

Hydrophilic Rubber Compounds

Most common rubber compounds are expected to repel water. However, water side print rolls require a rubber compound to be hydrophilic, not to absorb water but to hold a film of water on its surface. Plasthall[®] P-900, a polymeric polyester, provides this kind of water loving characteristic to rubber compounds.

Traditional water side print rolls are made from nitrile or nitrile/polyvinyl chloride (PVC) blends. These compounds are normally plasticized with di-2-theylhexyl phthalate (DOP). One of the main purposes of the water side print roll is to carry water to the paper. To do this effectively, solvents such as alcohols have been used to wet out the surface of the rubber print roll. Two major problems result from the use of these alcohols. The first is the extraction of the plasticizer from the print roll, which eventually causes the roll to harden and fail. The second is that the use of the alcohols and solvents is being heavily regulated by OSHA and the EPA. The continued use of these alcohols appears to be in doubt.

Plasthall[®] P-900 was compared to DOP in a recipe representative of a print roll compound. Print rolls are very soft, and the compounds were measured at 23 and 24 pts. Shore A. The softness is achieved by very high plasticization.

The purpose in this work was to investigate the use of a unique polymeric phthalate plasticizer, Plasthall[®] P-900, which would provide a hydrophilic (water loving) surface to print rolls. A hydrophilic surface would eliminate the use of solvents and prolong the life of the print roll.

The compound with Plasthall[®] P-900 provides interesting and useful properties compared to those containing DOP, as follows:

- After water immersion, lower hardness change
- After hexane (nonpolar fluid) significantly lower percentage change values, Typical of a highly polar polymeric plasticizer
- After isopropyl alcohol immersion, significantly lower property changes, typical of a polymeric plasticizer.

The measurement that shows greater hydrophilicity for the Plasthall[®] P-900 compound compared to the DOP compound is contact angle. Contact angle was measured by placing a drop of water on the surface of a section of the ASTM test slab. Then the angle the drop of water makes with the slab surface is observed. The angle with Plasthall[®] P-900 is one-half that of the compound with DOP. The lower angle accompanies a greater spread of the water drop, showing greater wetting for the surface of the compound containing Plasthall[®] P-900.

Physical Properties of Plasticizers

	P-900	DOP
Appearance	Clear	Clear
Acid Value	26.3	0.001
Hydroxyl Number	50	----
Specific Gravity	0.9722	0.9830
Water, %	0.13	0.01

Plasthall® P-900 has a unique combination of high acid value and hydroxyl number.

Experimental

MATERIALS	PPHR	SUPPLIER
Nipol® 1204X22	280.0	Zeon
Plasticizer	75.0	Hallstar
Hi Sil 233	25.0	PPG
Factice	10.0	Hallstar
Kadox 930	8.3	Hallstar
Agerite Resin D	2.0	R. T. Vanderbilt
Stearic Acid	1.5	Hallstar
Antioxidant 2246	1.5	Hallstar
Spider® Sulfur	1.5	Hallstar
TETD	1.0	Flexsys
MBTS	1.0	Flexsys
TMTM	1.0	Flexsys
<hr/> Total	<hr/> 407.8	

Viscosity and Curing Properties

Plasticizer	P-900	DOP
Mooney Viscosity at 121°C (250°F) ASTM D1646-91		
Minimum Viscosity	5.0	5.7
t5, min	20.3	29.2
t35, min	37.0	---
Oscillating Disc Rheometer at 170°C (338°F) ASTM D2084-93		
ML, lbf./in	1.0	0.9
MH, lbf./in	10.6	7.7
Ts2, min	2.9	3.3
t'c(90), min	7.7	7.6
1.25*t'c(90), min	9.6	9.5
Cure Rate Index	20.9	23.3

Compound Physical Properties

Plasticizer	P-900	DOP
Original Physical Properties: ASTM D412-92 and D2240-91		
Ultimate Elong., %	710	725
100% Modulus, psi	75	75
300% Modulus, psi	200	175
Tensile Strength, psi	575	500
Shore A Duro., pts	23	24
Air Oven Aging: ASTM D573-88, 70 h at 21°C		
Tensile Change, %	83	85
Elongation Change, %	-58	-61
Hardness Change, pts	33	24
Weight Change, %	-23	-28
Distilled Water Immersion: ASTM D471-79, 70 h at 100°C		
Hardness Change, pts	-2	-6
Volume Change, %	27	25
Weight Change, %	23	23

**Hexane and IPA Immersion
ASTM D471-79**

Plasticizer	P-900	DOP
Hexane Immersion: 70 h at 25°C (77°F)		
Tensile Change, %	65	130
Elongation Change, %	1	8
Hardness Change, pts	---	---
Volume Change, %	5.9	-33
Weight Change, %	-4.9	-35
IPA Immersion: 70 h at 25°C (77°F)		
Tensile Change, %	52	110
Elongation Change, %	-1	-2
Hardness Change, pts	7	7
Volume Change, %	-4.6	-13
Weight Change, %	-11	-17
Plasthall® P-900 has excellent resistance to solvents if the application warrants their use.		
<u>Contact Angle:</u>	35.0	70.0
The contact angle for Plasthall® P-900 is significantly lower than that for DOP, indicating a greater degree for wettability.		

The Contact Angle and Surface Science

A drop of liquid at rest upon a solid assumes a shape that is controlled by three forces of interfacial tension. The Contact Angle (θ) is a measured value relative to the combined forces.

In many applications, (θ) is the only value required for evaluating wetting properties. In addition, (θ) is used as a quality control value to monitor surface treatments and surface cleanliness.

For applications that require the determination of surface or interfacial energies, (θ) is analyzed in terms of vector forces using equations.

Summary

Plasthall[®] P-900 has been shown to provide a superior hydrophilic surface for a rubber compound. Compounds containing Plasthall[®] P-900 are excellent candidates for a water side print roll application. The ability of Plasthall[®] P-900 to provide a wettable surface without the use of alcohols and other solvents is advantageous when considering OSHA and EPA regulations.

Plasthall[®] is a registered trademark of Hallstar.