Pure monomer resins

Extending hydrogenated hydrocarbon resins with pure monomer resins in SIS-based nonwoven construction pressure sensitive adhesive formulations

Technical tip

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Extending hydrogenated hydrocarbon resins with pure monomer resins in SIS-based nonwoven construction pressure sensitive adhesive formulations

Introduction

Nonwoven construction adhesives based on SIS-type polymers traditionally use hydrogenated hydrocarbon resins such as Eastotac™ resins as the tackifier of choice due to their compatibility, thermal stability, and high-temperature properties. Eastman has investigated the possibility of extending hydrogenated hydrocarbon resins in these types of formulations with pure monomer resins (PMRs), with results that indicate PMRs can be added up to 13% by resin volume without negatively affecting adhesive performance or thermal aging properties.

Data

Pure monomer resins offer excellent thermal stability, high-temperature resistance, and low molecular weight. Traditionally used to selectively modify the styrenic end blocks to balance cohesion and viscosity, PMRs can be effectively used in synergy with hydrogenated hydrocarbon resins in SIS-based adhesives without negatively affecting performance.

Typical properties of selected hydrogenated hydrocarbon resins and PMRs are given in Table 1. Values shown are an average of typical samples and should not be interpreted as product specifications.

Table 1. Typical properties of resins[a]

Resins	Type	Ring & ball softening point (°C)	Mn/Mw/Mz (Daltons)	T_g (°C)	Gardner color/YID[b]
Eastotac™ H-100W	Hydrogenated hydrocarbon resin	100	450/1000/2150	41	<1/8
Kristalex™ 3085	PMR	85	650/1150/1900	41	<1/4
Piccotex™ LC	PMR	91	750/1350/2200	46	<1/8
Piccolastic™ A75	PMR	74	700/1300/2250	35	1/-

[a] *Obtained from Eastman publication WA-86A,* Spectrum of Hydrocarbon Resins; *WA133,* Eastman Hydrocarbon resins
[b] *YID = Yellowness Index*

An SIS-based disposable diaper construction adhesive formulation was prepared with Eastotac™ H-100W hydrogenated hydrocarbon resin as the control. Effects of three different PMRs (Kristalex 3085, Piccotex LC, and Piccolastic A75) as extenders for Eastotac H-100W were evaluated at two different levels; 4% and 8% by weight (in formulation) or 7% and 13% extension with respect to the total hydrogenated hydrocarbon resin amount (Eastotac H100W:PMR, 93:7 and 87:13 ratios). Table 2 shows the formulations used in this study.

Table 2. Disposable diaper construction adhesive formulations with PMRs (shown in weight %)

Formulation ingredient	Eastotac™ H-100W control	Kristalex™ 3085		Piccotex™ LC		Piccolastic™ A75	
		93:7 H100W:3085	87:13 H100W:3085	93:7 H100W:LC	87:13 H100W:LC	93:7 H100W:A75	87:13 H100W:A75
Kraton™ 1165[a]	20	20	20	20	20	20	20
Eastotac™ H-100W[b]	59.5	55.5	51.5	55.5	51.5	55.5	51.5
Kristalex™ 3085[b]	–	4	8	–	–	–	–
Piccotex™ LC[b]	–	–	–	4	8	–	–
Piccolastic™ A75[b]	–	–	–	–	–	4	8
Calsol™ 5550[c]	20	20	20	20	20	20	20
Irganox™ 1010[d]	0.5	0.5	0.5	0.5	0.5	0.5	0.5

[a]*KRATON Polymers LLC (polymer)*
[b]*Eastman Chemical Company (resins)*
[c]*Calumet Specialty Products (naphthenic oil)*
[d]*BASF (antioxidant)*

Study formulations were prepared using a Brabender mixer and evaluated for the following properties:

• Viscoelastic properties—Using Dynamic Mechanical Analysis (DMA)

• Viscosity profiles at different temperatures (before and after aging [177°C for 72 h])—Brookfield Viscometer

