TECHNICAL UPDATE

CRAY VALLEY
A BRAND OF TOTAL

BENEFITS

- RF and solvent-free dip formulation
- Improved adhesion to EPDM peroxide-cured rubber
- Simplified dipping process

TARGET MARKETS/ APPLICATIONS

- Textile treatment
- Belts
- Hoses

ADDITIONAL INFO

- **MSDS/TDS:** Ricobond® 7004

Ricobond® 7004 for Improved Adhesion of PET to Peroxide-Cured EPDM

Description

Textile reinforcement is a common practice to enhance the overall performance of rubber goods. This performance depends on the adhesive bond between the textile and the rubber. To achieve sufficient bonding between the elastomer and reinforcement, a Resorcinol Formaldehyde Latex (RFL) dip is typically used to treat the surface of the textile. Although RFL provides sufficient adhesion to a variety of substrates and elastomers, adhesion to Ethylene Propylene Diene Monomer (EPDM) rubber remains a challenge. Polyethylene Terephthalate (PET) reinforced EPDM elastomers are widely used in many mechanical rubber applications such as belt and hose. At times, a three-step dip process that includes an applied adhesive is necessary to achieve the required adhesion bond.

TOTAL Cray Valley has developed a series of aqueous dispersions of functionalized resins including Ricobond® 7004 (RB7004). Table 1 lists the chemical and physical properties of the Ricobond 7004. When mixed with other water-based emulsions, Ricobond 7004 can increase rubber adhesion to textile and metals and improve chemical resistance. The hydrophobic and hydrophilic components of Ricobond 7004 allow for interaction between polar and non-polar components.

Formulating with Ricobond 7004 offers a more environmentally acceptable and simple alternative to RFL. Here Ricobond 7004 is blended with two different latexes to treat non-adhesive activated PET fabric. The latexes included a carboxylated styrene butadiene, Tg: 54 °C (SB) and vinylpyridine-styrene-butadiene terpolymer, Tg: -50 °C (VP) emulsions. With the addition of Ricobond 7004 to the emulsions, low viscosity, good wetting behavior, pH stability, and good compatibility were observed.

A modified T-peel test method was used to test adhesion of treated fabric to EPDM peroxide-cured rubber. Table 2 shows the rubber compound formulation.

Table 1: Physical and Chemical Properties of Ricobond 7004

Identification	Ricobond 7004
Mn, g/mol	4500-5500
Functional Groups/Chain	11
Viscosity, cps @ 25 °C	<500
pH	8.0-9.0
Solids, wt%	28-31

Table 2: EPDM Rubber Compound Formulation

Material	phr
Nordel® IP 4640 EPDM	100.0
N 660 Carbon Black	100.0
Sunpar® 2280	50.0
Stearic Acid	1.0
TMQ	1.0
Dicup® 40 KE	7.5

Procedure and Testing

SAMPLE PREPARATION

A two-step dip process was used to treat the fabric. In the first step, the fabric was dipped in a bath containing the primer and then passed through rubber rollers to remove excess material. A standard formulation of the primer is shown in Table 3. The fabric was then dried at room temperature. This was followed by second drying step in the oven for 2 minutes at 225 °C. The fabric was then treated with a second dip that was an 80/20 (w/w) blend of Ricobond 7004 and the two emulsions (SB) and (VP). The final composition of the blends was then diluted to 25% solids. Each fabric was dipped in a bath and then passed through rollers to remove excess material. The treated fabric was then dried in an oven for 3 minutes at 130 °C followed by an additional drying step of 3 minutes at 215 °C. An RFL dip was also used as a control to treat fabric using the above dipping and drying process. The RFL formulation used here is especially formulated for PET treatment. As a baseline, dips containing only SB and VP latexes at 25% solids were used.

In a separate test, fabric that was treated by a primer and RFL was subjected to a third dipping step. The third, overcoat (OC) dip was a solvent-based adhesive. The PET fabric was allowed to dry at room temperature.

