EASTMAN

Eastman plasticizer alternatives for *ortho*-phthalate plasticizers

Industrial coating manufacturers often formulate coatings with a small amount of plasticizers to enhance properties such as cold check and thermal expansion/contraction. For lacquer systems like those in wood coating applications, ExxonMobil Jayflex™ DINP and others have been an industry standard. DINP, however, is in the class of *ortho*-phthalate plasticizers which have come under increasing scrutiny and regulation because of toxicity concerns.

Eastman Chemical Company has a broad portfolio of non-*ortho*-phthalate plasticizer alternatives. As with any coating, plasticizer performance efficiencies are often dictated by the solubility and compatibility with resin and solvent in the formulation and care should be taken in their selection.

Benefits and features derived from the use of Eastman plasticizers

- A non-*ortho*-phthalate alternative is available that closely matches performance requirements of the plasticizer in your current coating formulation. (The term "phthalates" is generally accepted to mean "*ortho*-phthalates.")
- Diisononyl phthalate (DINP) alternatives can be suggested depending on your current coating system.
- Eastman Optifilm™ enhancer 400, a low-VOC coalescing aid that also performs very efficiently as a plasticizer in some coating systems, reduces usage levels and cost.
- Optifilm 400 offers a very low-VOC alternative that can help meet Green Seal standards.

Table 1.
Eastman alternative plasticizers

	Specific gravity	Boiling point, °C
Plasticizers		
Eastman TXIB™ formulation additive	0.945	281
Eastman 168™ non-phthalate plasticizer	0.984	375
Eastman DOA plasticizer	0.927	417
Eastman 425 plasticizer	1.029	>300
Eastman TOTM plasticizer	0.989	414
Eastman Sustane™ SAIB	1.146	n/a
Coalescing aid		
Eastman Optifilm™ enhancer 400	0.967	374 – 381

Comparison data
Example 1—Matching DINP hardness and flexibility in a nitrocellulose/alkyd clear coat

This technical tip demonstrates the effects that plasticizers have on hardness, flexibility, and T_g reduction using DINP as a control. In the first example, the test plasticizers were formulated in a standard nitrocellulose/alkyd clear coat while monitoring their coating hardness and flexibility by the Konig pendulum and conical mandrel, respectively. The results in Chart 1 show Optifilm 400 is the most efficient option for this formula, which is 67% more efficient on softening the film than DINP, based on linear regression analysis on the calculated amount of plasticizer to theoretically achieve 100 oscillations. Eastman TOTM plasticizer is more efficient than DINP as well. Although the results are more subjective and less precise than pendulum hardness values, the conical mandrel bend test also shows Optifilm 400 improves the coating flexibility over DINP (see Chart 2). The conical mandrel samples were produced by casting films that contained the same level of plasticizer on aluminum panels. In this particular coating, Eastman 168™ non-phthalate plasticizer and Eastman Sustane™ SAIB were less efficient but these could be blended with the other Eastman plasticizers to produce a blend that could be utilized as a direct drop-in replacement for DINP.

Chart 1.

Plasticizer efficiency based on extrapolated pendulum hardness data

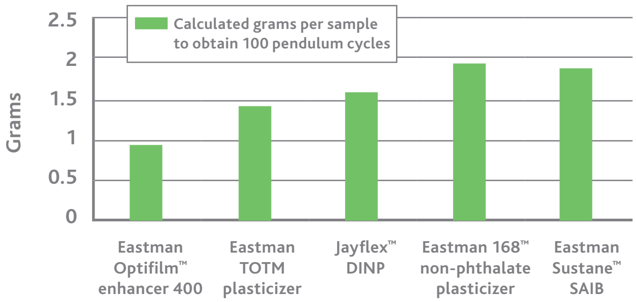
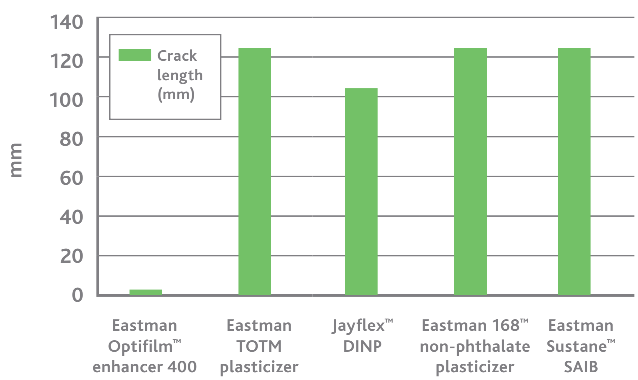


Chart 2.