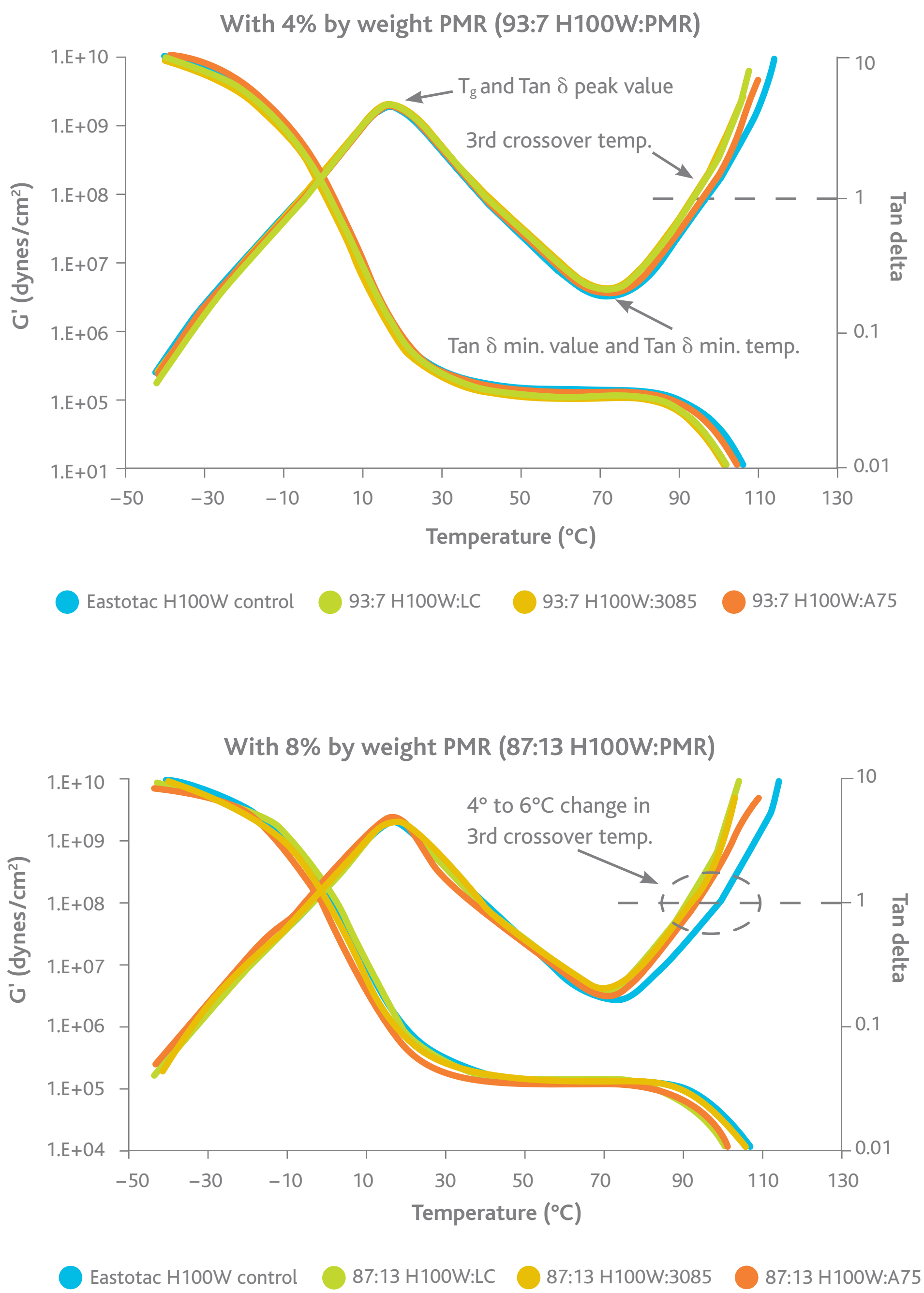
• Adhesive property evaluation—1-mil-thick adhesive coating on Mylar™

 – 180 degree peel on stainless steel substrate (peel rate @ 4 inches/min)

 – Loop tack on stainless steel substrate

The viscoelastic performance analysis (DMA) of the PMR extended formulations at two different levels, along with the control formulation is shown in Figure 1.

