AMERICAN ENGINEERING TESTING, INC.

CONSULTANTS
- GEOTECHNICAL
- MATERIALS
- ENVIRONMENTAL

REPORT OF CONCRETE CORROSION INHIBITOR TESTING

PROJECT:

COMPARATIVE STUDY

REPORTED TO:

CORTEC CORPORATION
4119 WHITE BEAR PARKWAY
ST. PAUL MN 55110

ATTN: BORIS MIKSIC

AET JOB NO: 05-00021

DATE: AUGUST 28, 2002

INTRODUCTION

This report presents the results of our testing of Cortec's MCI 2005, MCI 2006, and competing products. We understand the admixture was developed to provide corrosion protection to steel embedded in concrete. Mr. Boris Miksic of Cortec Corporation requested we evaluate the material's effectiveness. The scope of our work consists of batching concrete; testing plastic concrete for properties; casting, curing and testing cylinders for compressive strength; and casting beams containing steel and testing for corrosion.

CONCLUSIONS

Base on the results of our work and experience, it is our opinion the following conclusions are appropriate:

1. Cortec's MCI 2005 and 2006 provide valuable corrosion protection for steel embedded in concrete. The products delayed the onset of corrosion. When corrosion developed, the products reduced the corrosion current.

2. Cortec's MCI 2005 generally doubled and 2006 tripled the time to the onset of corrosion. The control concrete developed corrosion in the 9th test cycle. MCI 2005 developed corrosion in the 17th test cycle and 2006 in the 28th test cycle.

3. Cortec's MCI 2005 and 2006 reduced the corrosion current more than 4 fold once corrosion began. The control concrete corrosion current generally increased over the 47 cycles observed with an average corrosion current of 120 μA. MCI 2005 average corrosion current was 29 μA and MCI 2006 10 μA over the 6½ year testing period.

4. Cortec's MCI 2005 and 2006 reduced the total corrosion experienced during the test 4 to 16 fold, respectively. The average total current passed by the control concrete was 13,053 coulombs at the end of cycle 55. MCI 2005 passed only 2735 coulombs during the test and MCI 2006 passed only 793 coulombs after 55 cycles.

5. Cortec's MCI 2005 and 2006 extend the time to cracking of concrete from rebar corrosion at least two times. The control concrete cracked at an age of 1¼ years. One beam containing MCI 2005 cracked at about 3 years. The remaining MCI 2005 beams and all MCI 2006 beams are uncracked.

6. DCI and Rheocrete 222 dramatically impact set time of the concrete. The DCI accelerated initial set about 1 hour at 2 gallons and 2 hours at 4 gallons. Rheocrete 222 delayed initial set 30 minutes and final set more than 1 hour.

7. DCI delayed the onset of corrosion. The admixture extended the initiation time more than four times. Corrosion began in the forth-third cycle in the concrete with 4 gallons of DCI. The beams with two gallons of DCI have yet to average 10 μA in the beams.

8. Rheocrete delayed the onset of corrosion. In the forty-sixth cycle the average corrosion current was above 10 μA for the three beams.

TESTING METHODS AND RESULTS

On July 17, 1996, and the subsequent dates, six test batches of concrete were made at our laboratory. The batches were 2¼ cubic feet proportioned to the following mix designs:

	Mix 1	Mix 2	Mix 3	Mix 4	Mix 5	Mix 6
Portland Cement, Type I, pcy	600	600	600	600	600	600
3/4" Glacial Gravel, pcy	1800	1800	1800	1800	1800	1800
Sand, pcy	1130	1130	1130	1130	1130	1130
MCI 2005, pints/yd (liquid)	1.0	-	-	-	-	-
DCI, gal/yd			2	4	-	
Rheocrete, gal/yd			-	-	1	
MCI 2006, pcy (powder)	-	0.5	-	-	-	-
Neutralized Vinsol Resin, ocy	3.9	3.9	3.9	3.9	3.9	3.9
Water, pcy	300	300	300	300	300	300
Water/Cement Ratio	0.5	0.5	0.5	0.5	0.5	0.5

The plastic concrete was tested for slump, air content, temperature, and unit weight immediately after discharge into a wheelbarrow. The following data was obtained:

