TECHNICAL UPDATE

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Dymalink® 636 Metallic Coagent for Peroxide-Cured Chlorinated Polyethylene (CPE)

Introduction

Multifunctional coagents are used to improve the cure kinetics and ultimate physical properties of elastomers cured with organic peroxides. A wide variety of coagents are available from TOTAL Cray Valley, each providing unique structure-property relationships with various elastomers. However, improvements in certain physical properties may come at the detriment of others, and it is not uncommon for physical property improvements to be gained at the expense of processing ease.

Peroxide-cured chlorinated polyethylene (CPE) tends to have a relatively low cure state without the addition of a coagent compared to other elastomers. Zinc-containing coagents can improve physical properties, but these can degrade after exposure to heat. Dymalink® 636 is an alternative coagent that can improve physical properties, will not cause degradation in the elastomer when exposed to heat, contains no zinc, and can provide excellent adhesion to brass.

BENEFITS

- Improved physical properties after heat aging
- Excellent adhesion to brass
- Better scorch safety
- Contains no zinc

TARGET MARKETS/ APPLICATIONS

- Engineered products (e.g., belts, hoses, tubing)
- Wire and cable jacketing

ADDITIONAL INFORMATION

- **SDS/TDS:** Dymalink® 636
- **Technical Update:** Dymalink® 633 and Dymalink® 636 – Use of Metallic Coagents in Peroxide-Cured Chlorinated Polyethylene (CPE)

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Materials and Testing

Several coagents shown in Table 1 were compounded with a model CPE elastomer formulation, shown in Table 2. Triallyl cyanurate (TAC), another commonly used coagent, was also included.

The compounds were cured at 160 °C for 35 minutes, and evaluated for physical properties after curing and heat aging. Adhesion to steel and brass was also tested.

Table 1: Metallic Coagent Features and Typical Properties

Product	Description	Features
Dymalink 633	Zinc Diacrylate (non-nitroso scorch retarder)	Off-white powder Specific gravity = 1.58
Dymalink 708	Zinc Dimethacrylate	White powder Specific gravity = 1.49
Dymalink 636	Calcium Diacrylate	White powder Specific gravity = 1.48

Table 2: Model CPE Formulation

Ingredient	PHR
CPE (Tyrin™ CM0136)	100
N 550 Carbon Black	60
Calcium Carbonate	40
Diisodecyl Phthalate (DIDP)	30
Magnesium Oxide (Maglite® D)	5
Antioxidant (Agerite® Resin D®)	1
Dicumyl Peroxide (Di-Cup® 40KE)	7
Coagent	5

Tyrin™ is a trademark of Dow Chemical Company.
Maglite® is a tradename of Hallstar Innovations Corp.
Agerite® is a tradename of Vanderbilt Chemicals LLC.
Resin D® is a tradename of Emerald Polymer Additives.
Di-cup® is a tradename of Arkema Inc.

Curing

The coagents studied typically increase cure rate and thus lower scorch time in elastomer systems. At a cure temperature of 160 °C, Dymalink 636 provides higher scorch safety, as indicated by longer Ts2 times, than the zinc-containing coagents as shown in Figure 1. However, crosslink density as indicated by delta torque is lower for Dymalink 636 compared to the zinc containing coagents and TAC.

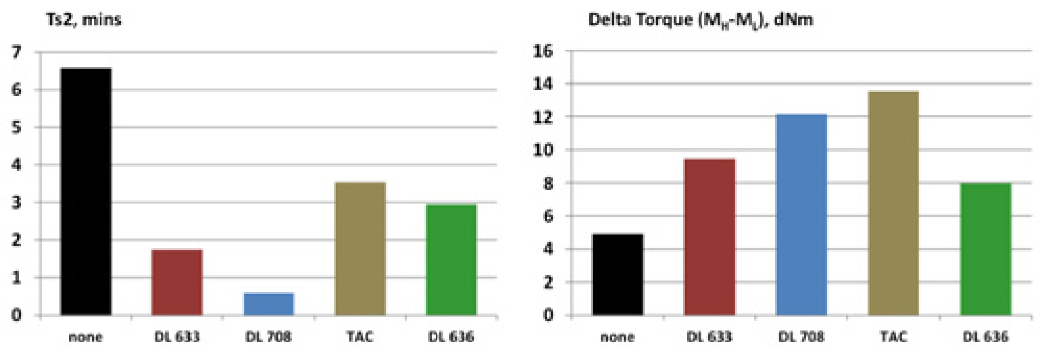

Figure 1: Scorch safety and crosslink density at coagent loading of 5 phr as compared to the CPE control (no coagent).

