Resin selection for Eastman Aerafin™ polymers

The introduction of Eastman Aerafin™ polymers presents new opportunities for hot-melt adhesive formulation. Aerafin polymers are fully saturated, low-molecular-weight, propylene-based olefin polymers that are compatible with a wide range of hydrocarbon tackifying resins.

To facilitate formulation of these new polymers, their compatibility with different tackifier resin classes was investigated using glass transition temperature (Tg) and cloud point temperature. Hydrocarbon resins with varying aromatic and aliphatic character were tested, including Piccotac™ C5 and C5/C9 hydrocarbon resins, Eastotac™ H and C hydrogenated hydrocarbon resins, Regalite™ C9 hydrogenated hydrocarbon resins, and Regalrez™ hydrogenated pure monomer resins. The effect of resin choice on softening point and viscosity was also characterized.

Fully hydrogenated resins with ring-and-ball softening points (RBSP) under 125°C are most compatible with Aerafin polymers. It is noteworthy that resins with as much as 7% aromatic content or with RBSP as high as 142°C have useful levels of compatibility with Aerafin polymers, therefore, the resins can be used in Aerafin polymer-based formulations.

Technical discussion

Tackifying resins raise the glass transition temperature of a compatible polymer. A relatively simple method to estimate the compatibility of two polymers is to measure the Tg of the mixture by differential scanning calorimetry. The Fox equation predicts the blend Tg when the polymer and tackifier resin are fully compatible \((1/T_g = w_1/T_{g1} + w_2/T_{g2})\) where \(w\) is the weight fraction of the component and Tg of the component is given in Kelvin. When the tackifier resin is not fully compatible in the polymer, the measured Tg will be shifted away from the predicted Fox Tg. A smaller shift away from the predicted Fox Tg indicates greater compatibility of the resin with the polymer.

Tackifier resins with different amounts of aliphatic and aromatic nature were tested for compatibility by preparing a 1:1 blend with Aerafin 17 polymer and with Aerafin 180 polymer. All of the 1:1 resin/polymer blends were clear or slightly cloudy at 180°C except for Regalite C6100, which was moderately cloudy.

The shift of the blend Tg from the predicted Fox Tg is shown in Figure 1 for various resins in Aerafin 17 and in Aerafin 180 polymers. The largest shifts from the predicted Tg were observed for high RBSP resins, indicating relatively lower compatibility. It is notable that aromatic-containing resins have greater compatibility in Aerafin 17 than in Aerafin 180, as indicated by smaller shifts from the predicted Fox Tg.
Alternatively, compatibility can be estimated by determining the cloud point temperature behavior of the tackifier resin/polymer blends. Lower cloud point temperatures indicate better compatibility of the blended materials. In the following tables, the symbols $\dagger$, $\div$, and $\ldots$ indicate whether the resin is fully compatible at a 1:1 ratio with the polymer, is usefully compatible with a clear blend at 120°C, or has some compatibility with the blend becoming cloudy before 120°C. Some resins with RBSP $>120°C$ showed signs of blend instability with Aerafin 17, as indicated by the black grid lines.

Additionally, lower-molecular-weight ($M_n$), low-aromatic-content, low-RBSP resins can result in a blend with some degree of tack as noted by the shaded boxes.

The choice of resin used in the formulation will affect the softening point and viscosity of the final formulation. Higher softening point resins yielded higher softening point Aerafin polymer/resin blends. The tackifier resins tested had RBSP of 50°–142°C and yielded blend softening points of 106°–111°C with Aerafin 180 polymer and 109°–115°C with Aerafin 17 polymer. Blend RBSP increased with increasing resin RBSP and appeared to decrease with resin aromaticity. The highest RBSP blends were obtained with Piccotac resins, and blends using hydrogenated Eastotac resins had higher RBSP than blends with similar Regalite and Regalrez hydrogenated resins.

Similar trends in blend viscosity with resin RBSP and aromaticity were seen for Aerafin 17 and Aerafin 180 polymers. Additionally, Eastotac resins gave higher viscosity than similar RBSP resins of different resin classes.
Figure 2  Resin/Aerafin polymer blend softening point changed with resin type and RBSP.

Figure 3  Resin/Aerafin 17 blend viscosity changed with resin type and softening point.
Conclusion

The lower-molecular-weight, fully hydrogenated Eastotac, Regalite, and Regalrez tackifier resin families are most compatible with the Aerafin olefinic polymers introduced by Eastman. Resins with as much as 7% aromatic content or with RBSP as high as 142°C have useful levels of compatibility with Aerafin polymers, therefore, the resins can be used in Aerafin polymer-based formulations. Higher-softening-point resins result in higher blend softening point and viscosity, with resin aromaticity appearing to reduce both properties. Additionally, use of low-molecular-weight aliphatic resins may increase the surface tack of an Aerafin polymer-based formulation.

For more information on formulation strategies using tackifiers and Aerafin polymers from Eastman, contact us at 1-800-EASTMAN or www.eastman.com/adhesives.