	MCI 2005 Mix #1	MCI 2006 Mix #2	DCI 2 gcy Mix #3	DCI 4 gcy Mix #4	Rheocrete 222 Mix #5	Control Mix #6
Slump, in	3¼	3¼	3	3½	3½	3¾
Air, %	6.3	5.8	5.7	7.0	5.5	5.7
Temp, °F	80	78	69	69	65	75
Unit Wt., lb/ft^3	143.6	144.5	144.0	140.5	143.0	144.0
Set Time						
Initial hr:min	4:55	4:25	3:25	2:20	4:45	4:15
Final hr:min	5:50	5:20	4:40	3:24	7:00	5:43
Compressive Strength, psi						
7 days	4340	3710	4430	4820	3340	3820
28 days	5530	5960	5700	6130	4080	5520
	5200	5850	5650	5940	4180	5590
Average	5370	5900	5680	5990	4130	5560

Three concrete beams were cast from each concrete batch for corrosion testing per ASTM:G109. The beams were 4.5" x 6" x 11". Three steel reinforcing bars were set in the form in a triangular pattern prior to casting. The bars were taped tightly with electroplater's tape to prevent rusting during curing. At one day the beams were stripped and moist cured for 27 days. Upon removal from the moist room, the concrete surface was wire brushed. The four vertical sides were sealed with a concrete epoxy sealer. A plastic dam was positioned on top of the beam. Silicon caulk was used to seal the dam to the beam. A 3% NaCl solution was poured into the dam for two weeks. After two weeks of ponding, samples were dried for two weeks. This cycle was repeated with the corrosion potential and current measured during the middle of the ponding interval. Corrosion is considered to occur when the macrocell current is at least 10 μA. Tables 1-6 contain the test data.

Report Prepared by:

