

Non-Phthalate Ester Plasticizers for Rubber and PVC

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Alternatives to phthalate esters have existed for at least 30 years. Trimellitates, adipates, phosphates, benzoates, citrate esters, polymeric plasticizers and many other chemistries can be used in place of phthalate esters. Initially, DEHP (Di-2-ethylhexyl phthalate) came under attack many years ago when it had to be classified as a potential carcinogen. The natural progression for most compounders were to DINP (Di-isononyl phthalate) and DIDP (Di-isodecyl phthalate). Also, several linear phthalates with varying carbon chain length alcohols (C-6 to C-11) were available in the market place.

Phthalate esters, as a whole, are coming under attack around the world especially when used in children's toys, medical goods and food contact products. HallStar has promoted many phthalate alternatives for over 25 years and continues to develop a portfolio of esters that meet the stringent demands of the market place. Our philosophy is not only to offer a phthalate alternatives, but provide our customers with products that will improve physical properties. We have several monomeric esters that are more efficient in providing low temperature, and are much less volatile for high temperature applications.

Many of our customers have utilized our PARAPLEX® APPROACH system, a computer designed program, which will provide a polymeric ester that meets their most critical needs. One of these products (Plasthall LCOA) is highly recommended as a phthalate alternative for PVC and Nitrile rubber, and is highlighted in the data. Plasthall LCOA is a low molecular weight, long chain oligomer designed to provide excellent extraction resistance to many fluids. Plasthall LCOA is equivalent to DOP in lowering hardness in PVC and nearly equal to other phthalate esters.

Permanence is the Key!

Plasthall LCOA, when compared to monomeric phthalates and adipates, stands out as an excellent phthalate plasticizer replacement. The data shows that LCOA has excellent

- heat aging properties,
- resistance to humidity,
- extraction resistance to both polar and non-polar fluids.

Another ester that we recommend is PLASTHALL® PR-A100. This adipate ester is a much more efficient ester than DOP and other phthalate esters and could be used at lower levels to achieve the same hardness. Plasthall PR-A100 provides excellent low temperature properties to PVC and NBR. Various combinations of Plasthall PR-A100 and Plasthall LCOA would allow compounders the flexibility of targeting specific physical properties.

Formulation: Krynac 3345C - 100.0, Kadox 920 - 5.0, Flectol TMQ – 1.00,
Stearic Acid – 1.00, N-660 – 65.00, Plasticizer – 20.00

Mill Addition: Sulfur – 0.40, MBTS 2.00, ZDMC

Major Variable	Plasthall LCOA	Plasthall DOA	Plasthall PR-A100	Plasthall DIDP	Plasthall DINP
Processing Properties					
<u>Viscosity and Curing Properties</u>					
<u>Mooney Viscosity at 121°C (250°F)</u>					
Minimum Viscosity	32.9	23.5	23.3	27.6	28.6
t ₅ , minutes	4.6	5.7	5.8	5.7	5.6
<u>Oscillating Disc Rheometer at 170°C (338°F)</u>					
M _L	5.8	4.4	4.3	5.0	5.0
M _H	41.6	32.1	29.2	34.3	34.2
t _c (90), minutes	2.7	2.6	3.0	2.6	2.8
<u>Vulcanizate Properties</u>					
<u>Original Physical Properties</u>					
Stress @ 100% Elongation, MPa	2.0	1.8	1.8	1.9	1.9
Tensile Ultimate, MPa	14.8	13.6	13.4	14.6	14.3
psi	2145	1975	1940	2115	2070
Elongation @ Break, %	595	590	560	620	615
Hardness Duro A, pts.	60	60	58	58	58
<u>Low Temperature Properties</u>					
<u>Low Temperature Impact - Brittleness</u>					
Brittle Point, as molded, all pass, °C	-33	-45	-42	-36	-36
<u>Low Temperature Torsion - Gehman</u>					
<u>As molded, Relative Modulus</u>					
T10, °C	-32	-35	-33	-30	-31
<u>Aged Vulcanizate Properties</u>					
<u>Air Oven Aging, 70h @ 125°C(257°F)</u>					
Stress @ 100% Elongation, MPa	3.0	4.1	3.3	3.0	3.0
Tensile Change, %	8	18	15	2	16
Elongation Change, %	-32	-39	-33	-39	-29
Hardness Duro A, pts	65	75	69	67	66
Hardness Change, pts.	5	15	11	9	8
Weight Change, %	-1.0	-9.9	-4.9	-2.2	-2.7



