EASTMAN

Eastek™ polymer dispersion

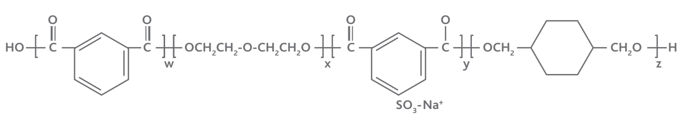
Optimizing the water resistance of sulfopolyester films via an ion exchange mechanism

Eastek™ polymer dispersions are used in applications such as printing inks, primers for flexible substrates, and wood coatings where features such as exceptionally small particle size (< 20 nm), high gloss, and excellent adhesion are key benefits achieved. For many applications, the inherent water solubility of the sulfopolyester is a positive feature but the unique chemistry of these resins allows customers to tailor this solubility for applications which require higher-resistance properties.

This technical tip demonstrates how posttreatment of films containing Eastek results in significant improvements to their water resistance.

Eastman's range of sulfopolyester resins are prepared by the melt-phase polymerisation of glycols and aromatic diacids. Among the monomers used to produce water-dispersible polyesters of this type, the key ingredient which provides the water dispersibility is 5-sodiosulfoisophthalic acid (5-SSIPA).

Figure 1.



Eastman's portfolio of sulfopolyester resins spans a broad range of physical properties to satisfy performance requirements in coatings, inks, adhesives, textile sizing, and personal care applications. Products are available in solid or liquid form to enable use in a variety of applications. All sulfopolyester resins disperse readily in water with this solubility being inversely proportional to the polymer's charge density; low-charge density polymers are lower in solubility than high-charge density polymers. The range of sulfopolyester resins is shown in Table 1 together with the calculated charge densities.

Table 1. Typical properties of Eastman water-dispersible sulfopolyesters

Approximate glass transition temperature (°C)[a]	Calculated charge density (meq/g)	Solid form	Dispersion form[b]
0	0.32	Eastman AQ™ 1350 copolyester	—
3	0.38	Eastman AQ 1950 copolyester	—
10	0.38	Eastman AQ 2350 copolyester	—
29	0.45	—	Eastek™ 1400 polymer dispersion
35	0.47	—	Eastek 1300 polymer dispersion
38	0.43	Eastman AQ 38S polymer	Eastek 1000 polymer dispersion
48	0.89	Eastman AQ 48 ultra polymer	—
55	0.66	Eastman AQ 55S polymer	Eastek 1100 polymer dispersion
63	0.33	Eastman AQ 65S polymer	Eastek 1200 polymer dispersion

[a] *Properties reported here are typical of average lots. Eastman makes no representation that the material in any particular shipment will conform exactly to the values given.*
[b] *Eastek products are supplied as 30% solids in aqueous dispersion. The exceptions are Eastek 1100 which contains 33% solids and Eastek 1200 which contains 2%* n*-propanol.*

In the dispersed form, Eastman markets certain polymer grades as Eastek polymer dispersions. Customers use Eastek dispersions for many applications, including printing inks, primers for flexible substrates such as biaxially orientated PET (BOPET), and wood coatings where features such as exceptionally small particle size (< 20 nm), high gloss, and excellent adhesion are achieved.

As mentioned previously, the key ingredient which makes the polyester resin inherently water dispersible is 5-SSIPA. For many applications, the inherent water solubility of the sulfopolyester is a positive feature but customers can sometimes require improvements in resistance characteristics. It is a little-known feature of 5-SSIPA that the monovalent sodium cation used to prepare this salt can easily be exchanged by other cations. If the

monovalent sodium cation is replaced by a multivalent cation, interesting improvements in properties, such as reduced solubility, are observed. In the liquid phase, addition of multivalent cations results in instantaneous coagulation, but in the dry phase, such as posttreatment of sulfopolyester films, this feature can be used to positive effect.

