THERMAL SPRAY COATINGS – PAST, PRESENT & FUTURE

Ted Call – District Sales Manager
KTA-Tator, Inc.
Pittsburgh, Pennsylvania, USA

Abstract: Thermal spray coatings (TSC) have been successfully used in all major sectors of the marine and industrial corrosion control coatings market. Approximately twenty years ago they were introduced to the bridge coatings sector of the market on a trial basis. The overall positive results of these TSC tests in the bridge market have generated a wealth of information and much is known today about their origin and benefits. TSC have proven to be the longest lasting coating systems available. They are the most cost effective from a life cycle cost (LCC) analysis and their initial application cost is continuing to drop (1). This paper will discuss the present status of TSC as an approved alternative coating system and what needs to be done in order to effectively promote their use as a viable mainstream coating system to benefit the future bridge coatings market.

Introduction

Dr. Max Ulich Schoop from Zurich is credited with inventing the thermal spray process around 1910. Dr. Schoop filed worldwide patents for his new revolutionary process from 1910 through 1913. The original process used molten metal, which flowed through hoses to a nozzle, surrounded by an annular orifice and was atomized with very high gas pressure (2). While these coatings were slow and crude they proved to be very effective.

The modern definition of Thermal Spraying is as follows:

"Thermal Spraying is a group of processes in which finely divided metallic or nonmetallic surfacing materials are deposited in a molten or semi-molten condition on a prepared substrate to form a sprayed deposit" (3).

In addition to their use as a corrosion control coating, TSC are used in other industrial market segments. In fact, the largest and primary market for TSC is the restoration or machine element repair industry. This is a very large, diverse and mature market segment that uses metallics, carbides and ceramics to restore worn dimensions to a variety of stationary and rotating equipment subject to erosion, high temperature and wear. Components that can be repaired by this process include, but are not limited to, shafts, impellers, bearing surfaces, turbine blades, pump housings etc. They are also being increasingly used to coat new surfaces before they are put into service, thereby delaying time-to-first-maintenance. This extends their useful life, further reducing overall operating and maintenance costs. A smaller but well-established market segment that also benefits from the durability of TSC is the safety or non-slip coating market. Metallic non-slip coatings are used in a variety of industries and applications where traditional epoxy non-slip coatings have a limited service life. Other industries, the oil & gas in particular have seen a substantial increase in the use of TSC on offshore production platforms and pipeline projects.

The smallest but fastest growing market segment for TSC is the protective coatings market. Another term or word widely used for TSC in the protective

coatings market is “metallizing”. Twin wire arc spray is the most productive and therefore, the most widely used thermal spray process in the marine, industrial, and bridge coatings market.

Benefits of Metallizing

There are numerous advantageous and benefits derived from using the metallizing process. The following are a few of the most important and well established:

- Long-Term-Performance
- Zero Volatile Organic Content (VOC) – 100% Solid Coating
- No Cure Time
- No Minimum Application Temperature
- Lowest Life Cycle Costs (LCC)

In addition to these well-known benefits, metallizing could potentially contribute to both the field maintenance and new construction or fabrication sectors of the bridge coating market.

Potential benefits for field maintenance metallizing:

1) Rapid deployment coating systems: In addition to the traditional liquid coatings used for this method, in some cases metallizing could offer an equally short production period with a coating system that would last substantially longer. This would reduce the need for future problematic and expensive lane closures.
2) Expansion joints: The use of metallized coatings for the highly corrosive area ten feet back on each side from expansion joints of bridge beams would be an excellent use of metallized coatings to their fullest potential.
3) Bearing pads: Metallized coatings could handle the expansion and contraction stresses associated with the bearing pad areas much better than traditional liquid coatings.

All of the above examples would benefit from the superior cathodic protection provided by a pure metallic coating (4).

Potential benefits for the bridge fabrication industry:

1) An increasingly large amount of physical space is needed by bridge fabricators to apply multi-coat paint systems. This causes logistical problems and is expensive. This negative impact could be substantially reduced, if metallizing and a one-coat sealer system were adopted.
2) Hourly, daily, monthly and annual VOC emissions could be substantially reduced.
3) If metallizing were applied in a shop environment with proper production equipment and quality control and quality assurance (QC/QA), the fabricator (and owner) could substantially reduce their liabilities associated with paint related problems.
4) The owner could have a long lasting coating system that results in more beneficial and accurate use of current and future maintenance dollars.

However, in order to fully realize these potential benefits, the process needs to be better understood. This is true for the owner, the fabricator and the contracting community. In order to achieve this understanding for any new or emerging industry, technology, or in this case, a coating system, it is critical that proper and

well thought out training and education take place.

Guides & Specifications

In the past twenty years the lack of recognized industrial guides, specifications and procedures were the largest impediment to the use of metallized coatings for corrosion protection. As a result of this deficiency, the TSC industry, consisting of equipment manufacturers, contractors, and suppliers, banded together in the mid 1980's to form the American Welding Society C2 Thermal Spray Committee. This committee put together a comprehensive Thermal Spray Guide titled ANSI/AWS C2.18-93 "Guide for the Protection of Steel with Thermal Sprayed Coatings of Aluminum and Zinc and Their Alloys and Composites." This Guide was many years in the making and was published and broadly distributed in 1993. As a result of this effort, owners such as the, FHWA, DOT, municipalities, private authorities and owners, became familiar and more comfortable with specifying metallized coatings for private and public projects. The creation and distribution of the AWS Guide substantially increased the use of metallized coatings for the remainder of the 1990's. As an example, in the early 1990's before the introduction of this Guide there may have been two to four bridge metallizing projects out for bid annually, and most of these were small test projects. By the late 1990's to early part of this century it was not uncommon to see at least twenty bridges out for bid annually. The number of states specifying metallizing is also growing annually (5). In addition, the overall size of the bridges themselves are going from small single span bridges to larger more complex structures.