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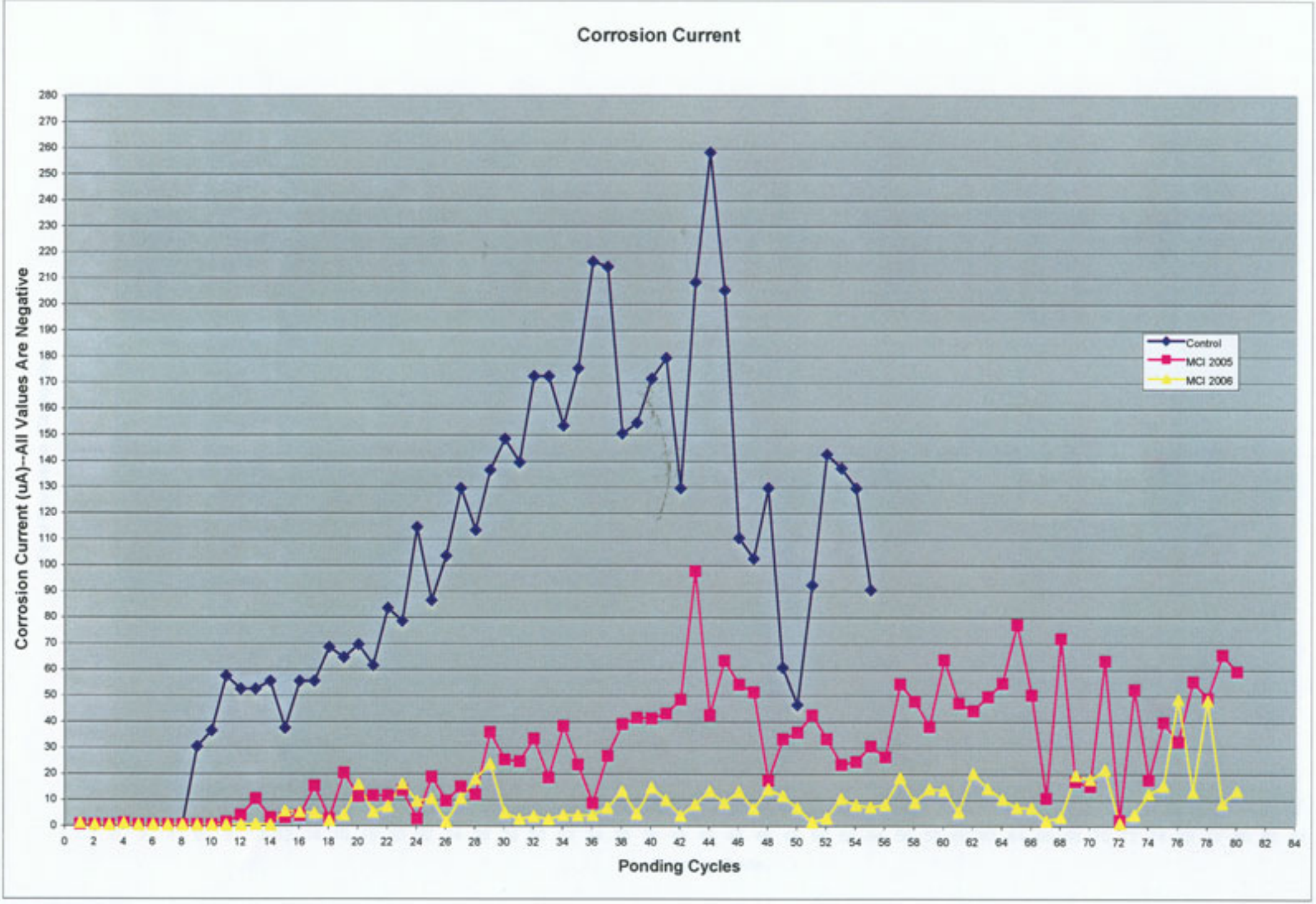
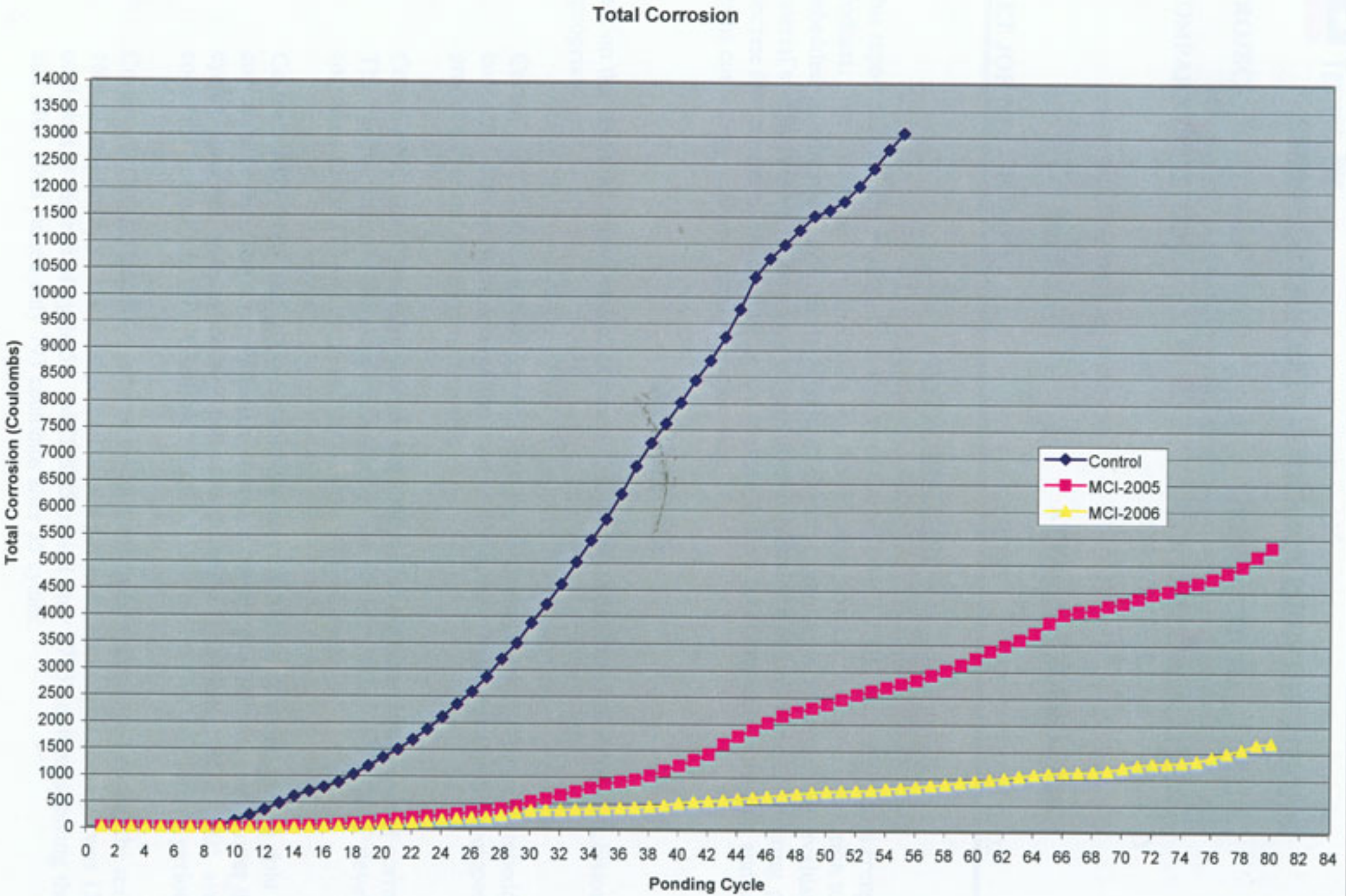