Table 3: Primer Formulation

Water	92.45
Blocked Isocyanate	6.0
Anionic Surfactant	0.19
Epoxy Resin	1.36
Total	100.0
Total Solids	5.1%

TESTING

Plaques of rubber-fabric-rubber were made and cured at 160 °C for 35 minutes in a heated press, based on the cure profile of the EPDM rubber. These plaques were then cut into four 1-inch wide by 5-inch long strips. A modified ASTM D1876 T-peel method was adapted to test the adhesion of the treated fabric to cured EPDM rubber. Figure 1 provides an illustration of the modified test. A Thwing-Albert EJA Vantage 10 tensile tester was used to perform the testing. T-peel speed and distance were constant for all samples. All strips were tested at room temperature (27 °C) and at 50% relative humidity.

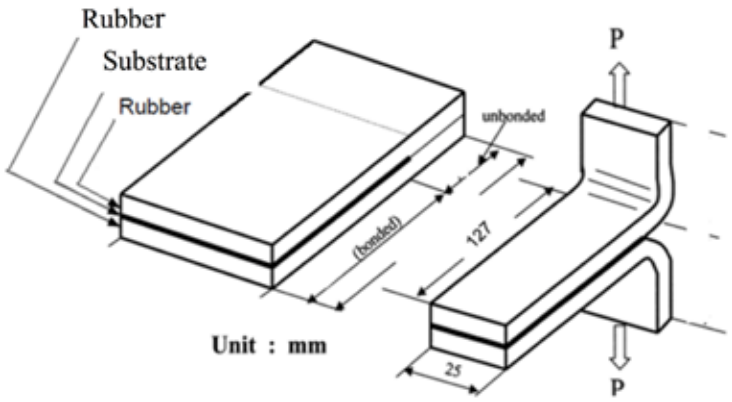

Figure 1: Modified ASTM D1876 test

Results

More than two-fold adhesion performance improvement over RFL for the dip based on Ricobond 7004 and SB latex is shown in Figure 2. Blends containing VP and RB7004 showed much lower adhesion performance but was comparable to RFL.

Specimens treated with the overcoat (OC) solvent-based adhesive improved the adhesion of RFL. The values were below those of substrates treated with the SB/RB7004 blend as shown in Figure 3.

In addition to T-peel testing, adhesion was also evaluated by rubber coverage on fabric. Figure 4 shows the rubber coverage differences among strips of PET treated with RFL, RFL with overcoat, and RB7004/SB blend. RB7004/SB and RFL/overcoat-treated PET shows significant rubber coverage while RFL-treated PET shows almost no rubber coverage.

Materials used in this study are shown in Table 4.

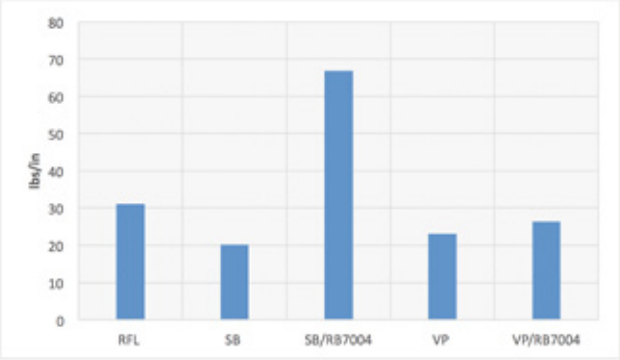

Figure 2: Adhesion performance of blend containing Ricobond 7004 vs. RFL

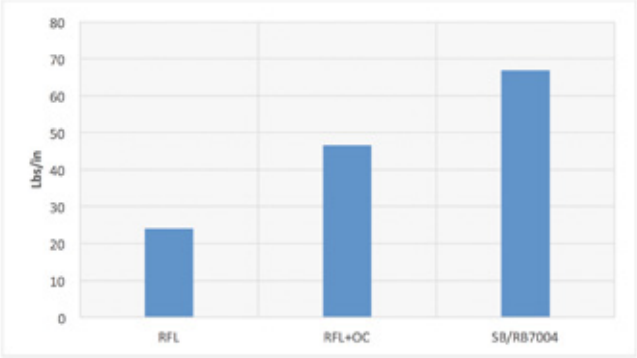

Figure 3: Adhesion performance of standard 3-step dipping process vs. 2-step dipping process using Ricobond 7004

