Eastman 168™ non-phthalate plasticizer with secondary plasticizers

Secondary plasticizers are typically aliphatic, aromatic, and naphthenic hydrocarbons used in plastisol applications. They generally have a lower cost compared to general-purpose plasticizers, which helps to optimize plastisol formulation cost. Secondary plasticizers are also used to adjust plastisol viscosity for proper processing of the material. However, many of these secondary plasticizers are not completely compatible in finished vinyl and cannot be used by themselves as the sole plasticizer. Incompatibility can be seen in the form of exudation and crease whitening.

Formulations and experimental data

The compatibility of secondary plasticizers in plastisols using Eastman 168™ non-phthalate plasticizer was investigated. Basic plastisol formulations containing Eastman 168, PVC resin, a heat stabilizer, and varying levels of secondary plasticizers were analyzed for compatibility. See Tables 1 and 2 for a description of the compositions used in these tests.

Table 1 Formulations

Formulation	Phr (parts per hundred resin)
Eastman 168™ non-phthalate plasticizer	60
Secondary plasticizer	5, 10, 15
Oxy™ 654 PVC dispersion resin, 71 K value	100
Akcrostab™ LT 4798 (Ba/Zn) heat stabilizer	3

Table 2 Secondary plasticizers used in experiment

Secondary plasticizer	CAS #
Jayflex™ 210 (Naphthenic hydrocarbon)	64742-53-6
Jayflex™ 215 (Aliphatic hydrocarbon)	64771-82-8
Mineral spirits	—
Mineral seal oil	—
Epoxidized soybean oil	8013-07-8
Eastman TXIB™ formulation additive	6846-50-0
Cereclor™ S45 C14-17 chlorinated paraffin (45% chlorine)	085535-85-9
Cereclor™ S52 C14-17 chlorinated paraffin (52% chlorine)	085535-85-9
Viscobyk™ 4040 (Aliphatic hydrocarbons[a])	—
Viscobyk™ 5050 (Low volatile carboxylic acid derivates[b])	—
Exxsol™ D80 (Dearomatized aliphatic hydrocarbon solvent[c])	64742-47-8
Exxsol™ D95 (Dearomatized aliphatic hydrocarbon solvent[d])	64742-47-9

[a]*With neutral wetting and dispersing component* [b]*+ Acidic wetting and dispersing components*
[c]*Initial BP 406°F, dry point 457°F* [d]*Initial BP 441°F, dry point 487°F*

Plastisols were prepared in Hobart mixers using low shear paddles. Mixing time was 25 minutes, followed by deaeration of the plastisols. Vinyl sheets 0.07″-thick were fused in a convection oven for 20 minutes @ 375°F. Loop compatibility tests were performed from samples of each formulation. A small piece of vinyl from each 0.07″-thick sheet was bent and held in position. The outside diameter of looped sample was 5/16″. Looped samples were checked after one hour, one day, and one week for any sign of exudation by wiping the inside of the loop with cigarette paper. Conditioning and testing were performed in an ambient temperature laboratory.

The following ratings were given for the level of exudation observed:

0 = no exudation **1 = slight exudation** **2 = moderate exudation** **3 = heavy exudation**

Table 3 One hour compatibility

Secondary plasticizer	5 phr	10 phr	15 phr
Jayflex™ 210 (Naphthenic hydrocarbon)	0	0	0
Jayflex™ 215 (Aliphatic hydrocarbon)	1	2	3
Mineral spirits	0	0	0
Mineral seal oil	0	0	2
Epoxidized soybean oil	0	0	0
Eastman TXIB™ formulation additive	0	0	0
Cereclor™ S45 C14-17 chlorinated paraffin (45% chlorine)	0	0	0
Cereclor™ S52 C14-17 chlorinated paraffin (52% chlorine)	0	0	0
Viscobyk™ 4040 (Aliphatic hydrocarbons[a])	0	0	0
Viscobyk™ 5050 (Low volatile carboxylic acid derivates[b])	1	1	2
Exxsol™ D80 (Dearomatized aliphatic hydrocarbon solvent[c])	1	1	1
Exxsol™ D95 (Dearomatized aliphatic hydrocarbon solvent[d])	1	1	1

[a]*With neutral wetting and dispersing component* [b]*+ Acidic wetting and dispersing components*
[c]*Initial BP 406°F, dry point 457°F* [d]*Initial BP 441°F, dry point 487°F*

Table 4 One day compatibility

Secondary plasticizer	5 phr	10 phr	15 phr
Jayflex™ 210 (Naphthenic hydrocarbon)	0	0	1
Jayflex™ 215 (Aliphatic hydrocarbon)	2	3	3
Mineral spirits	0	0	0
Mineral seal oil	0	1	3
Epoxidized soybean oil	0	0	0
Eastman TXIB™ formulation additive	0	0	0
Cereclor™ S45 C14-17 chlorinated paraffin (45% chlorine)	0	0	1
Cereclor™ S52 C14-17 chlorinated paraffin (52% chlorine)	0	0	1
Viscobyk™ 4040 (Aliphatic hydrocarbons[a])	0	1	1
Viscobyk™ 5050 (Low volatile carboxylic acid derivates[b])	1	1	2
Exxsol™ D80 (Dearomatized aliphatic hydrocarbon solvent[c])	1	1	1
Exxsol™ D95 (Dearomatized aliphatic hydrocarbon solvent[d])	2	2	2

[a]*With neutral wetting and dispersing component* [b]*+ Acidic wetting and dispersing components*
[c]*Initial BP 406°F, dry point 457°F* [d]*Initial BP 441°F, dry point 487°F*

Table 5 One week compatibility

Secondary plasticizer	5 phr	10 phr	15 phr
Jayflex™ 210 (Naphthenic hydrocarbon)	0	0	1
Jayflex™ 215 (Aliphatic hydrocarbon)	2	3	3
Mineral spirits	0	0	0
Mineral seal oil	0	1	3
Epoxidized soybean oil	0	0	0
Eastman TXIB™ formulation additive	0	0	0
Cereclor™ S45 C14-17 chlorinated paraffin (45% chlorine)	0	0	2
Cereclor™ S52 C14-17 chlorinated paraffin (52% chlorine)	0	0	2
Viscobyk™ 4040 (Aliphatic hydrocarbons[a])	1	1	2
Viscobyk™ 5050 (Low volatile carboxylic acid derivates[b])	1	2	2
Exxsol™ D80 (Dearomatized aliphatic hydrocarbon solvent[c])	1	1	0*
Exxsol™ D95 (Dearomatized aliphatic hydrocarbon solvent[d])	2	1	0*

**Exudate may have evaporated over the course of test period due to volatility of secondary.*

[a]With neutral wetting and dispersing component [b]+ Acidic wetting and dispersing components
[c]Initial BP 406°F, dry point 457°F [d]Initial BP 441°F, dry point 487°F

Conclusion

The secondary plasticizers used in this experiment have varying levels of compatibility in a plastisol containing Eastman 168™ non-phthalate plasticizer. This is dependent on the structure of the secondary and the level used. Highly aliphatic products are less compatible than aromatic and/or more polar products when used in PVC plasticized with Eastman 168 non-phthlate plasticizer. Proper laboratory experimentation should be performed to determine the compatibility of secondary plasticizers with Eastman 168 in other formulations and with other secondary plasticizers not listed in Table 5.

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