

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

### Summarv

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<sup>®</sup> 50, Santicizer<sup>®</sup> 160, Kronitex<sup>®</sup> 100, Plasthall<sup>®</sup> BSA, TegMeR<sup>®</sup> 804, Plasthall<sup>®</sup> 220, Plasthall<sup>®</sup> 226, KP<sup>®</sup>-140, Plasthall<sup>®</sup> P-622 and Hercoflex<sup>®</sup> 900. It is unlikely that any of the C.P. Hall products can compete with Benzoflex<sup>®</sup> 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<sup>®</sup> 50 or Santicizer<sup>®</sup> 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<sup>®</sup> 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® 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® 50 and Santicizer® 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® 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

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

EXCELLENT	GOOD	<u>POOR</u>
Benzoflex <sup>®</sup> 50 Santicizer <sup>®</sup> 160 Plasthall <sup>®</sup> BSA TegMeR <sup>®</sup> 804 Plasthall <sup>®</sup> 220 Plasthall <sup>®</sup> 226 KP <sup>®</sup> -140 Hercoflex <sup>®</sup> 900	Kronitex <sup>®</sup> 100 Plasthall <sup>®</sup> 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



Monoplex<sup>®</sup>, Paraplex<sup>®</sup> and Plasthall<sup>®</sup> are registered trademarks of Hallstar.

The stability of Airflex® 400 emulsions containing 50 PPHR of either P-550 or G-50 was tested at two levels of dilution with water. At 15 PPHR of added water, no visual evidence of emulsion instability was observed. At 50 PPHR of added water, the plasticizer quickly settled to the bottom of the emulsion. There are several reasons this behavior could occur. At some future point, we may want to determine if preemulsification of the plasticizer can prevent emulsion instability that occurs with certain plasticizers when the plasticized emulsion is highly diluted with water.

The usefulness of the compatibility test can be improved by casting emulsions such that dried emulsion samples have similar thickness within any series being compared. It is not believed that the variations in thickness of samples evaluated in this study significantly influence compatibility ratings. Aluminum weighing dishes are not the best "mold" to use for the preparation of dried emulsion samples. Clear polystyrene petri dishes are a better choice and should allow for relatively easy removal of the dried emulsion from the dish. Relatively thick samples should be used in evaluating plasticizer compatibility with various emulsions. This will make differences among plasticizers more apparent. A suggested target thickness is 175 ± 10 mils.

DATA Purpose: Evaluate compatibility of various plasticizers with Airflex<sup>®</sup> 400 emulsions

Recipe FF10-262	<u>0</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>
Airflex <sup>®</sup> 400 Water Benzoflex <sup>®</sup> 50 Santicizer <sup>®</sup> 160 TegMeR <sup>®</sup> 804	100 - - - -	100 40 40	100 100 100	100 15 - 20	100 35 - 50	100 20 - - 20	100 50 - - 50
TOTAL	100	180	300	135	185	140	200
Plasticizer	None	Ben 50	Ben 50	San 160	San 160	Teg 804	Teg 804
Emulsion Stability at 1 d at 3 d at 5 d	E E E	- E -	E -	- - E	- - E	- - E	- - E
Plasticizer Compatibility with dry emulsion Clarity Gloss	TL HG	T HG	T HG	T HG	T HG	TL LG	TL LG
Recipe FF10-263		<u>7</u>	<u>8</u>	<u>9</u>	<u>10</u>	<u>11</u>	<u>12</u>



Airflex <sup>®</sup> 400 Water Hallstar-79-N Plasthall <sup>®</sup> 220 (DBEEP) Plasthall <sup>®</sup> 226 (DBEEA)	100 50 25 -	100 100 50	100 20 - 21	100 50 - 50	100 20 - - 20	100 50 - - 56
TOTAL	175	50	141	200	140	206
Plasticizer	Hallstar -79-N	Hallstar- 79-N	DBEE P	DBEE P	DBEEA	DBEEA
Emulsion Stability at 1 d	E	E	Е	Е	E	E
Plasticizer Compatibility with dry emulsion						
Clarity Gloss	O D	O D	TL HG	TL HG	TL HG	TL HG
Recipe FF10-264	<u>13</u>	<u>14</u>	<u>15</u>	<u>16</u>	<u>17</u>	<u>18</u>
Airflex <sup>®</sup> 400 Water Plasthall <sup>®</sup> DOA Plasthall <sup>®</sup> DOP Monoplex <sup>®</sup> S-73	100 20 20 -	100 so 52	100 20 - 22 -	100 50 - 50	100 20 - - 20	100 50 - - 50
TOTAL	140	202	142	200	140	200
Plasticizer	DOA	DOA	DOP	DOP	S-73	S-73
Emulsion Stability						
Recipe FF10-269	<u>43</u>	<u>44</u>	<u>45</u>	<u>46</u>	<u>47</u>	<u>48</u>
Airflex <sup>®</sup> 400 Water Hercoflex <sup>®</sup> 900 RX-13215 RX-13216	100 20 20 -	100 50 50 - -	100 20 - 20 -	100 50 - 50 -	100 20 - - 20	100 50 - - 50
TOTAL	140	200	140	200	140	200
Plasticizer	H-900	H-900	RX- 13215	RX- 13215	RX- 13216	RX- 13216
Emulsion Stability			-	-	•	
at 1 d at 3 d at 5 d	- - E	- - E	- G -	- P -	- - G	- - P



Plas	ticiz	er C	Com	pati	bility
		_			

with Dry Emulsion						
Clarity		TL	TL	-	TL	TL
Gloss		HG	LG	-	LG	-
at 1 d						
at 3 d	-	-	-	-	-	-
at 5 d	Ε	Р	E	Р	E	Р
Plasticizer Compatibility						
with Dry Emulsion						
Clarity	0	0	TL	TL	0	Ο
Gloss	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