White Paper

Thermal Sprayed Zinc Alternative to Hot Dipped Galvanizing

By Joseph G. Radzik

Galvanizing has an historical background of use in reducing corrosion on piping products. *(It is the designer's responsibility to select products suitable for the intended service and to ensure that materials are acceptable for the specific application.)* Hot dipped galvanizing results in a cathodic protection system utilizing zinc as a sacrificial anode material dispersed on the surface of iron or steel products. Hot dipped galvanizing has been used in various markets for over 100 years as a method of corrosion protection.

The basic steps to the process are as follows:

1. Parts are de-greased in a hot alkaline solution.
2. Surface rust and scale are removed.
3. Parts are immersed in a liquid flux to prevent oxidation prior to dipping in the molten zinc.
4. Parts are immersed in the molten bath of zinc at a temperature around 850°F.
5. The parts are withdrawn from the galvanizing bath and the excess zinc is removed by draining or centrifuging and allowed to cool and dry.
6. Parts are inspected to complete the process.

In the hot dipped galvanizing method, it is important to keep the temperature of the bath above the temperature of molten zinc. This requires a large fuel consumption and a considerable loss of zinc occurs. Increased inspection and rework due to zinc drips may be required on complicated shapes such as grooved couplings and fittings.

An alternative to the hot dipped galvanizing process is the use of thermal sprayed zinc. Like galvanizing, thermal sprayed zinc also provides a cathodic protection system and is replacing hot dipped galvanizing in many applications for reasons of effectiveness and economics.

Thermal spray coatings are widely used in preventing corrosion of many materials. A common application is the use of zinc to protect iron substrates. In this method, the surface of the metal is prepared by abrasive blast cleaning to ensure it is cleaned and roughened. Metal wire or powder is fed at a controlled rate into a flame or arc spraying process and the atomized metal impinges upon the surface being coated and becomes bonded to it. This process is easily adapted to production environments and is especially suited to complicated surfaces found in grooved couplings and fittings.

Cathodic Protection

All metals have properties that cause them to react as an anode or a cathode when coupled to another material in a corrosive environment. The determination as to how two metals will react when coupled in a corrosive environment is based on a galvanic series shown below.

Galvanic Series; Anodic Magnesium; Zinc; Cadmium; Aluminum; Iron; Steel; Stainless Steels (active); Brass; Copper; Monel; Lead; Tin; Silver; Gold; Cathodic Platinum.

The application of zinc (anodic coating) to iron substrates forms a protective layer and results in a corrosion protection referred to as cathodic protection or sacrificial protection. The substrate iron becomes the cathode and the zinc coating becomes the sacrificial anode.

Independent Testing

Representative samples of thermal sprayed zinc and hot dipped galvanized ductile iron castings conforming to ASTM A 536, Grade 65-45-12, were subjected to a 5% salt spray fog test at 95°F in accordance with ASTM B 117.

Coating thickness was measured in the range of 3.4 to 5.5 mils for all samples evaluated, which conforms to the industry requirement for grooved piping products. An independent laboratory NADCAP accredited in materials and nondestructive testing methods performed the testing.

After 120 hours exposure, the hot dipped galvanized samples exhibited red corrosion. The thermal sprayed zinc samples did not exhibit red rust corrosion.

Testing was continued on the thermal sprayed zinc samples for an additional 72 hours for a total of 192 hours and examined for signs of red rust. None of the thermal sprayed zinc samples exhibited this condition and testing was stopped.

Conclusion

Independent laboratory testing verified that thermal sprayed zinc exhibited superior corrosion resistance to that of hot dipped galvanizing for ductile iron piping products when tested in accordance with ASTM B 117. Other benefits of thermal sprayed zinc making it a desirable alternative to hot dipped galvanizing are superior ease of application to complex shapes, the ability to control the coating thickness and superior adhesion of the zinc to the iron substrate.

About the Author:

Joseph G. Radzik is director of Engineering, Research & Development at Tyco Fire. Radzik's interests include the research, design and applications of grooved and CPVC piping products. He has been involved in piping products for more than 25 years. He worked as senior project engineer and later as engineering manager for Central Sprinkler Company, where he was responsible for the technical development of their grooved product line. Radzik's responsibilities include the engineering and quality assurance of Central grooved piping products and Tyco CPVC piping products worldwide. Radzik has authored numerous published articles and is a member of several trade associations.

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