Corrosion Current
Corrosion Current (uA)--All Values Are Negative
Ponding Cycles
Control
MCI 2005
MCI 2006


Total Corrosion
Total Corrosion (Coulombs)
14000
13500
13000
12500
12000
11500
11000
10500
10000
9500
9000
8500
8000
7500
7000
6500
6000
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76 78 80 82 84
Ponding Cycle
Control
MCI-2005
MCI-2006

SODIUM NITRITE, 5.1, UN1500, PGIII, OXIDIZER/TOXIC

98%-120 MESH Lot No: **NANI-03-171**

RQ: 100(45.4) Net Wt. **50 LBS.**

CAS#: 7632-00-0 RTECS#: RA 1225000

FW: 69.00 MERK INDEX: 9,8407

Emergency Contact: CHEMTREC:1-800-424-9300

CHEMTREC INTERNATIONAL: (703) 527-3887

HEALTH HAZARADS & FIRST AID:
MATERIAL IS DANGEROUS IF INHALED! IMMEDIATELY FLUSH EYES OR SKIN WITH COPIOUS AMOUNT OF WATER, FOR AT LEAST 15 MINUTES IN CASE OF CONTACT EXPOSURE. MATERIAL IS IRRITATING TO THE MUCOUS MEMBRANES AND UPPER RESPIRATORY TRACT. EXPOSURE
SYMPTOMS MAY INCLUDE - BURNING SENSATION, COUGHING, WHEEZING, SHORTNESS OF BREATH, HEADACHES, LARYNGITIS, NAUSEA AND VOMITING, DIURESIS, ANEMIA, METHEMOGLOBINEMIA, NEPHRITIS, GASTROENTERITIS AND VASODILATION. IF MATERIAL HAS BEEN INHALED, REMOVE SUBJECT TO FRESH AIR. IF SUBJECT IS NOT BREATHING GIVE ARTIFICIAL RESPIRATION - PREFERABLY MOUTH-TO-MOUTH. IF BREATHING IS DIFFICULT OXYGEN SHOULD BE SUPPLIED. CONTAMINATED CLOTHING SHOULD BE REMOVED AND THOROUGHLY CLEANED BEFORE REUSE. CALL A PHYSICIAN! WASH THOROUGHLY AFTER HANDLING.

INCOMPATIBILITIES: ACIDS, ACID ANHYDRIDES, FUELS, (REDUCING AGENTS). EXPLOSIVE MIXTURES MAY RESULT FROM IMPROPER HANDLING!

PRODUCTS OF DECOMPOSITION: OXIDES OF SODIUM AND NITROGEN.

HANDLING & STORAGE: APPROPRIATE OSHA/MSHA APPROVED RESPIRATOR, CHEMICALLY RESISTANT GLOVES, CHEMICAL GOGGLES AND OTHER APPROPRIATE PROTECTIVE CLOTHING (RUBBER APRON OR OVERWEAR)SHOULD BE WORN. MECHANICAL EXHAUST IS REQUIRED. AVOID CONTACT WITH EYES, SKIN AND CLOTHING. DO NOT BREATHE DUST. AVOID PROLONGED AND REPEATED EXPOSURE. HYGROSCOPIC. KEEP CONTAINERS SEALED. STORE IN COOL DRY PLACE. OBSERVE PROPER PERSONAL HYGIENE. SAFETY SHOWER SHOULD BE AVAILABLE. THE PREFERRED FIRE EXTINGUISHING MEDIA IS WATER, DRY CHEMICAL POWDER, CARBON DIOXIDE OR POLYMER FOAM. MATERIAL IS NONCOMBUSTIBLE. PROTECTADJACENT AREA!

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