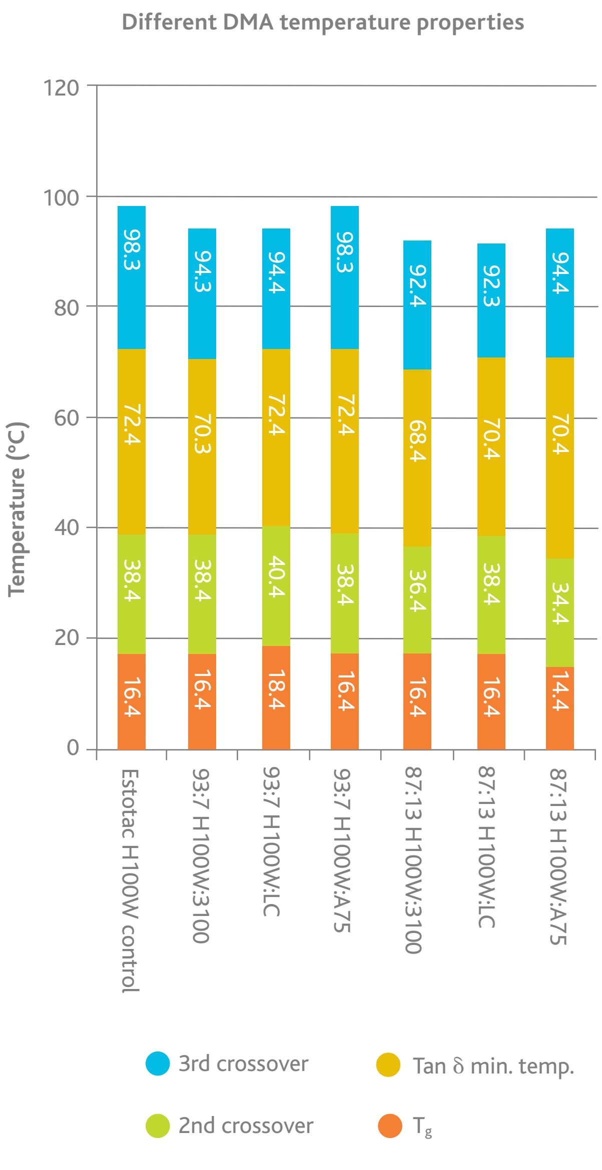
Figure 1. Viscoelastic properties of formulations extended with PMRs.

