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The Grid System for AST Bottom Protection: 30 Years Later

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ABSTRACT

The first Grid system for cathodic protection of aboveground storage tank (AST) bottoms was energized in 1989. This paper examines how the system is performing 30 years later. Design, system commissioning and long-term performance data are reviewed. Tank pad materials and current densities for protection at both ambient and high temperatures are discussed. The performance of individual system components is examined including ribbon anodes, conductor bars, electrical connections, power feeds, reference electrodes and power supplies. The economics of alternative tank bottom cathodic protection system configurations for new tanks are discussed. System limitations are identified. Conclusions are presented as to the effectiveness and optimal configurations for tank bottom protection that will assist with designing proper protection systems for new-build installations.

Key words: cathodic protection, aboveground tanks, AST, tank bottom protection, Grid system

INTRODUCTION

High density polyethylene (HDPE) liners have been installed for secondary containment under new aboveground storage tanks since the 1980s. The HDPE liner creates an electrically insulating barrier which requires that cathodic protection (CP) anodes be installed between the liner and the tank bottom to achieve effective CP for the soil side of the AST bottom. Sacrificial anodes were sometimes used, but they had limited life and current capacity. There was a need for a long life (50 years), low-profile, CP system that could be installed in the tank pad material between the liner and tank bottom. This need led to the development of the Grid™ by Corrpro, which was covered by U.S. Patents No. 5,065,893 and 5,340,455 - Cathodic Protection System for Above-Ground Storage Tank Bottoms. Now, over 30 years later, the first systems continue to perform and are providing CP as designed.

Trademark: Grid™ is a registered trademark of Corrpro Companies Inc.

FIRST SYSTEMS

A large, 345-foot diameter AST was to be built at a refinery in Texas City, Texas to store surface water from heavy rains that needed to be treated before being discharged into the Houston Ship Channel. The tank was to have an HDPE liner under the tank pad, requiring that a low-profile anode system be designed for installation between the HDPE liner and the tank bottom. A number of anode configurations were examined and ultimately the Grid system was developed, which consists of mixed metal oxide (MMO) coated titanium anode ribbons and titanium conductor bars resistance welded at each point of intersection as illustrated below in Figure 1. The conductor bar lowers the circuit resistance and limits the voltage drop along the anode ribbon to assure an even distribution of cathodic protection current. Redundant power feeds are shop assembled and field welded; and several reference electrodes are installed for system commissioning and performance monitoring.