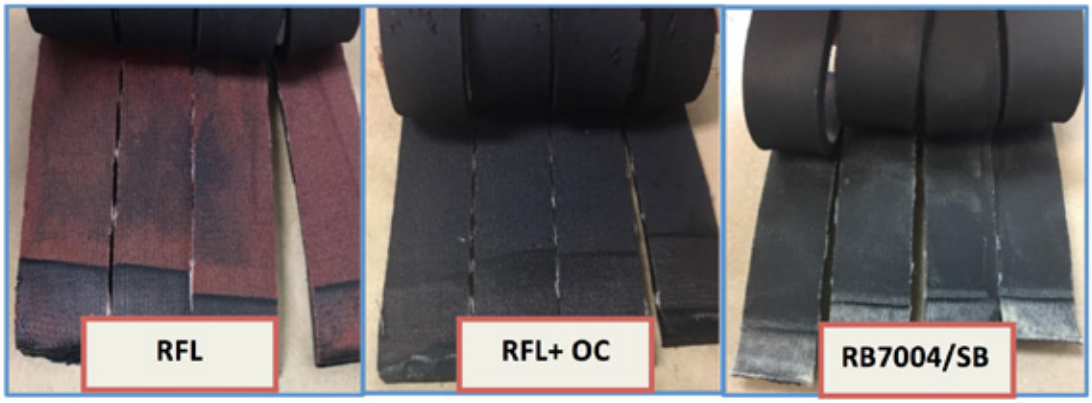

Figure 4: Rubber coverage on treated PET fabric

Table 4: Materials in this Study

	Code	Trade Name	Manufacturer
Substrates	PET	PET	Cerex Advanced Fabrics
Latexes	SB	GenFlo® 8045	Omnova Solutions
	VP	Pliocord® VP 106	Omnova Solutions
Aqueous Dispersions	RB7004	Ricobond® 7004	TOTAL Cray Valley
Primer	Blocked Isocyanate	Grilbond® IL-6	EMS-Griltech
	Epoxy Resin	Grilbond G 1701	EMS-Griltech
	Anionic Surfactant	Aerosol® OT-75	Cytec Solvay
Rubber	EPDM Master Batch	EPDM	Pelmor Laboratories Inc
Antioxidant	1,2 Dihydro 2,2,4-trimethylquinoline	TMQ	Harwick
Peroxide Catalyst	DiCup® 40KE	Dicumyl Peroxide	Arkema, Inc.

Summary

Ricobond 7004 is an aqueous dispersion that promotes superior adhesion performance of PET to peroxide-cured EPDM. Two-fold improvement in adhesion over RFL was achieved for dips based on Ricobond 7004 and carboxylated SB latex for a two-step dipping process. In addition, a two-step dipping process using Ricobond 7004 yielded better adhesion than a three-step dipping process based on RFL and a solvent-based adhesive overcoat.

Ricobond 7004 offers a simple, flexible and environmentally friendly dipping option. It is formaldehyde-free. It enables elimination of a third dipping step, thereby increasing productivity and reducing material consumption. The aqueous dispersion is simple to use and is shelf stable over long time periods.

Ricobond 7004 may also be used as additives in other water-baed formulations for adhesives, coatings, paper sizing, construction materials, and composites.

About TOTAL Cray Valley

TOTAL Cray Valley is the premier global supplier of specialty chemical additives, hydrocarbon specialty chemicals, and liquid and powder tackifying resins used as ingredients in adhesives, rubbers, polymers, coatings, and other materials. TOTAL Cray Valley has pioneered the development of these advanced technologies, introducing hundreds of products that enhance the performance of products in energy, printing, packaging, construction, tire manufacture, electronics, and other demanding applications.

For more information, please visit **www.crayvalley.com.**

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