In an attempt to stay abreast of this quickly expanding industry and streamline the competing, and sometimes conflicting Guides and Specifications, AWS, NACE and SSPC joined together to create a new Tri-Society Specification titled C2.23M/C2.23: 2003, "Specification for the Application of Thermal Spray Coatings (Metallizing) of Aluminum, Zinc, and Their Alloys and Composites for the Corrosion Protection of Steel". This document was introduced to the public in March 2003. This Tri-Society document is designated AWS C2.23M/23:2003, NACE No. 12 and SSPC-CS 23.00. Again, this new Tri-Society Specification's purpose was to create an even more up-to-date and more uniform document that could be used by owners as a Specification instead of a Guide. One of the reasons that lead to the creation of this specification was that different owners interpreted the original AWS Guide differently. Unfortunately this lead to a wide variety of Thermal Spray Specifications on the street, leading to confusion and quality related issues. The overall effect of this new Tri-Society Specification should further increase the use of metallized coatings with less confusion, particularly within the bridge coating industry.

Training & Certification

With any emerging coating system there are several impasses and milestones that must be overcome in order for it to become successful and mainstream. As previously mentioned the first and most important issue for TSC was overcoming the technical issue of uniform industrial specifications. History proved that introducing acceptable uniform specifications to the marketplace was successful in increasing the number of metallizing projects going out for bid on an annual basis. This has proven to be a good news – bad news scenario for the thermal spray industry. Obviously the good news

was that more projects were hitting the street: equipment manufacturers were selling more equipment; wire suppliers were selling more wire; there were new opportunities for coatings contractors. The most important part of this equation was that more bridges were receiving long-term protection from metallized coatings. This is all good news – right? For the most part the answer is yes. As a result, the volume of work started to exceed the capacity of qualified contractors with properly trained personnel. Another contributing factor for quality related problems was that while owners were comfortable with monitoring QC/QA for conventional paint systems, they were completely unprepared (i.e. untrained) to properly monitor the more stringent production and QC/QA steps associated with metallizing. Therefore they relied on the contractor, for the most part, to monitor both production and quality. While this worked in the early stages when projects were small, as projects became larger and more common place this inconsistency in QC/QA procedures allowed quality related problems to manifest themselves more frequently.

Now that uniform TSC specification are in place, the next milestone that needs to be overcome is proper training of technicians, contractors, QC/QA inspectors, and owners. In order for TSC to emerge as a mainstream bridge coating, both in the shop and in the field, owners need to decide among themselves if TSC are a viable coating solution for their industry. If the answer to this question is yes, then they need to work more closely with industry on coordinating proper education through training and certification for this emerging industry.

The answer to this question may have already been answered. SSPC recently accepted QP 6 “Standard Procedure for Evaluating the Qualifications of Contractors Who Apply Thermal Spray (Metallizing) for Corrosion Protection of Steel and Concrete Structures. In addition, AWS C2.16/C2.16M2000 “Guide for Thermal Spray Operators Qualification and its Annex A (Safety Information for Thermal Spray) has been effective for the last few years. If owners were to specify that these two documents be invoked, quality related issues for all future metallizing projects would all but be eliminated.

Summary

TSC or metallizing has come a long way in the last two decades. This is true in many respects. Many improvements have come in the form of production, quality of the coatings, and uniform industrial Guides, Specifications and Procedures. Another significant development in the past few years is the reduction of the initial application cost to metallize. This should also increase the use of metallized coatings. Because of this, the entire initial cost and LCC conversation needs to be revisited. NACE Paper No. 299, “Is Painting Structural Steel More Expensive Than Metallizing?” goes into this topic in greater detail and should be carefully reviewed by any owner considering using metallizing for their structure (6). All of these positive developments point to an industry that is becoming more mature.

Conclusion

In order for metallizing to be considered a mainstream coating system that is specified on a regular basis all interested parties need to be more thoroughly educated. Education needs to include both a top down and bottom up approach. In other words, information needs to be shared by all

parties. In order to learn and benefit from the mistakes made to date, concerns from the owners, fabricators and contractors all need to be put on the table and debated intelligently. Training and certification of thermal spray technicians, coatings contractors, QA inspectors and owners is in everyone's best long term interest and will prevent the same mistakes being repeated. Just like uniform specifications significantly increased the use of metallized coatings, a more uniform understanding through education will lead to a mature industry where suppliers and contractors will benefit from a larger more diverse marketplace. In addition, owners will have the piece of mind that TSC coatings are being applied correctly and will benefit from the long-term protection provided by TSC. The proper tools are in place, we now just need to implement them.

References

1) Robert Kogler, J. Peter Ault, Christopher L. Farschon, Federal Highway Administration, "Environmentally Acceptable Materials for the Corrosion Protection of Steel Bridges", (1997)

2) L. L. Shreir, R. A. Jarman G. T. Burstein, "Corrosion – Third Edition", (1994), Chapter 12, p. 85.

3) AWS Thermal Spraying: Practice, Theory and Application, Chapter 1, para. 1.2.

4) Robert A. Sulit, "Thermal Spray Coatings for the Protection of Steel", AWS Thermal Spray Symposium, (1997)

5) Robert A. Kogler & Carl Highsmith, Federal Highway Administration "Achieving Long-Term Coating Performance", Metallizing for Corrosion Control (Sept. 2000)

6) Joseph T. Butler, Paper No. 299, "Is Painting Structural Steel More Expensive Than Metallizing?", NACE International Conference, (1999)