Experimental

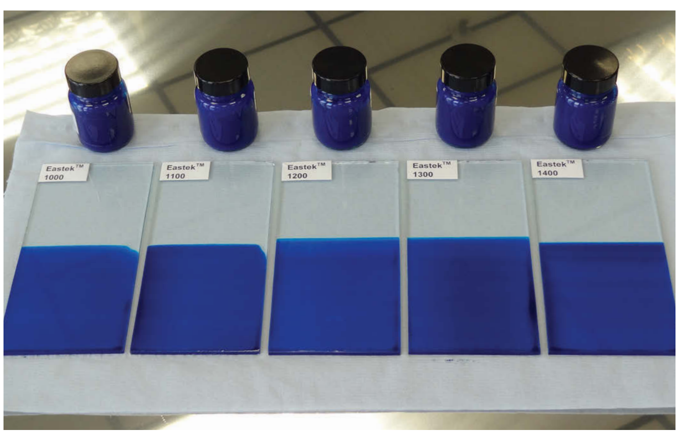
The multivalent cation used in our studies was a 10% solution of aluminium potassium sulphate in deionised water. This solution was used as a posttreatment of dry sulfopolyester films of all Eastek™ polymer dispersions. To enable a visual assessment of the polymer films, each Eastek dispersion was tinted with a waterborne blue pigment preparation. Water resistance was initially evaluated by immersion in hot (50°–55°C) water. The Eastek dispersion with the highest water resistance was also tested by immersion in water at 92°C.

Finally, a study was performed to assess whether the multivalent metal would cross-link with the sulfopolyester if it was used as a pretreatment on a porous substrate (wood) which was then overcoated with Eastek.

Preparation of drawdowns on glass

Each pigmented Eastek polymer dispersion was drawn down on glass using a 25 µm wet film thickness applicator bar. The films were allowed to dry at room temperature for 1 hour.

Figure 2.



Posttreatment of Eastek polymer dispersion films

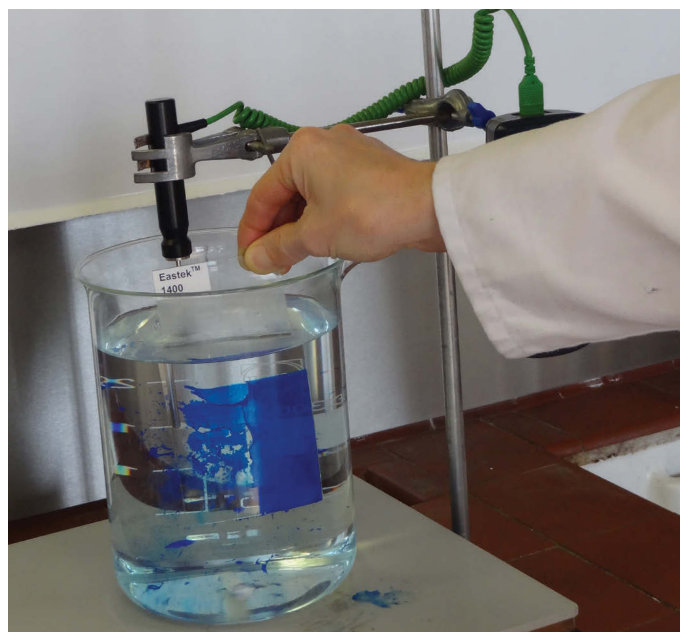
After 1 hour drying, half of each panel was briefly immersed (3–5 seconds) in a 10% solution of aluminium potassium sulphate and the panel allowed to dry.

Figure 3.

Assessment of water resistance

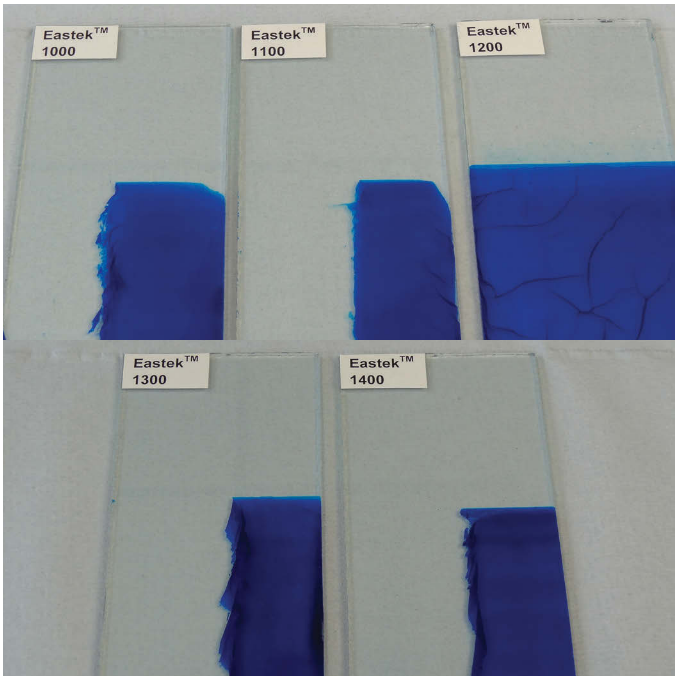
The panels were immersed in hot water (50°–55°C) for 5 minutes.

