Metalizing Alaskan Marine Structures: A Field-Friendly Method of Corrosion Protection

A Field-Friendly Method of Corrosion Protection

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FiG. 1: Instead of shipping individual items off-site to be galvanized, the fabrication company was able to metalize structures in the field with in-house staff. *Photos courtesy of the authors*

Many professionals within the coating and fabricating industry know that the battle against corrosion can oftentimes be a daily one. Issues stemming from this battle are quickly accelerated when entering environments where rust thrives, and the salty marine conditions found on Kodiak Island, Alaska, are no exception.

For one marine fabricator located in Kodiak, this challenging environment is an everyday reality. The company's customers, comprised mostly from the fishing industry, were seeking a coating that would be able to stand up to the constant corrosive environment found aboard their vessels, and more specifically, a coating that didn't need to be reapplied every year. In addition to the quick project turnaround and tight deadlines many companies in this industry face, this fabricator also has to regularly deal with freezing temperatures and a remote location.

For the fabricator, any hiccups in the process can ultimately cause its supply chain to be delayed for days, if not longer. Applying corrosion protection to the steel quickly and effectively to keep its customers working on schedule is of the utmost importance to the fabricator.

Galvanizing, a common process to add corrosion resistance to steel parts, could not be effectively utilized because galvanizing facilities are nonexistent in the state of Alaska. This meant that whether it was items pulled off of vessels to be repaired or even new locally fabricated items, they needed to be shipped out of state to be galvanized. Shipping not only delays projects, but is very expensive from Kodiak.

The owner of the fabrication company's search for an alternative solution led him to metalizing, a coating process that would allow his company to provide their own zinc and aluminum coatings in-house. In this particular case, electric arc spray metalizing equipment was the right choice for the intended use.

This article will outline the basics behind surface preparation and metalizing of steel structures, using specific examples from the Kodiak fabricator's successful metalizing applications as proof of the results it can offer in corrosion protection.

Fig. 2. These photos depict some of the marine structures that have recently been metalized by the fabricator, including *(clockwise from left)* ship hulls, rudders and metal stairways and railings.

METALIZING PROCESS

Metalizing, or thermal spray as it is also referred to, provides many unique benefits to industries around the world. It is a process that has been around for longer than most people realize, being introduced in the early 1900s by Dr. Max Ulrich Schoop, a Swiss inventor. There are many different types of metalizing processes available today, and the industry has come a long way since Dr. Schoop designed his simple gas flame, wire-fed gun.

The addition of oxy-fuel flame spray advancements, along with the invention of electric arc spray, plasma spray and high-velocity-oxygen fuel (HVOF) processes, have created an industry where the use for these coatings are almost endless in range of applications. In addition to corrosion control, the uses for thermal spraying include machine element repair, wear resistance, thermal barrier and many other industrial applications. The subject of this article will cover the use of electric arc spray metalizing for corrosion control coatings.

Zinc and aluminum (and their alloys) are very common in corrosion control metalizing applications because of their ability to provide galvanic and/or barrier protection to steel. Zinc's greater chemical activity provides greater cathodic protection than aluminum, but both are widely used to protect steel structures. Barrier protection is provided when the coating is applied in a non-through porosity thicknesses (normally 6 mils or more) and galvanic protection when applied in a through porosity thickness. Aluminum can also be used in high-temperature applications (as high as 1200 degrees F).

Most other coating systems for steel structures function solely by acting as a barrier between the environment and the substrate. If the barrier coating is damaged, the steel substrate is then vulnerable to corrosion when the damaged area is exposed to moisture, oxygen, and contaminants. Further damage to the steel substrate and the barrier coating occurs as the corrosion migrates away from the original damaged area. This is not the case with metalizing.

When the barrier coating is scratched or nicked (exposing the steel substrate) the metalized coating around the damaged area sacrifices itself by "galvanic action." This sacrificial action will continue to protect the steel substrate from corrosion as long as any zinc or aluminum remains in the area.