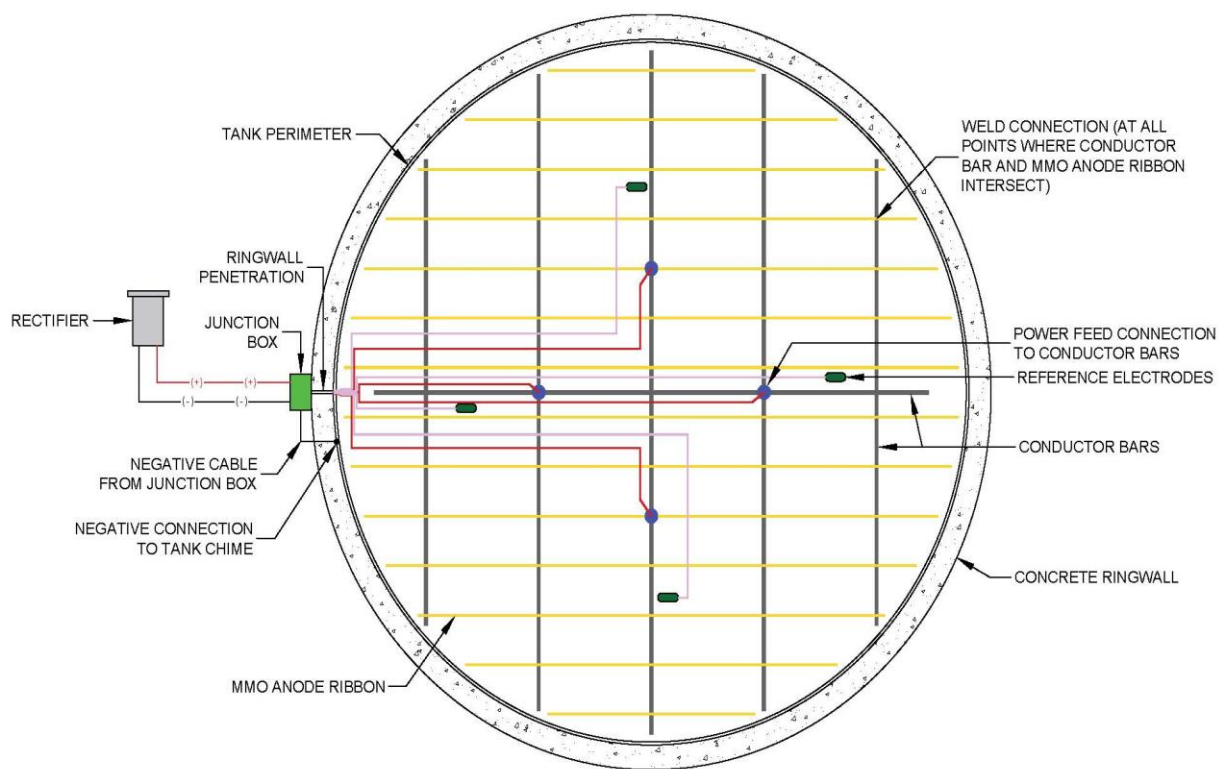


Figure 1: Grid System for AST Bottom Protection

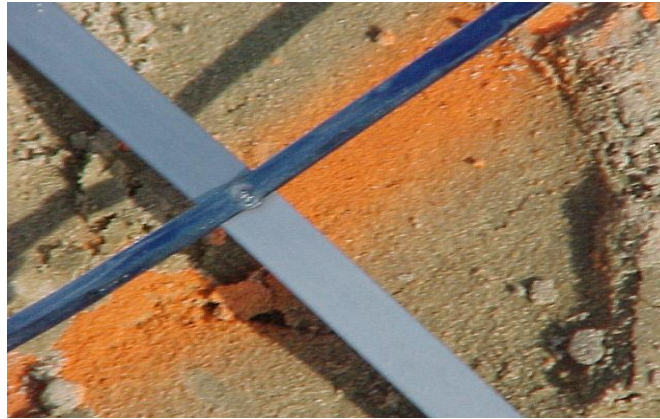


Figure 2: Anode Ribbon Welded to Conductor Bar

For this 345-foot diameter tank, the cathodic protection design parameters were:

- Current capacity of 1 mA/ft² of bare steel tank bottom
- 100 mV cathodic polarization criterion for cathodic protection
- 8-inch minimum separation of anode from tank bottom
- 1/4-inch wide, iridium oxide MMO ribbon anode spacing of 5 feet
- 1/2-inch titanium conductor bar spacing of 25 feet
- 8 power feeds
- 6 zinc reference electrodes
- 50-year design life
- Tap adjust, oil cooled rectifier rated at 30 volts, 50 amperes

The sand used for tank pad construction was first tested to assure satisfactory properties and to select the design current density for protection. The concrete ring wall was constructed, HDPE liner installed and a 4-inch lift of sand placed and compacted above the liner. The Grid system was then placed on the compacted sand and the remainder to the pad material placed and compacted. During pad construction, power feed - to - power feed resistances were monitored to ensure there was no damage during pad material placement, spreading and compaction.

Following tank construction, the tank was filled to create good contact between the tank bottom and sand pad, and free corrosion potentials were recorded on all of the reference electrodes. The system was energized and the tank bottom allowed to polarize for 60 days and then 120 days. Polarization data was recorded as shown in Table 1 and Table 2.

Reference Electrode	Free Corrosion Potential	Current-Applied Potential	Instant-Off Potential	Polarization Shift
1	-118	-810	-591	473
2	-201	-1192	-892	692
3	-436	-1115	-906	470
4	-302	-1038	-859	557
5	-496	-936	-768	272
6	-413	-895	-729	316

* All zinc potential measurements converted to CSE by -1070 mV

Table 1: First Grid 60-day Polarization Test (1989)