Simple Corrosion Study with Poly-Ground® in Different Evolutionary Stages

Corrosion is an electro-chemical phenomenon where a metal tends to return to its native oxide state. Cathodic corrosion is possible if the conductive circuit is completed with the Poly-Ground® foam as the backfilling material when setting steel poles or other metal structures. Foam with a closed cell structure also separates environment elements from metal structures; thus, corrosion might be stopped or slowed down even if the cathodic potential does exist. These simple experiments were performed in our lab with different samples during the evolution of Poly-Ground®. The experiments were designed to work out a true picture for steel structures set with Poly-Ground® under severe condition.

Tests Setting Up

The initial study of Poly-Ground® started on 05-28-03 and ended on 10-14-03. The tests were run with 4 separate samples of Poly-Ground® from different stages of development. The tests were run with a 0.75 inch wide and 0.1 inch thick steel bar foamed up in the center of the Poly-Ground® foam with and without outer skin. The center steel bars were connected to positive DC source of 10V, and the Poly-Ground® foam samples were inserted in the 3% salt water solution with another steel bar connected to the negative DC source. The 3% salt water solution plus DC electric potential is simulated as the worst environment for the structure. For comparison, the same tests were set up with 1) an electric positive steel bar and electric negative bar in distilled water only, 2) a distilled water plus carbon black without the Poly-Ground® foam structure and 3) a test with the Poly-Ground® structure in distilled water only.

Results

1. The test with the 10V electric positive steel bar and electric negative bar in nothing but distilled water showed no significant changes in the first week. The dust from the air was eventually observed and the water changed into light brown color. After one week, the similar test with distilled water plus carbon black (without the Poly-Ground®) was observed with some rust on the positive steel bar and a little rust on the negative bar also, but it had no significant change in the first few days. In weeks, the test on the positive steel bar showed it as slightly rusted. On the other hand, the test with 3% salt water solution showed a lot of bubbles on the negative steel bar and the positive steel bar was consumed very quickly in couple of days and only about 20% was left within the liquid in two days time.

2. Bubbles were observed on the negative steel bar right after the connection to the electric source with the tests of the foam structure in the distilled water and in the 3% salt water solution both. The bubbles stopped after one week in the distilled water test. A little rust was observed on the negative steel bar with the distilled water. The water passed through the foam and the water line was always under the steel bar. In months, these tests showed no rust on the electric positive steel bar in the center with distilled water.

3. The tests with different foam structure in the 3% salt water solution always had bubbles on the negative bar during the test, but bubbles decreased over time. The negative steel

bars in different tests always showed no signs of rust. The water can always pass through the foam with different cells and formula. All tests with water line below the center steel bar showed no rust on the center steel bars. The rusty levels in the center positive steel bar with the water line above the bottom of the bars depended on the cell and completeness of foam skins. Smaller cells and more totality of the skin showed less signs of rust, and bigger cells and less completeness of the skin showed more signs of rust. In comparison, the levels of rust were much lower than tests without foam protection. The worst one showed about 20% area with shallow corrosive sign. The best one had no apparent corrosion and the center bar surface only was a little darker than normal.

4. The same test was run on the J-9B phase of Poly-Ground® from 10-28-03 to 11-06-03 with no observed water permeation through the foam, and no rust observed on the steel bar in the center. Then, the duplicate tests of Poly-Ground® J-9B were run between 11-06-03 and 12-05-03. One 0.75 inch diameter steel pipe and one 1.25 inch diameter steel pipe were foamed in the center, instead of the steel bar. In addition to above condition, the 3% salt water solution level was kept at the top edge of the testing cups and about two inches of the center steel pipes were kept deep below the water line all the time. At the end of the experiments, no water permeation through the foam was observed, and no rust was observed on the pipe in the center or on the electric negative bar.

Conclusion

The tests showed that the early stage Poly-Ground® foams was not totally closed cell within the range of testing density, and channels to allow the water to pass into the foam existed. Better closed cells and better polymer skin on the metal surface has better protection on the metal structure. Without water permeance into the foam, it will not cause the corrosion only because Poly-Ground® is conductive. The foam can slow down the corrosive environment to permeate into metal structure. Since these foam are not absolutely unpermeable, the foam itself can not provide steel structure good protection from the corrosive environment.

However, Poly-Ground® version J-9B appears to lack such a problem, and cells seems better closed than early versions Poly-Ground®. One nine days and duplicate 30 days experiments showed that the current Poly-Ground® can provide good protection for the metal structure from the corrosion under the testing conditions. Further lab tests under different conditions and field test might be necessary to confirm these conclusions. One more duplicate J-10 formula test showed that the thickness of the foam around the testing steel bar must be enough to provide the corrosion protection. Otherwise, the possibility of the leakage of the water still could cause corrosion for the metal structure.