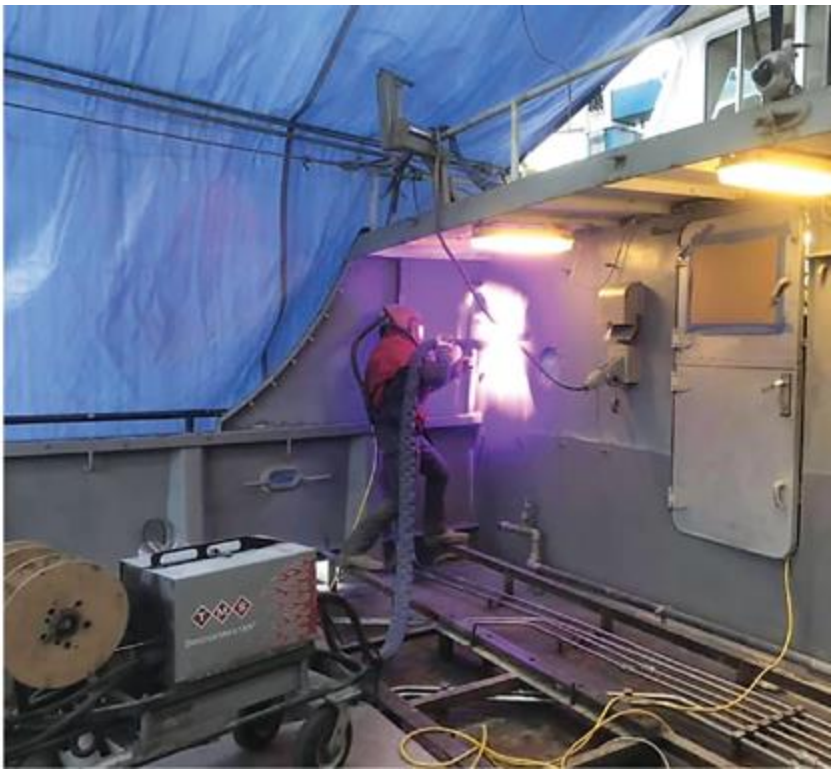

Fig. 3: Compared to galvanizing, which requires removing items and dipping them individually into a large molten bath, metalizing allows for field application and immediate curing of the protective zinc or aluminum layer—even on small and hard-to-access areas.

APPLICATION

Because metalized coatings are mechanically bonded to the steel substrate, surface preparation is arguably the most critical step. In corrosion control applications, the steel substrate should be:

- Prepared with a White Metal finish, SSPC-SP 5/NACE No. 1, for marine and immersion service, or a minimum of Near-White Metal finish, SSPC-SP 10/NACE No. 2, for other service applications; and
- Prepared to a minimum profile depth of 2.5 mils with a sharp angular shape. Note: Substrates with a thickness of less than 1/8-inch may require additional care in surface preparation to minimize substrate distortion.

A corrosion control metalized coating is applied much like a paint sprayed coating, except that the material being sprayed is atomized molten metal. In the twin-wire arc-spray process, an electric arc is created between two metalizing wires that are fed through a spray head at a controlled rate. The molten metal is then propelled with compressed air and deposited on a prepared surface. A low-voltage, high-amperage, direct-current power source is required to maintain the electric arc. A supply of clean, dry compressed air is required to propel the molten metal to the substrate.

The metalized coating needs to be applied to the prepared substrate within six hours of the completion of the blast. Depending on the environment, shortening holding periods may be required. Coating thickness is application driven and is normally defined in job specifications. In general, most corrosion control metalized coatings are specified in a range of 8-12 mils thick. Where required, a thicker coating can be

applied to further extend the service life of the coating. When properly applied, the coating can realistically provide 30 years of corrosion protection.