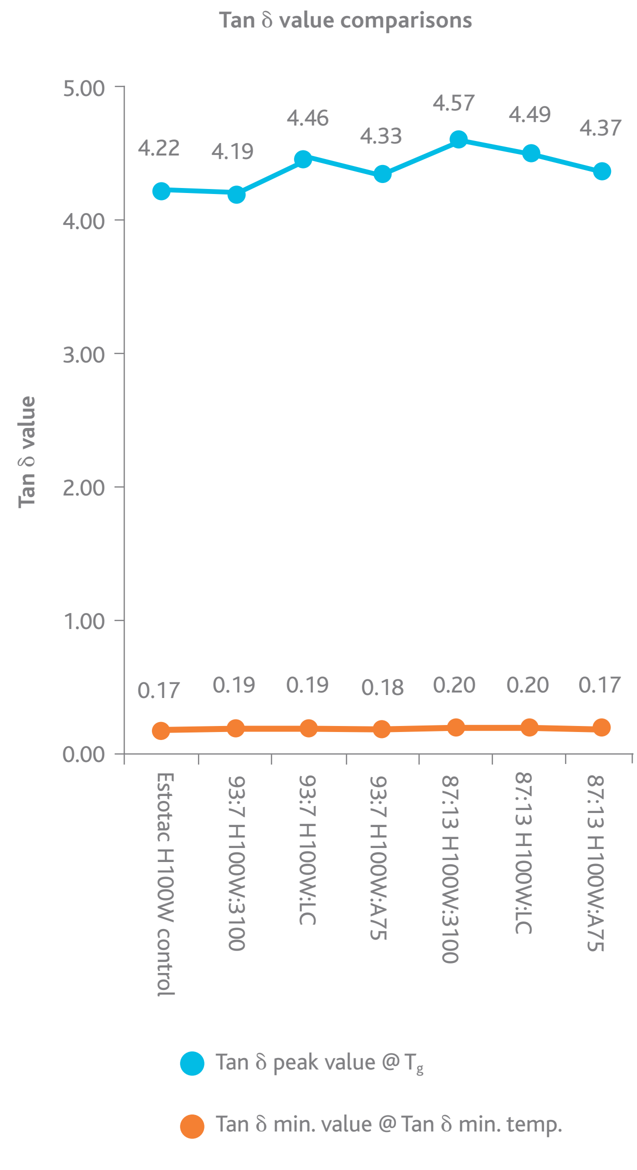


As shown in Figure 1, the viscoelastic characteristics, T_g, and elastic modulus are not significantly affected by the addition of PMRs to the control formulation. The single T_g exhibited by the extended formulations is also an indication of good compatibility between the polymer and tackifiers. The only notable exception is a slightly lower melting temperature (approximately 4° to 6°C) when the formulation is extended with PMRs at the highest loading level weight (8%).

Figure 2 illustrates the absolute values of important parameters such as T_g, Tan δ minimum value at Tan δ minimum temperature (an indication of cohesive property), 3rd crossover temperature (indication of melting temperature), and Tan δ peak value at T_g (indication of tack). The only significant difference noted is for the 3rd crossover temperature with the 8% PMR extended formulations (87:13) with Eastotac™ H-100W. All other properties are comparable.

Figure 2. Viscoelastic property comparison values from DMA.





Figures 3 and 4 summarize the adhesive property evaluation results, which were performed with 0.9–1-mil-thick Mylar™-coated films on a stainless steel substrate. While most extended formulations exhibit similar performance to the control, a notable exception is Piccotex™ LC at 7% loading with Eastotac™ H100W. Improvement is shown in both adhesive peel and loop tack. The higher loop tack shown for Piccolastic™ A75 extended formulations can be attributed to the slightly lower softening point characteristics of Piccolastic™ A75 compared to the other PMR resins.

Figure 3. 180 degree peel on stainless steel (peel rate at 4 inches/min)

