

## Compatibility of Various Plasticizers With Airflex® 400 Emulsion

### Summary

A number of plasticizers were evaluated at 20 PPHR and 50 PPHR per 100 PPHR Airflex® 400 emulsion. Plasticizer compatibility was rated qualitatively by judging the clarity, gloss and surface appearance of a dried sample of emulsion. Emulsion stability was also evaluated by visual inspection of the emulsion for evidence of surface films, separation or settling of the plasticizer. Twenty-three plasticizers were tested. Plasticizers rated as having good to excellent compatibility and good to excellent emulsion stability were Benzoflex® 50, Santicizer® 160, Kronitex® 100, Plasthall® BSA, TegMeR® 804, Plasthall® 220, Plasthall® 226, KP®-140, Plasthall® P-622 and Hercoflex® 900. It is unlikely that any of the C.P. Hall products can compete with Benzoflex® 50 or Santicizer® 160 on a cost basis. This makes it necessary to determine if any of the Hallstar products can provide a performance property that cannot be obtained with Benzoflex® 50 or Santicizer® 160. A more detailed knowledge of application needs would be helpful in designing meaningful performance property testing.

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### Compatibility of Various Plasticizers With Airflex® 400 Emulsion

The effects of 21 plasticizers on emulsion viscosity and adhesive peel strength to a limited number of substrates of Airflex® 426 emulsions were examined in a previous study. Plasticizers were evaluated at the 10 PPHR level. Results showed few significant differences in performance for the group of plasticizers tested. One conclusion reached as a result of that work was that a simple test was needed to screen plasticizers being considered for evaluation with a given water-borne adhesive base. It was decided that plasticizer compatibility with the adhesive should be tested to determine if compatibility could be used as an effective screening device, thus eliminating the need to run unnecessary application tests. Airflex® 400, a general purpose VAE copolymer emulsion, was chosen as the emulsion with which to test the plasticizer compatibility of 23 plasticizers.

### Experimental

Plasticized emulsions were prepared by mixing the proper amount of plasticizer and Airflex® 400 in a beaker with the aid of a lightning mixer. Plasticizers were evaluated at 20 PPHR and 50 PPHR based on 100 PPHR Airflex® 400 emulsion. Plasticized

emulsions were diluted with water to lower emulsion viscosity and to enable the casting of air-free samples. Emulsions were mixed for a total of 30 min. The resulting emulsion was aged a minimum of one day ambient conditions and then visually observed for separation or other evidence of instability. Samples of dried emulsion were prepared by casting in an aluminum weighing dish. A three day air dry in ambient conditions was followed by a 14 day dry at 50 °C. Dried discs were then judged for clarity and surface appearance.

## Conclusion

Emulsion stability and plasticizer compatibility results suggest only a limited number of the C.P. Hall products tested merit further evaluation in Airflex<sup>®</sup> 400 emulsion. These plasticizers are Kronitex<sup>®</sup> 100, KP<sup>®</sup>-140, Plasthall<sup>®</sup> BSA, Plasthall<sup>®</sup> 220, Plasthall<sup>®</sup> P-622 and TegMeR<sup>®</sup> 804 and are considered the candidates best suited for use with this emulsion. The cost of Benzoflex<sup>®</sup> 50 and Santicizer<sup>®</sup> 160 makes it unlikely that any of the C.P. Hall plasticizers can compete on a cost basis. Therefore, C.P. Hall products will not be of interest unless they provide a desired performance property that cannot be obtained when using Benzoflex<sup>®</sup> 50 or Santicizer<sup>®</sup> 160. A more detailed knowledge of application needs is needed to design meaningful performance property testing.

## Discussion

Compatibility testing did not provide the definitive results hoped for when testing was started. However, there are significant differences in compatibility among the group of plasticizers tested. The test does provide a useful although imprecise measure of compatibility. A qualitative rating of plasticizer compatibility with Airflex<sup>®</sup> 400 was made based on clarity, gloss and surface dryness of the dry, plasticized emulsion. Four categories were used to rate relative plasticizer compatibility. None of the manufactured Hallstar esters tested appear as compatible with Airflex<sup>®</sup> 400 as Benzoflex<sup>®</sup> 50 or Santicizer<sup>®</sup> 160. Relative compatibility ratings are listed in Table I.

