

Phthalate Alternatives Comparison in PVC

Introduction

With environmental concerns becoming more important, the desire to remove phthalates from polymer compounds in the EU and US is rapidly increasing. With the Plasthall® line of plasticizers, Hallstar is on the leading edge of phthalate replacement technology and has several commercially available phthalate alternatives/replacements for use in all types of polymer applications, especially polyvinyl chloride (PVC) and synthetic elastomers. These economical products offer the same or improved functional benefits as phthalates, without the environmental problems. Our newest phthalate replacement is Plasthall® PR-A610. This ester plasticizer is based 100 percent on renewable raw material streams.

In this study, Hallstar evaluated our phthalate alternatives Plasthall® PR-A217, Plasthall® PR-A200, Plasthall® LCOA and Plasthall® PR-A610 versus Hexamoll® DINCH and Palatinol® DPHP from BASF and Mesamoll® II from Lanxess, as well as industry standards DINP and DOP. The test recipe consists of 100 PPHR of a calendaring grade PVC resin, 7.0 PPHR of a heavy metals-free stabilizer system and 67 PPHR of plasticizer. Compounds were tested using our full battery of PVC tests.

Performance Study

Data for original physicals indicates that Plasthall® PR-A200 has the greatest plasticizing efficiency relative to all other plasticizers evaluated in this study, as indicated by the lowest value for the 100 percent modulus, the lowest compound durometer (hardness, Shore A) and the highest value for elongation at break. Plasthall PR-A200 is excellent for efficiency properties because its compound softening capabilities are better than all the other plasticizers tested. Its viscosity is comparable to DINP and DOP, which would not require any changes to the handling procedures.

Upon examining the results for low-temperature brittleness, Plasthall® PR-A200 was found to have the best low temperature (-44 °C), with Hexamoll® DINCH® being second best.

Air oven aging results indicate that Plasthall® LCOA has the best volatility characteristics, with Plasthall® PR-A610 performing better than all the other offerings. All plasticizers have excellent permanence following exposure to humid environments. The extraction results indicate LCOA is the most permanent of all the plasticizers in the study, except for the soapy water extraction, where Palatinol® DPHP is slightly less extractable than LCOA. With respect to non-polar mediums, such as hexane and cottonseed oil, LCOA far exceeds the performance of either DINP or DOP.

When looking at the overall performance of the phthalate replacements and assigning a rating system, the ranking would be as follows: Plasthall® LCOA, Plasthall® PR-A217, Plasthall® PR-A200, Mesamoll II, Plasthall® PR-A610, Palatinol® DPHP and Hexamoll® DINCH®.

Compound Properties

PVC K-65	100.0
Plasticizer Variable	67.0
Stabilizer – heavy-metal-free system	7.0

Performance Color Key

FIRST	SECOND
-------	--------

	Plasthall®				Mesamoll®	PalatinoI®	Hexamoll®	
	PR-A217	PR-A200	LCOA	PR-A610	II	DPHP	DINCH®	DOP
Plasticizer Viscosity at 25°C, cPs	250	60	950	52		122	52	57
Original Physical Properties								
100% Modulus, MPa	6.3	5.0	6.1	6.5	6.5	7.1	6.7	6.1
100% Modulus, MPa	9.8	7.7	9.7	10.1	10.0	10.2	9.7	9.2
100% Modulus, MPa	12.6	10.1	12.6	13.0	13.1	12.4	12.1	11.9
Tensile Strength, MPa	14.7	14.3	15.9	15.8	16.3	14.5	14.3	14.8
Elongation at Break, %	376	495	410	400	405	402	386	408
Hardness, Shore A, pts.	67	63	65	69	67	68	68	66
Specific Gravity	1.236	1.207	1.295	1.223	1.244	1.192	1.185	1.203
Tg, °C	-22.7	-32.0	-22.6	-41.1	-26.3	-32.4	-37.7	-27.8
Low Temperature Impact:								
Brittleness								
Brittle Point, °C	-27	-44	-25	-31	-25	-30	-39	-30
Volatility Resistance, 3d at 36°C								
Tensile Strength, MPa	15.1	17.8	16.1	16.4	18.1	16.2	19.1	17.0
Tensile Change, %	+3	+24	+1	+4	+11	+12	+34	+15
Elongation at Break, %	350	418	430	380	280	230	50	125
Elongation Change, %	-7	-16	+5	-5	-31	-43	-87	-69
Retention of Elongation, %	93	84	105	95	69	57	13	31
Hardness, Shore A, pts.	67	63	63	62	73	72	75	92
Hardness Change, pts.	0	+10	-2	-7	+6	+4	+7	+26
Weight Change, %	-4.9	-13	-2.1	-4.2	-14	-8.7	-19	-30

Extraction: Mediums as noted

Weight Change, %

Hexane, % 24h at 23°C, DO

Cottonseed Oil, 24h at 70°C

Distilled Water, 24h at 90°C, DO

1% Soapy Water, 7d at 90°C, DO

Humid Environment, 9d at 90°C, DO

-10.2	-22	-6.2	-27	-19	-32	-31	-30
-9.9	-17	-8.4	-20	-11	-17	-20	-14
-0.8	-1.4	-0.4	-1.4	-0.5	-0.6	-1.4	-0.8
-6.8	-8.4	-3.7	-12	-2.8	-2.1	-3.4	-6.8
-0.5	-1.0	-0.2	-0.7	-0.2	-0.4	-0.6	-0.4