Improved rubber to fabric bonding with Rhenosin® T

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Abstract

Rhenosin® T is a resorcinol pre-condensate used as an adhesion promoter for rubberized fabric coatings. For pre-impregnation of textiles, pre-reacted resorcinol formaldehyde dispersions and dips of latex (RFL) are usually employed. The so-called RFL dips are either made of individual components or with pre-reacted resorcinol.

The formation of the pre-polymer by the reaction of resorcinol with formaldehyde is a sensitive chemical process that requires elaborate staff protection measures due to its hazard potential. This is why a pre-reacted product such as Rhenosin® T is often used. This guarantees uniform resin qualities and makes it unnecessary to master a complicated chemical process.

Rhenosin® T is a resorcinol formaldehyde prepolymer which has not yet fully completed its reaction. It guarantees consistently uniform resin properties for processing and regarding latex-fabric adhesion. It is usually processed in combination with latex but does not require handling of formaldehyde, which is a health hazard.

The finished dispersions do not polymerize under storage conditions and are of low viscosity so that they can be easily metered and applied. It is available as 40 percent dispersion. Upon customer request it can also be provided in customized concentrations.
The dip is usually composed of Rhenosin® T, water, and latex. Depending on the application, water, resorcinol, formaldehyde, and additional adhesion promoters may be added. The latices used may be SBR, NBR, CR, or VP (vinylpyridine).

**Dosage guideline for Rhenosin® T**

a) Rhenosin® T concentration

The concentration may require some adjustment for the desired strength of adhesion and the type of fiber. For rayon fibers, a typical Rhenosin® T dry weight content would be 15 - 20 weight percent of the rubber solids; for polyester or polyamide it should be 20 - 30 weight percent. For high-performance fabric and difficult-to-bond fibers (e.g. aramid), Rhenosin® T can also be used in undiluted form (40 percent). Thus, better wetting is achieved. Usually, Rhenosin® T can be adjusted to the desired dry weight content by dilution in water.

b) Formaldehyde concentration

The pre-reacted Rhenosin® T is optimized for best adhesion, but it can be further modified by adding formaldehyde. Stronger adhesion can be achieved by a higher formaldehyde concentration. However, this results in stiffer latex films which are harder to process.

c) Sample formulation

The following formulation is a sample of a basic application on rayon fabric.
Before use, Rhenosin® T is diluted with water at, for example, a ratio of 1:5, and mixed with the required volume of formaldehyde. For alkaline stabilization ammonia or NaOH-solutions are applied. No maturation is required for resin to form. The remaining water is mixed with the latex. After that, the diluted resin dispersion is stirred into the latex dispersion. The dip can be used either immediately or after a period of storage. Its durability can be up to several weeks. Typically the finished dips are processed within a few days. An exception to this is the CR latex, where zinc oxide is used as an additive. In order to prevent phase separation it is useful to add latex soaps (e.g. 1 percent Emulvin W®) and to stir the dispersions. The recommended quantity of solids to be applied to the fabric from the finished RFL dispersion is 4 - 8 percent of the fabric weight, depending on the desired properties. In some cases, in particular for high-performance fibers with high stiffness such as polyamide or aramid, a two-coat process can be used, in which an epoxy or isocyanate dip is first applied to the fabric (see Chart 1).

For complete post-reaction of the RFL resin, temperatures of 120 - 180°C are required for a period of 10 - 1 min, which should also allow the fabric to dry.

**Properties of the coated fabric**

Coatings with RFL dips based on Rhenosin® T ensure excellent rubber–fabric adhesion properties. These are generally superior to those of the traditional RFL mixture-based composites. In particular, dynamic durability and consistency of quality are remarkably improved. This is the case in particular with vinylpyridine latices.

**Formulations Guide**

1. **RFL dip activated with Rhenocure® TT for polyamide bonding**

   a) Preparation of the activator dispersion with Rhenosin® T concentration

   Tamol® NN 9104 is dissolved in water under slight stirring. Rhenocure® TT is dispersed in this solution with fast stirring. The thickener Prox® A 300 is added under high speed stirring as well.
b) Preparation of the RFL basic dip

Rhenosin® T is mixed with water. Then formaldehyde is added under stirring. The mixture of Rhenosin® T with water is poured into the diluted latex Pyratex® 240 and stirred for 3 hours.

<table>
<thead>
<tr>
<th>Tab. 4: RFL dip</th>
<th>parts wet</th>
<th>dry weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pyratex® 240 (41%)</td>
<td>250</td>
<td>100</td>
</tr>
<tr>
<td>Water</td>
<td>100.5</td>
<td></td>
</tr>
<tr>
<td>Rhenosin® T (40%)</td>
<td>50</td>
<td>20</td>
</tr>
<tr>
<td>Water</td>
<td>250</td>
<td></td>
</tr>
<tr>
<td>Formaldehyde (30%)</td>
<td>20</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>670.5</td>
<td>126</td>
</tr>
</tbody>
</table>

Dry wt. content: 20%

Tab. 5: Activated RFL dip for polyamide

<table>
<thead>
<tr>
<th>Finished activated dip</th>
<th>parts wet</th>
<th>dry weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFL dip (b)</td>
<td>670.5</td>
<td>126</td>
</tr>
<tr>
<td>Rhenocure® TT dispersion (a)</td>
<td>25</td>
<td>13.1</td>
</tr>
<tr>
<td>Total</td>
<td>695.5</td>
<td>139.1</td>
</tr>
</tbody>
</table>

Dry wt. content: 20%

2. RFL dip for rayon

The latex Litex® S71 is diluted with water. The dispersion of Rhenosin® T containing water and formaldehyde as added is mixed while stirring. Ammonia (25% solution) can be used for adjustment of pH values. Dip can be used immediately. An optimum is achieved after 3 hours of stirring. For higher cord adhesion multiple dipping may be required.