Figure 4.



Comparison of Eastek polymer dispersion grades

Figure 5.

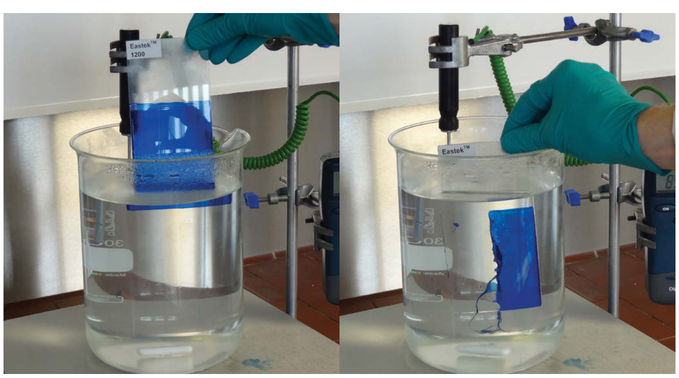


In all cases, the posttreatment of the sulfopolyester film resulted in a dramatic improvement to the hot water resistance properties. The Eastek 1200 polymer dispersion film also resisted hot water without posttreatment, indicating this has the highest level of water resistance of the grades tested. What appear to be cracks on the Eastek 1200 panel are actually where the water has lifted the film from the panel without dissolving it.

Water immersion results (92°C)

Since the Eastek 1200 film, both treated and untreated, withstood immersion in water at 50°–55°C for the test period, water immersion was conducted at a higher temperature to observe the effect of ion exhange treatment.

Figure 6.



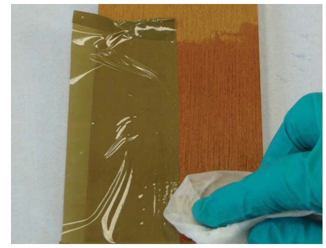
After 2 minutes immersed in 90°C water, the aluminium cation-treated Eastek film remained intact while the untreated portion of the film was completely removed.

Pretreatment of substrate with multivalent metal cation solution

A study was performed to observe whether it was possible to pretreat a porous substrate (wood) with a solution of the multivalent metal cation and it still interact with an Eastek polymer dispersion applied over this.

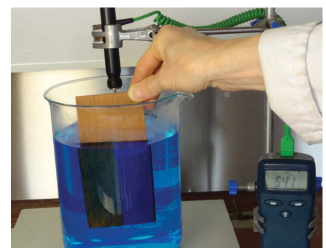
Half of a wooden panel was impregnated by simply wiping with a tissue soaked in a 10% solution of aluminium potassium sulphate (Figure 7). The panel was allowed to dry for 1 hour before a pigmented Eastek dispersion was applied over the entire panel.

Figure 7.



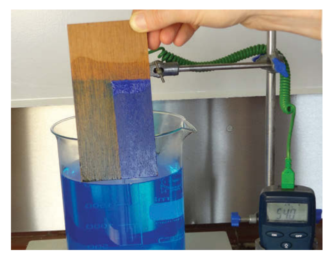
The coated panel was allowed to dry for 1 hour before it was immersed in hot water at 50°–55°C (Figure 8).

Figure 8.



After 5 minutes immersion in hot water, the treated film remained intact while the untreated portion had been almost completely removed, showing that pretreatment of the substrate was a viable route to improving subsequently applied sulfopolyester films (Figure 9).

Figure 9.



Conclusion

Eastman's range of sulfopolyester resins is made water dispersible by the inclusion of 5-sodiosulfoisophthalic acid along the polymer backbone. We were able to demonstrate that the monovalent sodium cation in this salt can be easily exchanged by a multivalent cation by simple immersion of a cast film in an ionic solution or, alternatively, by pretreatment of the substrate prior to the application of the sulfopolyester film. The resulting films of ion-exchanged polymer showed improved resistance to hot water.

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