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## *Comparing Corrosion Rate of Deicers by PNS Testing*

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**Project #:** 15-055-1215

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Robert T. Kean  
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**Background:** LCS 5000 is a corrosion inhibitor for deicing salt, used at concentrations of 10% to 20% in combination with the Chloride based deicer. Freezgard Zero CI Plus magnesium chloride based deicer contains corrosion inhibitor. Providers of both product claim that they are passing PNS\* corrosion test.

\* Pacific Northwest Snow fitter's snow and ice control chemical products specification and test protocols for the PNS of British Columbia, Colorado, Idaho, Montana, Oregon, and Washington.

**Goal:** To compare the performance of LCS 5000 and Freezgard Zero CI Plus with Cortec corrosion inhibitors for the deicing salts M 605 L and M 605PS.

**Sample Received:**

- 1) Freezgard Zero with CI Plus Corrosion Inhibitor, from North America Salt Company (Compass Minerals), in good condition, received 2/22/15
- 2) LCS 5000 from Envirotech Services, in good condition, received 2/22/15

**Method:**

Corrosion rate determination by PNS Test per Pacific Northwest Snow fighters Snow and Ice Control Chemical Product Specifications and Test Protocol.

**Materials:**

- 1) Hydrochloric Acid
- 2) S-11, Lot 22754
- 3) Steel Alloy 4130 Washer, 1.3/8" Diameter x 0.125". 0.56" hole, per ASTM F 436 Type I with Rockwell hardness of C 38-45
- 4) Fishing line, Searguard Red label, 100% Fluorocarbon
- 5) DI water
- 6)  $MgCl_2 \cdot 6H_2O$
- 7) NaCl
- 8) M-605 L (lab prepared sample, no batch#)
- 9) M-PS (lab prepared sample, no batch #)
- 10) Testing stand ('Dipper') the timer for providing up and down positions of the testing coupons with set up frequency.

**Procedure:**

Coupon Preparation:

- 1) Coupons were wiped with methanol to clean them.
- 2) An identifying mark was written on each coupon using an engraver.
- 3) The coupons were then weighed and measured.

Sample Preparation:

Deicers:

- a. Solution of 28%  $MgCl_2$  + 4% M-605 L
- b. Freezgard Zero with CI Plus
- c. NaCl + 20% LCS 5000
- d. Solution of 28%  $MgCl_2$  + 4% M-605 PS

Solutions to test:

300 mL (% by weight) of the following solutions were prepared, one for each sample prepared in the above step, plus two controls.

- a. 3% of (28% Mg Cl<sub>2</sub> + 4% M-605 L)
- b. 3% of Freegard Zero with CI Plus
- c. 3% of (80% NaCl + 20% LCS 5000)
- d. 3% of (28% MgCl<sub>2</sub> + 4% M-605 PS)
- e. Deionized water (DI Control sample)
- f. 3% NaCl (NaCl Control sample)

PNS Test Procedure:

- 1) The cleaned coupons were hung from the holes located in the arm of the dipper machine, using the fluorocarbon fishing line. The coupons were placed so that they hung down into the flask, above the test solutions.
- 2) The dipper machine was turned on, which lowered the carbon steel coupons for 10 minutes of each hour, in the solutions prepared above. For each sample tested, a control NaCl sample and a DI sample (as described in the sample preparation section) were prepared.
- 3) When the 10 minutes had completed, the dipper automatically raised the metal coupons out of the solutions for 50 minutes. This cycle was continued over the course of 72 hours.
- 4) After 72 hours, the coupons were removed, and washed off with tap water. They were then cleaned by dipping them for 30 seconds in a HCl acid cleaning solution, that consisted of 2% S-11 in HCl. They were then rinsed with tap water, to remove the acidic cleaning solution, and were dried.
- 5) The panels were then weighed after being cleaned.
- 6) The weight loss of each coupon was determined by subtracting the final weight from the original weight and the corrosion rate, expressed as MPY (mils per year). It was found using the following formula:
  - a.  $MPY = \frac{\text{weight loss (mg)} (534)}{(\text{area}) (\text{time}) (\text{metal density})}$ . Density for carbon steel is 7.85g/cc. The corrosion rate for the DI water was then subtracted from each of the test solution's MPY.
- 7) A product was determined to be acceptable if the corrected corrosion value is 30% or less of the sodium chloride MPY. The corrected value of the chemical product was divided by the corrected value of the salt, and multiplied by 100 to give percent.

**Results:**

**PNS Test Results\*\***

Sample	MPY (Average)	Percentage of NaCl MPY (Average)	Pass/Fail
LCS 5000	39.5	77.2	Fail
Freezgard Zero CI Plus	16.0	41.7	Fail
M-605L	6.7	15.1	Pass
M-605 PS	5.9	11.5	Pass

**Results relate only to the items tested**

\*\* Criteria for 'Pass' is the corrosion rate of  $\leq 30\%$  of the corrosion rate in 3% of NaCl

**Interpretations:**

- The PNS Corrosion Rate test results determined that sodium chloride based deicer with of 20% LCS 5000 and Freezgard Zero with CI Plus failed PNS corrosion test. The deicer with LCS 5000 had the highest MPY, at 39.5.
- Deicer 28% MgCl<sub>2</sub> + 4% M-605 PS or 4% M-605 L both passed the PNS test, and the results showed that they provided good corrosion protection for carbon steel.