Best Available Fiberglass Technology for Sodium Hypochlorite Storage

Michael G. Stevens, Senior Staff Scientist, Ashland Inc.
Paul Cohen, Vice President, Diamond Fiberglass

The Problem and Objective

Fiber reinforced thermoset polymer (FRP or Fiberglass) storage tanks for sodium hypochlorite service are widely accepted in the water treatment industry. However, due to continued technological developments, there are a wide variety of resin types, cure systems, reinforcements and construction methods available for fabrication of these tanks. Significant confusion exists among users and fiberglass tank specifiers as to which combination will provide optimum corrosion resistance and longest service life for bleach storage.

In response to this dilemma, a study was undertaken to establish the optium combination of materials and fabrication methods that would provide maximum corrosion resistance to bleach. These results will be immediately applicable for end users and FRP bleach storage tanks specifiers who desire.to maximize service life and safe operation of their existing and planned bleach storage facilities.

Introduction

Sodium hypochlorite disinfection has become the most common chemical treatment for waste water in North America. With the ever-heightening scrutiny around transportation and use of chlorine, concentrated bleach and on-site bleach generation as a source of chlorine is increasing in popularity. FRP has become the industry standard for hypo storage tanks as it is quite economical and gives remarkably long service life. Another advantage of FRP is the wide variety of engineered materials available for use in vessel fabrication. Users and specifiers often dictate which materials are to be used. When the proper resin, cure system, fabrication design and methods are specified, FRP tanks will often last for decades. Alternatively, poor specification of these items can result in significantly shortened service life, or worse, catastrophic failure. It is in the best interest of all stakeholders to use the most robust construction materials and fabrication methods in order to deliver top notch performance in these critical goods.

Materials and Methods

This study consisted of both laboratory and field testing of coupons using the ASTM C581 Standard Practice for Determining Chemical Resistance of Thermoset Resins Used in Glass-Fiber Reinforced Structures Intended for Liquid Service test procedure. All of the test coupons were prepared according to ASTM C581 test procedure and the coupons were completely submerged in the test liquid. For laboratory conditions, testing was at both 120°F and 150°F sodium hypochlorite. The sodium hypochlorite used in the studies contained between 9 and 15% available chlorine. The solutions were changed out on a regular basis to maintain the available chlorine in the solution at above 9%. For field conditions, test coupons were placed in two sodium hypochlorite storage tanks at waste water treatment facilities in Colorado. A third test was conducted in a sodium hypochlorite reactor in Houston, TX. Six different resins were evaluated along with 2 different cure systems and 2 different veils. Test coupons are evaluated for retention of flexural strength, flexural modulus, Barcol Hardness, and visual examination for attack on the resin.

Results and Discussion

The test results obtained from the ASTM C581 laboratory testing at 120°F are shown in Table 1 and the results from the coupons from the waste water treatment facilities are shown in Tables 2 and 3. These test showed that none of the resins or cure systems had dramatic reductions in flexural strength, flexural modulus or Barcol hardness even after 12 months. Visual examination of the coupons did reveal some differences between samples. The epoxy novolac vinyl ester resin (NEVER) suffered the greatest attack on its coupon surface as indicated by a loss of surface gloss and attack on the coupon edge coating. The brominated epoxy vinyl ester resins cured with a BPO/DMA/TBPB showed the least amount of attack on the coupon surface with most of its gloss retained. The alternative cure system – cobalt naphthenate and MEKP showed complete loss of surface gloss, an indication of serious corrosion. The cobalt metal in the resin is theorized to cause sodium hypochlorite to become unstable and attack the resin at the surface. These data tend to confirm that theory. It has been thought by some that synthetic polyester veil would perform better in sodium hypochlorite than C-glass veil. This evaluation demonstrates that synthetic polyester veil has no advantage over C-glass veil in sodium hypochlorite service. Moreover, testing at elevated temperature(s) indicate that C-glass veil may actually perform better.

Conclusions

The best system to use for sodium hypochlorite storage tanks based on this study would be a brominated epoxy vinyl ester resin cured with BPO/DMA/TBPB and designed with a corrosion liner consisting of 2 layers of C-glass veil backed by a minimum of 100 mils of chopped strand ECR glass. A post cure of the equipment is required for maximum service life of the tank.