Major Variable	Plasthall LCOA	Plasthall DOA	Plasthall PR-A100	Plasthall DIDP	Plasthall DINP
Fluid Resistance					
<u>ASTM 1 Oil, 70h @ 125°C</u>					
Stress @ 100% Elongation, MPa	3.0	3.3	3.2	3.5	3.3
Tensile Change, %	10	9	15	7	17
Elongation Change, %	-31	-41	-35	-44	-33
Hardness Duro A, pts	63	70	71	70	72
Hardness Change, pts.	3	10	13	12	14
Volume Change, %	-3.2	-12	-12	-11	-11
Weight Change, %	-3.1	-9.4	-9.8	-9.4	-9.4
<u>IRM 903 Oil, 70h @ 125°C</u>					
Stress @ 100% Elongation, MPa	2.5	2.7	2.8	2.9	2.6
Tensile Change, %	-2	5	2	0	5
Elongation Change, %	-35	-38	-38	-44	-31
Hardness Duro A, pts	57	62	62	60	60
Hardness Change, pts.	-3	2	4	2	2
Volume Change, %	9.8	4.4	3.5	3.7	4.0
Weight Change, %	6.7	3.0	2.6	2.2	3.0
<u>Distilled Water, 70h @ 100°C</u>					
Stress @ 100% Elongation, MPa	2.4	2.4	2.1	2.4	2.3
Tensile Ultimate, MPa	15.5	13.1	13.2	14.0	14.9
, psi	2245	1905	1910	2035	2155
Tensile Change, %	5	-4	-2	-4	4
Elongation @ Break, %	475	420	450	430	485
Elongation Change, %	-20	-29	-20	-31	-21
Hardness Duro A, pts	58	55	55	57	55
Hardness Change, pts.	-2	-5	-3	-1	-3
Volume Change, %	6.3	3.7	4.6	3.8	3.9
Weight Change, %	5.3	3.2	4.1	3.3	3.5



**PVC Formulation: PVC Resin - 100.0, Stabilizer - 1.0, ESO - 5.0,
Plasticizer - 67.0**

	Plasthall LCOA	Plasthall PR-A100	Plasthall DIDP	Plasthall DOP
<u>Original Physical Properties</u>				
Stress @ 100% Elong., MPa	5.9	6.6	7.4	6.2
Tensile Strength, psi	2295	1950	2300	2295
Elongation @ Break, %	415	380	405	415
Hardness Duro A, pts.	65	67	70	65
<u>Low Temperature Impact</u>				
Brittle Point, °C	-24	-53	-32	-30
<u>Low Temperature Torsion - Gehman</u>				
T-45,000 psi, °C	-27	-46	-40	-44
T-135,000 psi, °C	-39	-61	-52	-53
<u>Air Oven Aging, 3 days @ 121°C*</u>				
Tensile Change, %	0*	-1	-3	17
Elongation Change, %	-11*	-25	-11	-45
Weight Change, %	-2.6*	-12	-3.3	-20
*Air Oven, 3 days @ 136°C				
<u>9d Humidity, Dry Out 1hr @ 90°C</u>	-0.3	-4.1	-1.0	-1.0
<u>Immersion/Extraction, Percent Weight Change After:</u>				
Hexane Dry Out, 4hrs @ 70°C	-6.6	-34	-35	-34
Cottonseed Oil, 24hrs @ 60°C	-7.8	-28	-21	-19
Distilled Water Dry Out, 24hrs @ 60°C	-0.8	-1.9	-1.1	-0.6
1% Soapy Water 7d @ 90°C, DO	-3.3	-10	-5.9	-15

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L O C A T I O N S

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