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Thermal Spray Coating Process and its variants

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Thermal Spray Coating Technology is universal, it allows to apply coverings on different basic surfaces: metal, plastic, wooden, etc. These methods allow to put the following types of coverings: wear resistant, corrosion resistant, antifriction, heat resistant, thermobarrier, electric insulation, electrowire etc. These technologies can find the application in different industries, for example such as: mechanical engineering, medicine, aviation and space industry [1].

Thermal spray is a generic term for a group of processes that utilizes a heat source to melt material in powder, wire or rod form. The molten or semi-molten material is propelled toward a prepared surface by expanding process gases. The particles quench rapidly, upon impact with the surface, and bond with the part. Subsequent impacting particles create a coating buildup. Several variations of thermal spraying are distinguished: *Plasma-Arc Spray Coating, Electric-Arc Spray Coating, Flame Spray Coating, High Velocity Oxy-Fuel Coating (HVOF) and Cold Spray Coating* [2, 3].

Plasma-Arc Spray Coating

In plasma spray devices, an arc is formed in between two electrodes in a plasma forming gas, which usually consists of either argon/hydrogen or argon/helium. As the plasma gas is heated by the arc, it expands and it is accelerated through a shaped nozzle, creating velocities up to MACH 2. Temperatures in the arc zone approach 20,000°K. Temperatures in the plasma jet are still 10,000°K several centimeters from the exit of the nozzle. Depending on the gun power rather high-powder flow rates can be deposited (up to 10 kg/h) [1, 4].

Electric-Arc Spray Coating

Electric-arc spray coating uses a simple, low power arc drawn between two electrically charged wires. Arc spray equipment resembles GMAW (MIG) welding equipment, in the power source and wire feeding units. Common arc spray units are capable of spraying iron and copper alloys at rates up to 18 Kg/hr. Electric-arc spray coating devices are thermally efficient and, because of this there is no flame or plasma, little heat is transferred to the part being coated [1, 4].

Flame Spray Coating

Flame spray is divided into three subcategories, based on the form of the feedstock material, either powder-, wire-, or rod-flame spray. Flame spray coating utilizes combustible gasses to create the energy necessary to melt the coating material. Combustion is essentially unconfined, in that there is no extension nozzle in which acceleration can occur. Common fuel gases include hydrogen, acetylene, propane, natural gas, etc. The lower temperatures and velocities associated with conventional flame spraying typically result in higher oxides, porosity, and inclusions in coatings. Rates of sputtering can reach 6 kg/h. [2 – 4].

High Velocity Oxy-Fuel Coating (HVOF)

High-velocity, oxy-fuel, (HVOF) devices are a subset of flame spray. There are two distinct differences between conventional flame spray and HVOF. HVOF utilizes confined combustion and an extended nozzle to heat and accelerate the powdered coating material. Typical HVOF devices operate at hypersonic gas velocities, i.e. greater than MACH 5. The extreme velocities provide kinetic energy which helps produce coatings that are very dense and very well adhered in the as-sprayed condition. Rates of sputtering can reach 9 kg/h. [3, 4].

Cold Spray Coating

Cold spray is technically not a true thermal spray process because it does not use thermal energy as the primary energy source to melt materials. Instead cold spray utilizes kinetic energy to project particles onto a prepared surface. The extreme velocities of the process cause plastic deformation of the particles on impact, which in turn creates very dense coatings. An analogy to how a cold spray coating is created is that the particles are essentially friction welded to each other during impact. Rates of sputtering can reach 3.5 kg/h [1, 2].

Conclusion

Forming of coverings by Thermal spray methods allows not only to strengthen parts, but also to recover already worn out parts. These methods are suitable for strongly worn out parts. Recovery of parts allows reducing the cost of replacement of parts. It allows to reduce idle time and to prolong life cycle of worn out parts. Among the provided methods the most productive is plasma method; however its application is limited to the admissible level of workpiece temperature.

References:

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