



## Florida Weathering Performance of *Eastman 1,4-CHDA* in White Gel Coats

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# Florida Weathering Performance of *Eastman* 1,4-CHDA in White Gel Coats

## Introduction

*Eastman* 1,4-CHDA (1,4-cyclohexanedicarboxylic acid) is a nonaromatic diacid that is used in the manufacture of unsaturated polyester resins for fiberglass-reinforced plastics (FRP) and saturated polyester resins for coatings. Its unique cycloaliphatic structure imparts some very interesting performance characteristics to unsaturated polyester composites. The weathering performance imparted by 1,4-CHDA is the focus of this literature.

Weatherability of gel coats is an important property for consumer appeal. It preserves the “new look” of a boat, jet ski, truck, recreational vehicle, and other FRP products. Weatherability can be evaluated a number of ways. Following is a list showing some of the most commonly used methods for measuring weatherability. Florida weathering is the most accepted measurement with QUV-B being the most suspect.

### Weatherability Methods

- Florida
- Local Outdoor & EMMAQUA
- Xenon, Carbon Arc, & QUV-A
- QUV-B

The objective of this literature is to show the results of three Florida weathering studies to demonstrate the excellent weatherability that 1,4-CHDA imparts to gel coats.

## Experimental Conditions

Three Florida weathering studies (1994 Part A and Part B and 1976) were carried out on white gel coats under standard exposure conditions (ASTM D 4141). The responses measured were increase in yellowness (b\*-color increase) and gloss retention (% retained from initial gloss readings).

**Note: Lower yellowing (b\*-color increase) and higher gloss retention indicate better weatherability.**

*Eastman* 1,4-CHDA was benchmarked with PIA (purified isophthalic acid), an industrial standard used in weathering applications.

Other abbreviations that will be used:

- SA—saturated diacid [1,4-CHDA or PIA]
- MA—maleic anhydride
- NPG—NPG glycol (neopentyl glycol)
- PG—propylene glycol

## Part A

Only a single glycol (*NPG* or *PG*) was used for the evaluation of CHDA-based gel coats as compared to PIA-based gel coats. This Florida weathering study on the following four resin systems was initiated in 1994. The numbers represent the ratio of saturated diacids (CHDA or PIA) to unsaturated anhydride (MA).

PG/PIA/MA 1:1      *NPG*/PIA/MA 1:1  
PG/CHDA/MA 1:1    *NPG*/CHDA/MA 1:1

When examining yellowing ( $b^*$ -color increase) results, the weathering advantage of CHDA is greater in the *NPG*-based gel coats than the PG-based gel coats in this study with the *NPG*/CHDA yellowing resistance being of borderline significance. The opposite is true for gloss retention—the weathering advantage of CHDA is greater in the PG-based gel coats than the *NPG*-based gel coats. The difference in gloss retention between the CHDA and PIA gel coats for the PG gel coats is significant.

Figure 1

Single Glycol (*NPG* or PG)/SA/MA 1:1

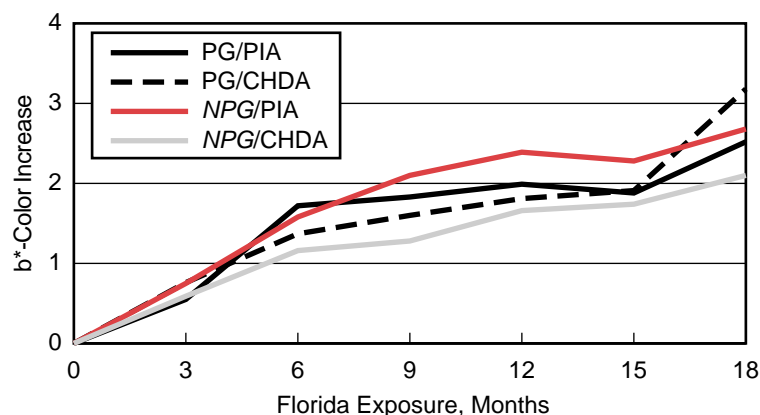
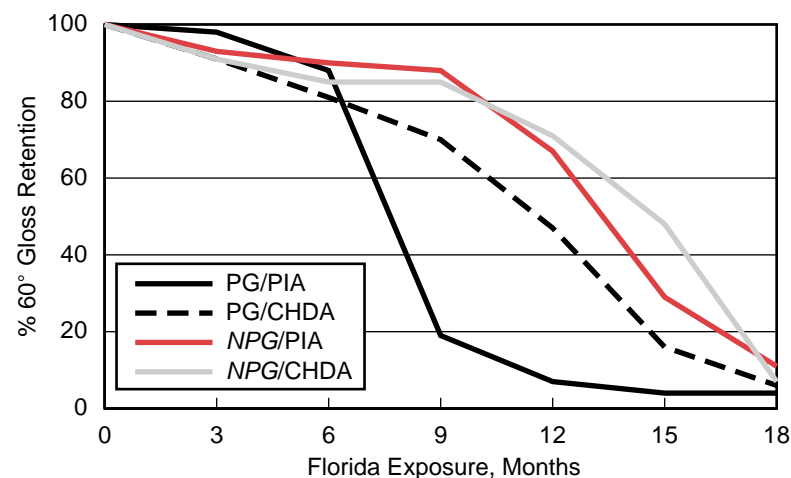