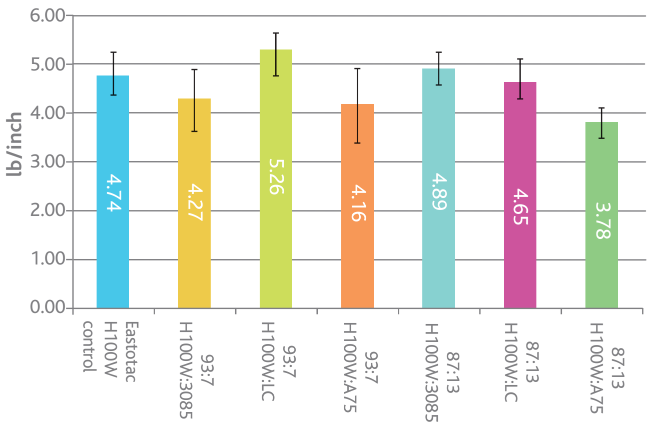


Figure 4. Loop tack on stainless steel

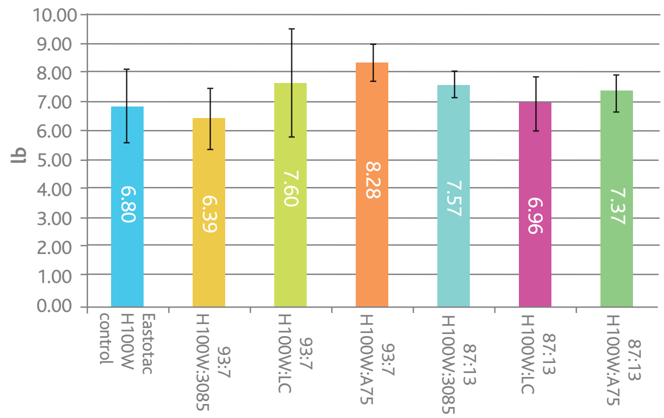


Figure 5 illustrates there are no significant differences above 150°C in the viscosity profiles at 5 different temperatures between the control formulation and PMR extended formulations, even after aging at 177°C for 72 h.

Figure 5. Brookfield viscosity (cps) profiles of formulations at different temperatures.

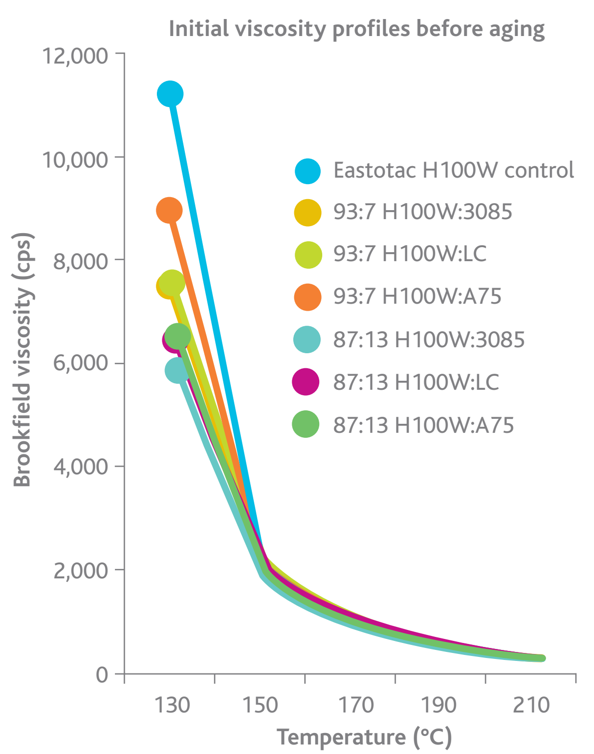
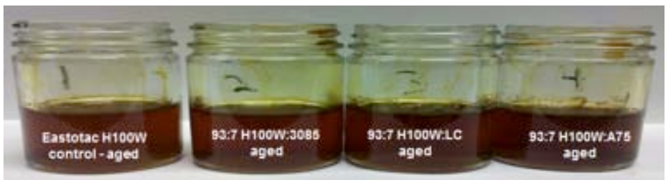


Figure 6. Aging studies of the formulations at 177°C for 72 h.

Initial (before aging)

Initial (before aging)

Aged pictures of formulations extended with 7% PMRs (93:7 H100W:PMRs)



Aged pictures of formulations extended with 13% PMRs (87:13 H100W:PMRs)

Depicted in Figure 6 are the before and after color-aging characteristics for both the control and PMR extended formulations, which also exhibit similar or better performance.

Conclusion

SIS-based nonwoven adhesive formulations that utilize hydrogenated hydrocarbon resins can be extended with pure monomer resins from 7%–13% (with respect to hydrogenated resin level) without negatively affecting the adhesive performance and thermal aging properties.

Benefits include:

- Improved adhesive peel and loop tack
- Higher amount of PMRs gives a slightly lower viscosity and melt transition (4° to 6°C from DMA)
- Good thermal stability (color and viscosity) on aging

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