Conical mandrel results at 3% addition level

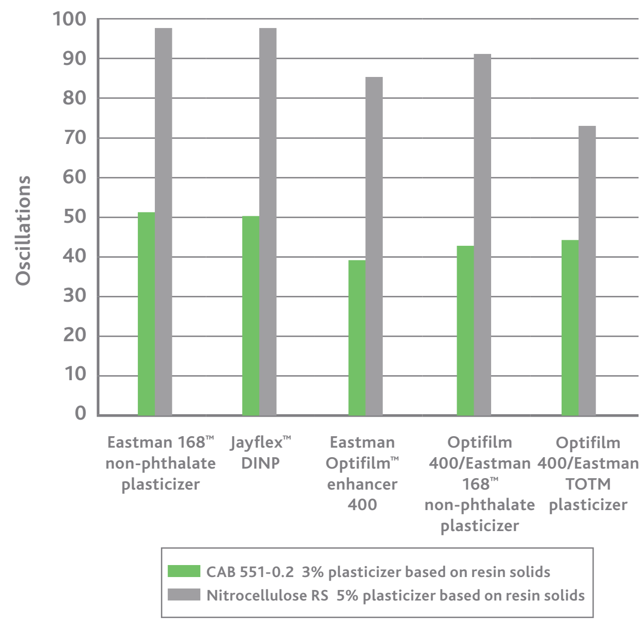


Example 2—Performance in pigmented N/C-acrylic and CAB-acrylic systems

The next set of evaluations involved the testing of Eastman plasticizers with a couple of blends in two lacquer formulas. These formulas were white lacquer formulas with either Eastman CAB 551-0.2 and Rohm and Haas Paraloid™ B-66 or a blend of nitrocellulose ¼ and ½ RS and Paraloid™ B-66. The test methods used were pendulum hardness and conical mandrel for flexibility. A higher number of oscillations means the coating is harder and the plasticizer is less effective in this system. Chart 3 indicates that Eastman 168™ non-phthalate plasticizer has the same effect as Jayflex™ DINP in both lacquer systems. The other Eastman plasticizers were more efficient in this system since the test results show that the films were softer. Slight adjustments in the plasticizer levels would increase the hardness in the CAB 551-0.2 films. None of the combinations tested in the CAB-acrylic system revealed any cracking during the conical mandrel tests. The results are different in the nitrocellulose formula. Most of the coatings had similar hardness values except for the nitrocellulose formulas containing Eastman Optifilm™ enhancer 400 and the blend of Optifilm 400 and Eastman TOTM plasticizer which were more efficient than the others.

Chart 3.

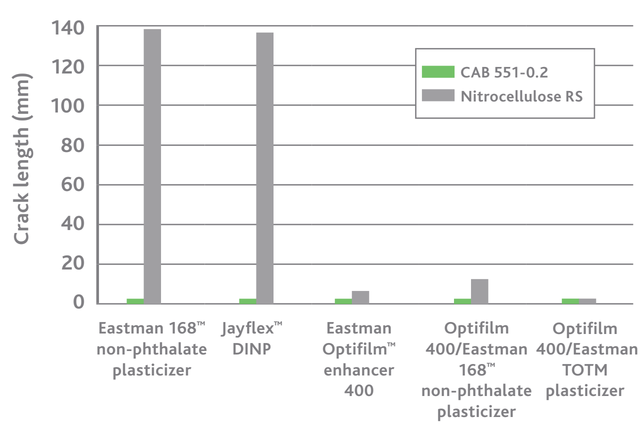
Pendulum hardness of white lacquer coatings



Again, the conical mandrel results did not distinguish between the performance of the plasticizer as well as the hardness values did, especially with the CAB coatings. The nitrocellulose coatings show an improvement in flexibility with the sample containing Optifilm 400 and the two (75%/25%) blends of Optifilm 400/ Eastman 168™ non-phthalate plasticizer and Optifilm 400/TOTM.

Chart 4.

Conical mandrel results of white lacquer



Example 3—Compatibility of Eastman plasticizers with selected Eastman cellulose esters and Eastman Solus™ performance additive

Eastman cellulose esters have historically been used as co-resins in many lacquer systems, especially in wood formulations where they enhance many of the drying and performance properties. Plasticizers are often incorporated into those systems to provide flexibility in the lacquer. The data in Table 2 provides the relative compatibility and efficiency in reducing the polymer's T_g when incorporated into commonly used mixed cellulose esters and Eastman performance additives. Occasionally, hydrocarbon resins are incorporated into coatings for a variety of reasons, including usage as a plasticizer substitute. Piccolastic™ A-5 hydrocarbon resin, a low MW aromatic hydrocarbon tackifier, is also compatible with the cellulose esters that were evaluated.

