Application Variables for Arc-Spray Coatings: A Review

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Arc-spray metal coatings are becoming more widely used for a variety of applications, including heat and corrosion resistance in the transportation and infrastructure industries. For example, coatings of zinc and aluminum and their alloys offer outstanding corrosion resistance. Aluminum coatings are resistant to high temperatures. Although the installed cost of arc-spray metal coatings, or metallizing, is often high compared to liquid-applied coatings, metallizing can be cost-effective in the long run if applied correctly. Several variables can affect the quality of arc-spray metal coatings, including the equipment and its setup, spray parameters, and surface preparation.

As metallizing in the field becomes more common, a review of variables that affect its application can be useful, especially to owners and specifiers. One group of owners that has studied metallizing for many years is the U.S. Army Corps of Engineers. This article reviews research performed by the Corps of Engineers on the application variables of arc-spray on steel.[1] The report is titled "An Evaluation of Application and Surface Preparation Parameters for Thermal Sprayed Coatings." While several types of thermal spray equipment are available, the focus of this review is on arc-spray because of its field portability and high production rate.

Variables in the Study

Equipment variables studied include the actual equipment used, type of metal, and wire diameter. The equipment variables affect both the cost of application and the coating quality. The type of metal used is dictated by the end user and reflects the exposure environment and intended use of the coating.

Equipment setup variables include the electric current, which forms the arc to melt the wires, and the air pressure, which atomizes and propels the metal to the surface. Current is optimized to increase production rates (wire feed rate is proportional to the current) as well as coating quality. Atomizing air pressure is optimized to reduce coating roughness, oxidation, and porosity, and increase productivity and transfer efficiency. Current and atomization air pressure that are either too high or too low may compromise the coating quality.

Operator variables include the spray angle and spray distance. If the spray angle deviates too far from normal to the surface, then coating transfer efficiency, morphology, and quality will be negatively affected.

Surface preparation variables are those parameters that affect the shape and depth of the blast profile. Profile shape is dictated by the shape of the media. Angular media such as aluminum oxide produce an angular profile. Sub-angular media such as used recycled steel grit will produce a sub-angular profile. Steel shot will, of course, provide a rounded profile. Blast media kinetic energy and size affect the depth of the blast profile.

Experimental

Experiments were conducted using classical and statistically designed fractional-factorial schemes. The arc-spray variables included spray angle, spray distance, current, and system pressure. The experiments were planned to illustrate the range of variables and their effects on the applied coating. Coating quality was quantified by measuring the adhesion (pull off), and oxidation and porosity (optical metallography). The transfer efficiency was determined by mass transfer. Six coating systems were evaluated, including $\frac{1}{8}$-inch 85Zn/15Al, $\frac{3}{16}$-inch 85Zn/15Al, $\frac{1}{8}$-inch Al, $\frac{3}{16}$-inch Al, $\frac{1}{8}$-inch Zn, and $\frac{3}{16}$-inch Zn. Experimental equipment setup and operator variables were selected to reflect the manufacturer-recommended parameters. High and low values were selected that bracketed the recommended parameters. Atomization air pressure values were 90, 100, and 110 psi. Standoff distance values were 6, 9, and 12 inches. Electric current values were 2,540; 350; and 450 amp. Spray angle

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