Tensile Properties After Heat Aging

After curing at 160 °C, and after heat aging at 150 °C for 70 hours, tensile strength and elongation were measured at room temperature. These results are shown in Figure 2. Initial tensile strength of samples with Dymalink 636 is comparable to those with zinc-containing coagents. After heat aging, the tensile strength of CPE with Dymalink 636 does not decrease as much as the tensile strength of CPE with zinc-containing coagents. Elongation at break after curing is about the same regardless of coagent used. However, after heat aging, elongation of CPE with Dymalink 636 remains above 100%, while the elongation at break of the samples with zinc-containing coagents drops to just 1-2%. This indicates zinc-containing coagents lead to brittleness in CPE upon heat aging, while with Dymalink 636, physical properties are largely maintained.

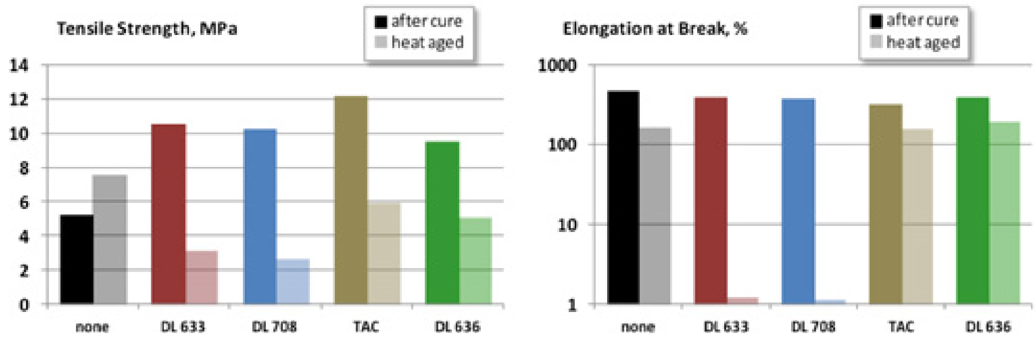

Figure 2: Tensile strength and elongation at break at coagent loading of 5 phr, after curing and after heat aging.

Heat Degradation Mechanism

Zinc-containing compounds are thought to degrade CPE by forming zinc chloride, which then forms low amounts of acid upon prolonged exposure to high temperatures. To see if this does occur, cured specimens of CPE with Dymalink 633, 708, 636, and TAC as coagents were heat aged at 150 °C for 70 hours, then soaked in deionized water for 30 minutes. The pH of the deionized water was then measured. The results are shown in Table 3. The water exposed to CPE with the zinc containing coagents Dymalink 633 and 708 became acidic, while the water exposed to CPE with Dymalink 636 and TAC was close to neutral, indicating the acid-forming heat degradation mechanisms can be avoided.

Table 3: pH of Deionized Water After Soaking Heat Aged Specimens

Coagent	pH
Dymalink 633	2-3
Dymalink 708	3-4
Dymalink 636	6
TAC	6

Adhesion to Brass and Steel

After curing at 160 °C on both steel and brass, the lap shear of CPE with various coagents was measured at room temperature. Dymalink 636 provides comparable adhesion of CPE to steel, and excellent adhesion to brass, as shown in Figure 3. Dymalink provides improved adhesion over TAC with both steel and brass.

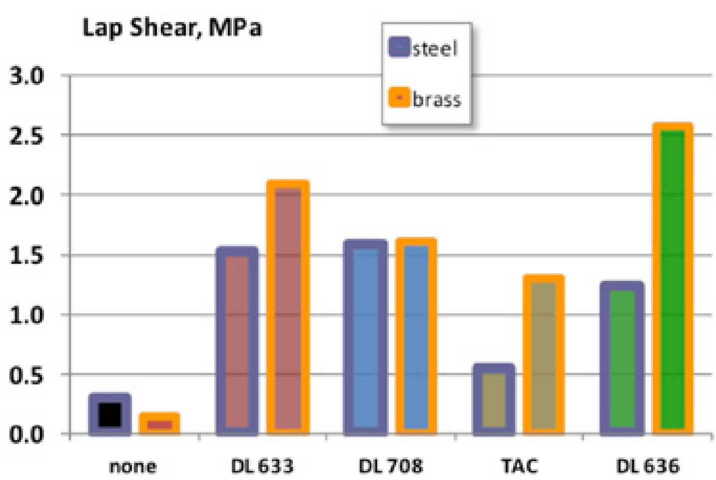

Figure 3: Lap shear of steel and brass at coagent loadings of 5 phr.

Summary

Dymalink 636 is a viable alternative to zinc-containing coagents and triallyl cyanurate for CPE formulations. While having lower initial crosslink density and tensile strength after cure compared to zinc-containing coagents, CPE with Dymalink 636 maintains its physical properties after aggressive heat aging conditions and does not become brittle. Dymalink 636 gives excellent adhesion to brass, which is much improved compared with CPE with either triallyl cyanurate or zinc-containing coagents.

Appendix: Test Methods

Property	ASTM Method	Comments
Delta Torque and Scorch Safety	D 5289	M_H-M_L, ts_2
Tensile Strength and Elongation at Break	D 412	Method A, Die C
Lap Shear	D 816	Method A

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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