Table 2.

Compatibility of cellulose esters with various plasticizers, Eastman Optifilm™ enhancer 400 (a low-VOC coalescing aid), and Piccolastic™ A-5 tackifier

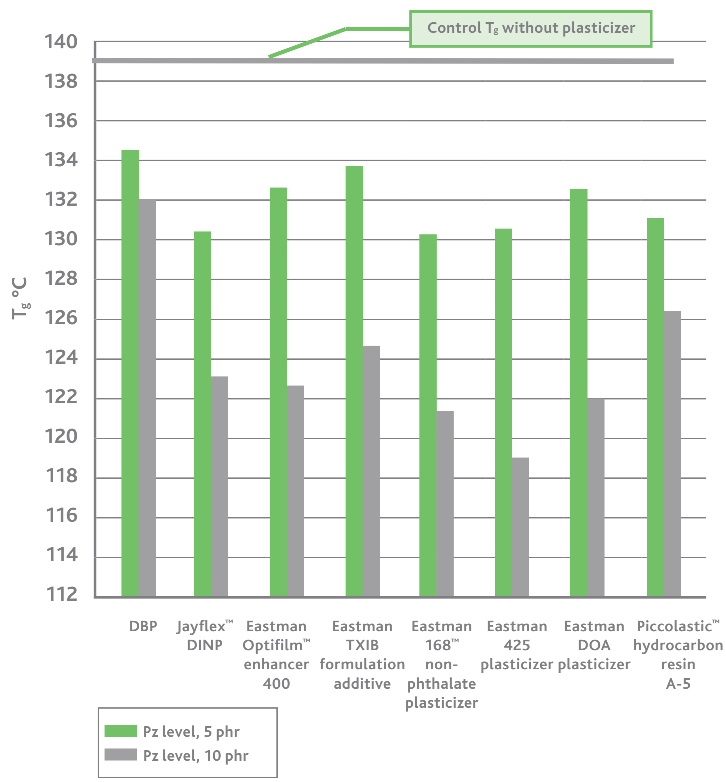
	Eastman CAB 551-0.2		Eastman CAB 381-0.5		Eastman Solus™ 2100 performance additive		Eastman Solus™ 2300 performance additive	
	4 phr	8 phr	5 phr	10 phr	3 phr	6 phr	4 phr	8 phr
Eastman Optifilm™ enhancer 400	✓	✓	✓	✓	✓	✓	✓	✓
Eastman TXIB™ formulation additive	✓	✓	✓	✓	✓	✓	✓	✓
Eastman 168™ non-phthlalate plasticizer	✓	✓	✓	✓	✓	✓	✓	✓
Eastman 425 plasticizer	✓	✓	✓	✓	✓	✓	✓	✓
Eastman DOA plastcizer	✓	✓	✓	✓	✓	✓	✓	✓
Piccolastic™ hydrocarbon resin A-5	✓	✓	✓	✓	✓	✓	✓	✓
DBP	✓	✓	✓	✓	✓	✓	✓	✓
Jayflex™ DINP	✓	✓	✓	✓	✓	✓	✓	✓

To measure the efficacy on reducing the T_g, dried films from the CAB 381-0.5 were tested by the Dynamic Mechanical Thermal Analysis (DMTA) method. Chart 5 reflects the change in T_g from the original control film of CAB 381-0.5 without any plasticizer. The two control plasticizers, DBP and DINP, have different efficiencies in reducing the T_g of CAB 381-0.5. A Pz level of 5 phr of DINP yields T_g reduction equivalent to 10 phr of DBP. Alternative plasticizers were tested at both 5 phr and 10 phr for comparison.

While Eastman offers several alternatives to Jayflex™ DINP with similar ability to reduce the coating's T_g, it is recommended that formulators conduct a more complete evaluation to ensure that the desired performance properties are met.

Chart 5.

T_g reduction of CAB 381-0.5 with various alternatives



Eastman's value proposition

Eastman offers a broad range of plasticizers ready to meet the demands of today's coatings market. If a non-*ortho*-phthalate replacement is what you need, Eastman products and technical expertise are here for you. If you need a plasticizer that is effective in both waterborne and solventborne coatings, Eastman is here for you. If you need a plasticizer that is low in VOCs but high on performance, Eastman is here for you. Eastman provides high quality products to enable your company to meet current and future performance and regulatory needs. Industry coatings requirements are constantly changing. What doesn't change is our dedication to providing high quality products and reliable technical service to our customers around the world. Visit our website at www.eastman.com or call us at **1-800-EASTMAN**. Your coatings solutions are just a click or phone call away.

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The results of **insight**™

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