<table>
<thead>
<tr>
<th>Tab. 6: RFL dip for rayon</th>
<th>parts wet</th>
<th>dry weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Litex® S71 (40%)</td>
<td>159</td>
<td>63.6</td>
</tr>
<tr>
<td>Pyratex® 240 (41%)</td>
<td>85</td>
<td>34</td>
</tr>
<tr>
<td>Water</td>
<td>640</td>
<td></td>
</tr>
<tr>
<td>Rhenosin® T (40%)</td>
<td>42.5</td>
<td>12</td>
</tr>
<tr>
<td>Formaldehyde (30%)</td>
<td>11.4</td>
<td>3.4</td>
</tr>
</tbody>
</table>

Dry wt. content: 12%

3. RFL dip for polyamide filaments in belts

The latex Lipren® MKB is diluted with water and mixed with the dispersion of Rhenosin® T. Formaldehyde, zinc oxide and Rhenofit® DDA-50EM are added and stirred.

<table>
<thead>
<tr>
<th>Tab. 7: RFL dip for polyamide filaments</th>
<th>parts wet</th>
<th>dry weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lipren® MKB (58)</td>
<td>173</td>
<td>100</td>
</tr>
<tr>
<td>Water</td>
<td>395</td>
<td>17.2</td>
</tr>
<tr>
<td>Rhenosin® T (40%)</td>
<td>42.9</td>
<td>7.5</td>
</tr>
<tr>
<td>ZnO dispersion (50%)</td>
<td>15</td>
<td>1</td>
</tr>
<tr>
<td>Rhenofit® DDA-50 EM (50%)</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Formaldehyde (30%)</td>
<td>12</td>
<td>129.7</td>
</tr>
<tr>
<td>Total</td>
<td>639.9</td>
<td></td>
</tr>
</tbody>
</table>

Dry wt. content: 20%
4. **RFL dip for polyester**

a) **Preparation of RF resin dispersion**

First sodium hydroxide (NaOH) 5\% is mixed with water. Rhenosin\textsuperscript{®} T is added during stirring. The solution is agitated for 5 min.

<table>
<thead>
<tr>
<th>Parts</th>
<th>Wet</th>
<th>Dry Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>NaOH solution (5%)</td>
<td>9</td>
<td>0.45</td>
</tr>
<tr>
<td>Water</td>
<td>153.4</td>
<td>0</td>
</tr>
<tr>
<td>Rhenosin\textsuperscript{®} T (40%)</td>
<td>31.5</td>
<td>12.6</td>
</tr>
<tr>
<td>Formaldehyde (37%)</td>
<td>12.2</td>
<td>4.51</td>
</tr>
<tr>
<td>Total</td>
<td>206.1</td>
<td>17.56</td>
</tr>
</tbody>
</table>

b) **Preparation of latex dispersion**

The latex Pyratex 240 is mixed with water and ammonia is added. The dispersion is immediately ready for use.

<table>
<thead>
<tr>
<th>Parts</th>
<th>Wet</th>
<th>Dry Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pyratex\textsuperscript{®} 240 (41%)</td>
<td>244</td>
<td>100</td>
</tr>
<tr>
<td>Water</td>
<td>70.8</td>
<td>0</td>
</tr>
<tr>
<td>Ammonia (25%)</td>
<td>13.4</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>328.2</td>
<td>100</td>
</tr>
</tbody>
</table>

c) **Preparation of RFL dip for polyester**

The dispersions in Tab. 8 and Tab. 9 are combined in the ratios as given in Tables 7 and 8. The mixture is slightly stirred to blend the components.

The dip is ready for use after 12-24 hours of reaction time. It should be used within 3-4 days while stirring the dispersion.

<table>
<thead>
<tr>
<th>Parts</th>
<th>Wet</th>
<th>Dry Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resin dispersion (a) (8.5%)</td>
<td>206.1</td>
<td>17.56</td>
</tr>
<tr>
<td>Latex dispersion (b) (30.5%)</td>
<td>328.2</td>
<td>100</td>
</tr>
<tr>
<td>Total</td>
<td>534.3</td>
<td>117.56</td>
</tr>
</tbody>
</table>

2. **Summary**

Fabric reinforcement meets high performance requirements of modern radial tire carcasses, pressurized hoses, belting, or in air suspension systems. Rhenosin\textsuperscript{®} T offers a clean, safe solution for the fabrics coating industry to apply high performance dips on RFL basis. The dips show good stability and support the achievement of a highly uniform performance level in bonding between rubber and fabric. The activity can be further activated by adding bonding activators like Rhenocure\textsuperscript{®} TT to the dip. Rhenosin\textsuperscript{®} T guarantees a very high bond strength and a superior rubber coverage of cord before and after aging.
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