Metalizing allows for a much quicker turnaround than multi-coat paint systems. Since the coating instantly solidifies once it hits the substrate, once sprayed it is ready to handle and be put into service – no time or temperature controls are required for a coating cure. In addition to no cure restrictions, metalizing can also take place in cold weather environments—including below freezing temperatures. Metalized coatings can also be used in duplex systems as the base coat to paint. Zinc, zinc/aluminum and aluminum coatings range in color from gray to silver, but if a color is desired, metalizing provides an excellent base for seal coats and topcoats. This combination of coating technologies creates a system that can protect the underlying steel and requires little or no maintenance for many years.

Fig. 4: Electric arc application equipment propels the molten metal onto the prepared surface with clean, dry compressed air, powered by a low-voltage, high-amperage, direct-current power source.

METALIZING VS. GALVANIZING

Though the two processes are similar, and the two terms are mistakenly used interchangeably at times, there are key differences between galvanizing and metalizing.

First, metalizing, unlike galvanizing, presents no distortion due to heat. The surface being coated remains at ambient temperatures and the metalized coating process does not distort the shape of steel nor will it affect its metallurgical structure.

When fabrications are too large or cannot be hot-dip galvanized, zinc metalized coatings are an excellent alternative. Unlike galvanizing, which requires dipping steel items into a large molten bath, metalizing is applied with portable equipment so it can easily be used as a field coating process or a shop-applied coating. This allows companies to have complete zinc or aluminum coating applications in-house, therefore giving them complete control of their fabrications. Zinc metalized coatings can also be used for repairing galvanized coatings that have become damaged during fabrication (such as welded areas).

In addition, when metalizing equipment is not being used, it can easily be switched off, creating potential energy cost savings.

Of course, metalizing also offers alternative benefits to traditional coatings systems applied for corrosion protection. One of the starkest differences between metalizing and protective coatings is that zinc or aluminum metalized coatings are inorganic and do not contain volatile organic compounds that can potentially harm the environment.

In addition, corrosion control metalized coatings have replaced many paint systems due to the predictable service life of the metalized coating and the lower life cycle coating cost. Metalized coatings also offer greater resistance to heat damage, and hot and cold cycling, than conventional paint systems. Finally, as previously outlined, metalizing does not need the same level of temperature control during application, which allows for all-season protective coating application.

Where colors are required, metalizing can provide an excellent surface for paint, while also providing corrosion protection if the paint coating becomes damaged.

SSPC-CS23.00, “Specification for the Application of Thermal Spray Coatings (Metallizing) of Aluminum, Zinc, and Their Alloys and Composites for the Corrosion Protection of Steel,” is the industry’s primary source of information regarding metalized coatings and their surface preparation and application requirements.

BACK TO KODIAK ...

Back on Kodiak Island at the marine fabricator’s site, arc spray equipment is used to apply coatings both in the shop or in the field. As one can imagine, the landscape and the environment around Kodiak makes for some challenging field projects. The fabricator has even had projects where they’ve had to load the metalizing equipment onto bush planes and boats to access extremely remote job sites.

More regularly, they’ve metalized decks, tanks, cranes, booms, winches, anchors, fish handling equipment, shaft couplings, mufflers and exterior hulls. On shore, they have also metalized walkways, stairs, railings, pier support equipment, piping and pipe stands.

Beyond simply being an alternative to galvanizing and paint coatings, the company also realized that they could even offer metalizing for entire vessels, something that would become a game-changer in its ongoing “battle against rust.”

According to the owner, the fabrication company has been coating at least one entire vessel per year on average, in addition to all of the equipment and other parts that they metalize. And the superintendent says that those vessels look exactly like they did the day they were finished.

For the fabricator, the metalizing process has become part of daily operations. The owner estimates that they now metalize at least 10 to 60 hours per week, depending on the season and workload. Many pieces of the marine equipment brought into the shop are still brand new and freshly painted, but the customers know that if they have the parts metalized, they will potentially last many more years on their vessels without corroding.

ABOUT THE AUTHORS

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