References

1. "Sodium Hypochlorite General Information for the Consumer", Odyssey Manufacturing Co., March 21, 2004
2. ASTM C-581 Standard Practice for Determining Chemical Resistance of Thermoset Resins used in Glass-Fiber Reinforced Structures Intended for Liquid Service, Annual Book of ASTM Standards, July, 2003.

3. Don Kelley, "Fiberglass Reinforced Plastic Equipment for Treating Waste Incineration Gases", Corrosion 2004 paper # 04617,(Houston, TX, NACE, 2004)

TABLE 1
TEST RESULTS AFTER 12 MONTHS IN 10% SODIUM HYPOCHLORITE AT 50°C

Resin Type	BREVER1	BREVER1	BREVER1	BREVER2	EVER1	EVER2	NEVER
Cure System	CoNap/MEKP	BPO/DMA	BPO/DMA	BPO/DMA	BPO/DMA	BPO/DMA	BPO/DMA
Veil Type	Polyester	Polyester	C-Glass	C-Glass	C-Glass	C-Glass	C-Glass
Flexural Strength Retention, %	66	104	93	83	98	93	88
Flexural Modulus Retention, %	79	101	93	87	104	93	93
Surface Hardness Retention, %	73	100	98	96	93	98	76
Surface appearance	Flat	Flat	Semi-Gloss	Semi-Gloss	Slightly flat	Slightly flat	No gloss
Resin Attack	Moderate	Slight	None	None	Slight	Slight	Moderate, only 40% of edge coating remains

TABLE 2
TEST RESULTS AFTER 12 MONTHS IN 10% SODIUM HYPOCHLORITE STORAGE TANKS IN THRONTON, CO

Resin Type	BREVER1	BREVER1	BREVER1	BREVER2	EVER1	EVER2	NEVER
Cure System	CoNap/MEKP	BPO/DMA	BPO/DMA	BPO/DMA	BPO/DMA	BPO/DMA	BPO/DMA
Veil Type	Polyester	Polyester	C-Glass	C-Glass	C-Glass	C-Glass	C-Glass
Flexural Strength Retention, %	90	97	113	98	81	83	103
Flexural Modulus Retention, %	85	100	109	92	93	92	100
Surface Hardness Retention, %	119	114	113	112	108	108	106
Resin Attack	Slight	None	None	None	Very slight	Very slight	slight

TABLE 3
TEST RESULTS AFTER 12 MONTHS IN 10% SODIUM HYPOCHLORITE STORAGE TANKS IN CITY OF WESTMINSTER, CO

Resin Type	BREVER1	BREVER1	BREVER1	BREVER2	EVER1	EVER2	NEVER
Cure System	CoNap/MEKP	BPO/DMA	BPO/DMA	BPO/DMA	BPO/DMA	BPO/DMA	BPO/DMA
Veil Type	Polyester	Polyester	C-Glass	C-Glass	C-Glass	C-Glass	C-Glass
Flexural Strength Retention, %	84	88	131	88	107	87	105
Flexural Modulus Retention, %	85	94	103	89	98	89	99
Surface Hardness Retention, %	111	100	113	105	110	100	106
Resin Attack	Slight	None	None	None	Very slight	Very slight	slight

TABLE 4
TEST RESULTS AFTER 12 MONTHS IN 10% SODIUM HYPOCHLORITE AT 65°C

Resin Type	BREVER1	BREVER1
Cure System	BPO/DMA	BPO/DMA
Veil Type	Polyester	C-glass
Flexural Strength Retention, %	29	71
Flexural Modulus Retention, %	26	65
Surface Hardness Retention, %	0	47
Surface Attack	Moderate	Slight

TABLE 5
TEST RESULTS AFTER 30 MONTHS IN SODIUM HYPOCHLORITE REATOR AT 40°C

Resin Type	BREVER1	BREVER1	BREVER1	BREVER2	EVER1	NEVER	BRNEVER
Cure System	CoNap/MEKP	BPO/DMA	BPO/DMA	BPO/DMA	BPO/DMA	BPO/DMA	BPO/DMA
Veil Type	Polyester	Polyester	C-Glass	C-Glass	C-Glass	C-Glass	C-Glass
Flexural Strength Retention, %	71	85	121	93	97	107	130
Flexural Modulus Retention, %	73	107	113	95	102	95	99
Surface Hardness Retention, %	59	85	91	91	90	94	93
Resin Attack	Moderate	Moderate	Moderate	Slight/Moderate	Moderate	Slight	Very Slight