**TABLE I**  
**Relative Plasticizer Compatibility with Airflex® 400**

**Compatibility Rating and Dry Emulsion Appearance at  
~50 PPHR Plasticizer/100 PPHR Airflex® 400 Emulsion**

<b><u>BEST</u></b> <b>Transparent</b>	<b><u>GOOD</u></b> <b>Translucent</b>	<b><u>FAIR</u></b> <b>Opaque</b>	<b><u>POOR</u></b> <b>Greasy</b>
Benzoflex® 50 Santicizer® 160 Kronitex 100 Plasthall® BSA	TegMeR® 804 Plasthall® 220 Plasthall® 226 KP®-140 Plasthall® P-622 Hercoflex® 900 Paraplex® G-57 Plasthall® P-1070	Hallstar-79-n Plasthall® P-612 Plasthall® P-670m Plasthall® P-550 Paraplex® G-50	Plasthall® DOA Plasthall® DOP Plasthall® 810-TM-E Monoplex® S-73

Plasticized emulsions were diluted with water to reduce viscosity, aid air release and thereby provide air-free samples of dried emulsion. Plasticizer choice had a significant influence on the stability of the diluted emulsions. Unstable emulsions were characterized by oily surface films, the formation of several layers in the emulsion or the settling of the plasticizer to the bottom of the emulsion. Emulsion stability was rated as excellent, good or poor based on visual inspection. Ratings are listed in Table II.

**TABLE II**  
**Relative Stability of Plasticized Airflex® 400 Emulsions**  
(Based on observations 1–5 days after preparation)

<b><u>EXCELLENT</u></b>	<b><u>GOOD</u></b>	<b><u>POOR</u></b>
Benzoflex® 50 Santicizer® 160 Plasthall® BSA TegMeR® 804 Plasthall® 220 Plasthall® 226 KP®-140 Hercoflex® 900	Kronitex® 100 Plasthall® P-622	Monoplex® S-73 Paraplex® G-50 Paraplex® G-57 Plasthall® DOA Plasthall® DOP Plasthall® P-550 Plasthall® P-612 Plasthall® P-670M Plasthall® P-1070 Plasthall® 810-TM-E RX-13215 RX-13216



Airflex® 400	100	100	100	100	100	100
Water	50	100	20	50	20	50
Hallstar-79-N	25	50	-	-	-	-
Plasthall® 220 (DBEEP)	-	-	21	50	-	-
Plasthall® 226 (DBEEA)	-	-	-	-	20	56
<b>TOTAL</b>	<b>175</b>	<b>50</b>	<b>141</b>	<b>200</b>	<b>140</b>	<b>206</b>

<b>Plasticizer</b>	<b>Hallstar-79-N</b>	<b>Hallstar-79-N</b>	<b>DBEE P</b>	<b>DBEE P</b>	<b>DBEEA</b>	<b>DBEEA</b>
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## Emulsion Stability

at 1 d	E	E	E	E	E	E
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## Plasticizer Compatibility with dry emulsion

Clarity	O	O	TL	TL	TL	TL
Gloss	D	D	HG	HG	HG	HG

## **Recipe FF10-264**

<b>Airflex® 400</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>
<b>Water</b>	<b>20</b>	<b>so</b>	<b>20</b>	<b>50</b>	<b>20</b>	<b>50</b>
<b>Plasthall® DOA</b>	<b>20</b>	<b>52</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>Plasthall® DOP</b>	<b>-</b>	<b>-</b>	<b>22</b>	<b>50</b>	<b>-</b>	<b>-</b>
<b>Monoplex® S-73</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>20</b>	<b>50</b>
<b>TOTAL</b>	<b>140</b>	<b>202</b>	<b>142</b>	<b>200</b>	<b>140</b>	<b>200</b>

<b>Plasticizer</b>	<b>DOA</b>	<b>DOA</b>	<b>DOP</b>	<b>DOP</b>	<b>S-73</b>	<b>S-73</b>
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## Emulsion Stability

## **Recipe FF10-269**

<b>Airflex® 400</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>
<b>Water</b>	<b>20</b>	<b>50</b>	<b>20</b>	<b>50</b>	<b>20</b>	<b>50</b>
<b>Hercoflex® 900</b>	<b>20</b>	<b>50</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>RX-13215</b>	<b>-</b>	<b>-</b>	<b>20</b>	<b>50</b>	<b>-</b>	<b>-</b>
<b>RX-13216</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>20</b>	<b>50</b>
<b>TOTAL</b>	<b>140</b>	<b>200</b>	<b>140</b>	<b>200</b>	<b>140</b>	<b>200</b>

<b>Plasticizer</b>	<b>H-900</b>	<b>H-900</b>	<b>RX-13215</b>	<b>RX-13215</b>	<b>RX-13216</b>	<b>RX-13216</b>
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## Emulsion Stability

at 1 d	-	-	-	-	-	-
at 3 d	-	-	G	P	-	-
at 5 d	E	E	-	-	G	P

## **Plasticizer Compatibility with Dry Emulsion**

Clarity

Gloss

at 1 d

at 3 d

at 5 d

-	-	-	-	-	-
E	P	E	P	E	P

## **Plasticizer Compatibility with Dry Emulsion**

Clarity

Gloss

O	O	TL	TL	O	O
D	G	LG	G	LG	G

## **Rating Key**

### **Clarity:**

T = Transparent

TL = Translucent

O = Opaque

### **Gloss:**

HG = High Gloss

LG = Low Gloss

D = Dull or No Gloss

G = Greasy

### **Discoloration:**

Y = Yellow

### **Emulsion Stability:**

E = Excellent

G = Good

P = Poor