Figure 2

Single Glycol (*NPG* or PG)/SA/MA 1:1



## Part B

This Florida weathering study was also initiated in 1994 (as was Study A). In this evaluation, only an *NPG*/PG molar blend of 85:15 was used for the glycol component for both gel coat resins. This ratio of glycols approximates the composition used in high-performance gel coat resins.

In this study, the superior yellowing resistance of CHDA-based gel coat is clearly indicated by the marked difference in yellowing development. The PIA gel coat exhibited a delta b\*-color increase of 3.5 after 9 months while the CHDA gel coat had a delta b\*-color increase of *only 2.5 after 18 months*. The gloss retention advantage still favors CHDA over PIA to a less degree but still supports an advantage for CHDA.

Figure 3

Glycol Blend *NPG*/PG (85/15M)/SA/MA 1:1

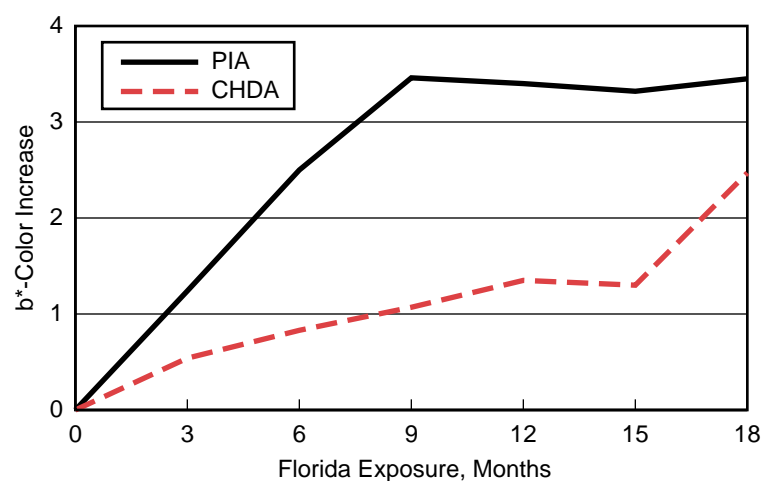
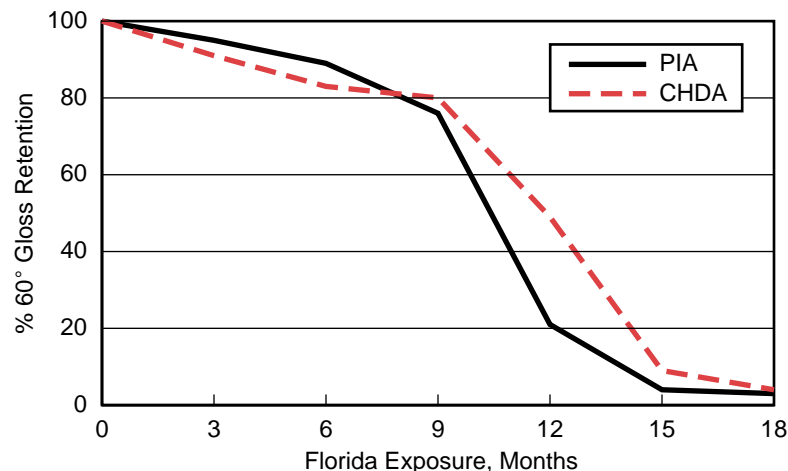


Figure 4

Glycol Blend *NPG*/PG (85/15M)/SA/MA 1:1



## Florida Weathering Study, 1976

This 1976 single-glycol study is very similar to the 1994 Study A because both use a single glycol. The gel coat resins are the same.

