.S.A.

Telephone:

U.S.A. and Canada
800-EASTMAN
(800-327-8626)

Other Locations
(1) 615-229-2000
(1) 423-229-2000 (Effective September 11, 1995)

Facsimile:

(1) 615-229-1673
(1) 423-229-1673 (Effective September 11, 1995)

Material Safety Data Sheets providing safety precautions that should be observed in handling and storing Eastman products are available on request. You should obtain and review the available material safety information before handling any of these products. If any materials are mentioned that are not Eastman products, appropriate industrial hygiene and other safety precautions recommended by their manufacturers should be observed.

Neither Eastman Chemical Company nor its marketing affiliates shall be responsible for the use of this information, or of any product, method, or apparatus mentioned, and you must make your own determination of its suitability and completeness for your own use, for the protection of the environment, and for the health and safety of your employees and purchasers of your products. No warranty is made of the merchantability or fitness of any product, and nothing herein waives any of the Seller's conditions of sale.

EASTMAN

ECP 8548M 4b Printed in U.S.A.

Publication WA-61
June 1995