PG/PIA/MA 1:1      *NPG*/PIA/MA 1:1  
PG/CHDA/MA 1:1    *NPG*/CHDA/MA 1:1

This study shows that CHDA imparts the same resistance to yellowing in both the *NPG* (solid bars) and the PG gel coats (striped bars). In gloss retention measurements, CHDA only shows a clear advantage in PG-based gel coats. The *NPG* gel coats did not show significant loss of gloss during the first year of Florida exposure; therefore, no differentiation in *NPG* gel coat gloss retention is possible.

Figure 5

Single Blend (*NPG* or PG)/SA/MA 1:1

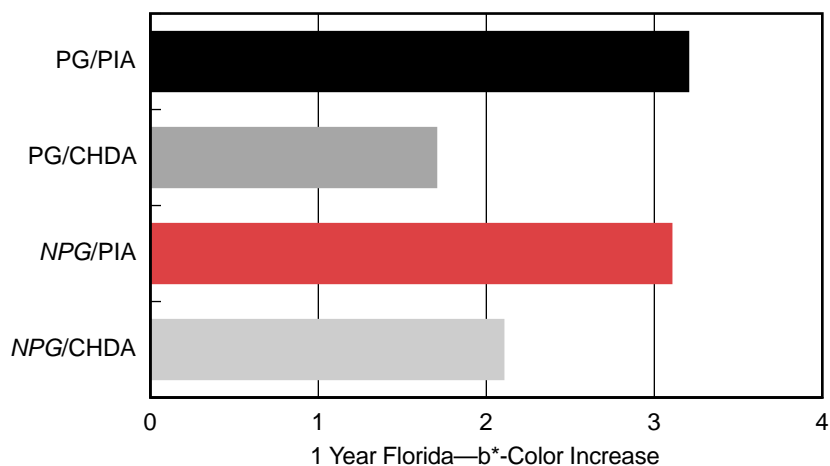
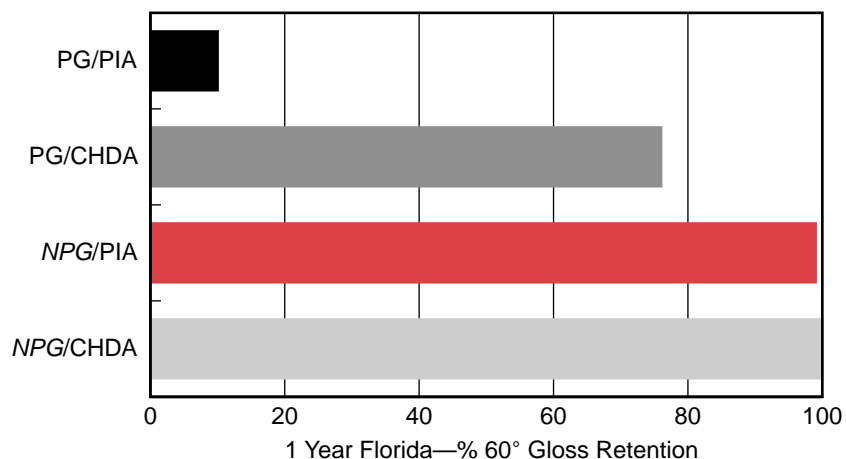


Figure 6

Single Glycol (*NPG* or PG)/SA/MA 1:1



## Conclusion

Table 1 summarizes the three studies (totaling 4 years of Florida weathering data) by indicating the superior performing gel coat. The term “similar” is used when there is an insignificant difference between CHDA compared to PIA based on the data. In all cases, CHDA has demonstrated superior or equal weatherability to PIA in white gel coats. Some results are marked with an (\*) because a greater weathering performance difference was observed when PG is the glycol used as compared to *NPG*. This can be explained due to the superior weathering performance of *NPG* compared to PG, which decreases the weathering performance difference between the diacids, CHDA and PIA.

There are many performance criteria to consider when selecting a gel coat resin. This literature has shown that **CHDA is the “diacid of choice” for high-performance weathering gel coat applications**. Consult your supplier on other gel coat performance criteria before finalizing your selection of a gel coat resin.

Table 1

Florida Weathering Study	Yellowing	Gloss Retention
<b>1994</b>		
Part A	CHDA/PIA	CHDA
Single Glycol <i>NPG</i> or PG)/SA/MA 1:1	Similar*	Superior*
Part B	CHDA	CHDA/PIA
Glycol Blend <i>NPG</i> /PG (85/15M)/SA/MA 1:1	Superior	Similar
<b>1976</b>	CHDA	CHDA
Single Glycol ( <i>NPG</i> or PG)/SA/MA 1:1	Superior	Superior*

Use of an \* indicates that the weathering difference is greater when PG is the glycol used rather than *NPG*.



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