A Review on Coating of Titanium Alloy on Mild Steel Using Thermal Spray Techniques

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ABSTRACT: The surface of the material can be protected by the coating process. The coating itself use for covering the whole surface or particular parts of the mild steel substrate. Various coatings are used to achieve the desired properties. In that, Thermal spray coating is one of the most effective methods to protect the new parts from wear, erosion, high temperature corrosion, and to provide hard and dense coatings, thus life of the material is increased. The optimum coating process is selected on the basis of desired coating properties. The material which is using for coating is in the form of wire, powder, rod, cord or molten-bath form. In this paper an effort has been made to focus on Electric arc welding spray, Cold spray, Flame spray, High velocity oxy-fuel spray (HVOF) technique- their basic principle and benefit.

1.INTRODUCTION:

A coating is a substrate that is used to cover the surface of an object. It improves the surface properties of a substrate and the properties differ by different methods of coating processes. In industries, the important properties required are thickness, porosity, adhesion, deposition rate and surface finish. The coating process is selected based on the end uses.

Durability is an important factor required by coating process. It is mainly important during setting up of pipelines, mining equipment's, tunnels and other monopolies like automobile, aerospace, shipbuilding, gas mining, etc. Coating also improves the surface properties like adhesion, corrosion resistance and wear resistance.

2.LITERATURE SURVEY

2.1 CLASSIFICATION OF COATING:

Coating is mainly classified into three types. They are:

- **OVERLAY COATING:** It is a gradient overlay coating which provides high temperature corrosion protection in wide range of operating conditions. Overlay coating improves the wear resistance of all the substrate materials. The performance of overlay coating is determined by the functional properties and adhesion. [1][2]

- **DIFFUSION COATING:** Metal components subjected to high temperature conditions and highly corrosive environments are coated with a non-corrosive material. It is also called surface alloying. New element is diffused onto the substrate surface. [1][2]

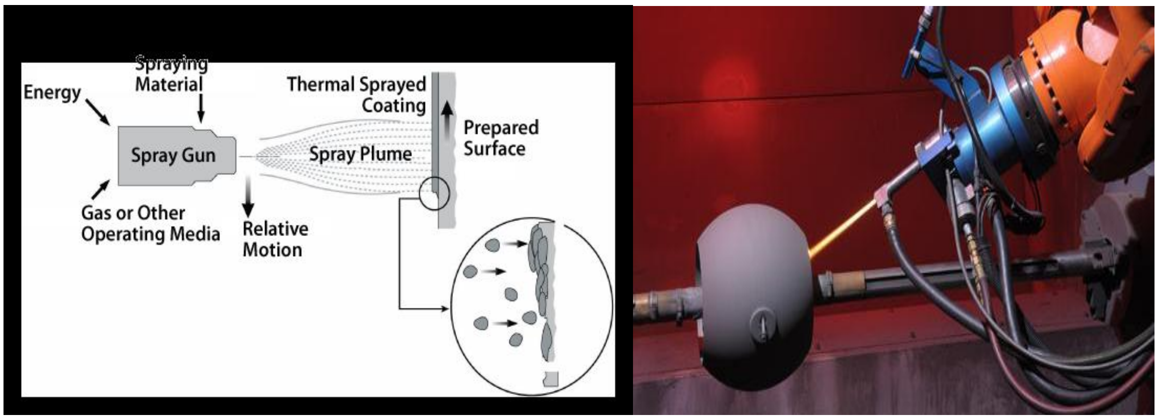
- **THERMAL SPRAY COATING:**

Thermal spray coating process that consists of a heat source and a coating material in a powder or wire form which is literally melted into tiny droplets and sprayed onto surfaces at high velocity. Thermal spraying is widely used in the coating properties and in particular residual stresses. Its applications include wear resistance, frictional control, corrosion resistance, dimensional restoration and thermal applications. [3][4]

2.2 Thermal spraying

It is a low coating method which is using in thin coating for changing the surface properties of given substrate. The rate for production is little high and coating hold is also tolerable. Thermal spraying is widely used in application of aircraft engine, automotive, bridge, dies, marine turbine. There are many type of thermal spraying process like: Flame spraying, Electric arc welding spraying, plasma spraying, High velocity air fuel spraying (HVAF), cold spraying. [5]

A great advantage of this process is the extremely wide variation of material that can be used to make a coating. Almost any material that melts without decomposing can be used. Thermal spray process to apply a coating to a component without expressively heating it.



(A) General schematic diagram of thermal spray coating processes and (B) Thermal spray coating set-up.
Fig no: 2.1-Thermal Spraying

(a) Cold spray

The Cold Spray or cold gas-dynamic spraying process is the next reformist step in the development of high kinetic energy coating processes. As like as other thermal spray principle, it also follows the trend of increasing particle spray velocity and reducing particle temperature as with the HVOF/HVAF processes. [6]

The Cold Spray process basically uses the energy stored in high pressure compressed gas towards propel fine powder particles at very high velocities (500 - 1500 m/s). Compressed gas (usually helium) is fed via a heating unit to the gun where the gas exits through a specially designed nozzle (lava type convergent-divergent nozzle mostly) at very high velocity. Compressed gas is also fed via at high pressure powder feeder to introduce powder material into the high velocity gas jet. The powder particles are accelerated and temperately heated to a certain velocity and temperature where on effect with a substrate they deform and bond to form a coating. As with the other processes a fine balance between particle size, density, temperature and velocity are important criteria to achieve the desired coating. [7][8]

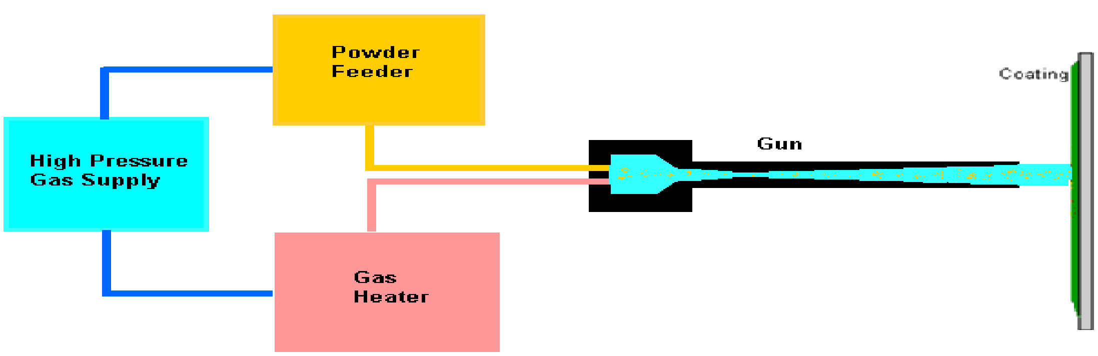
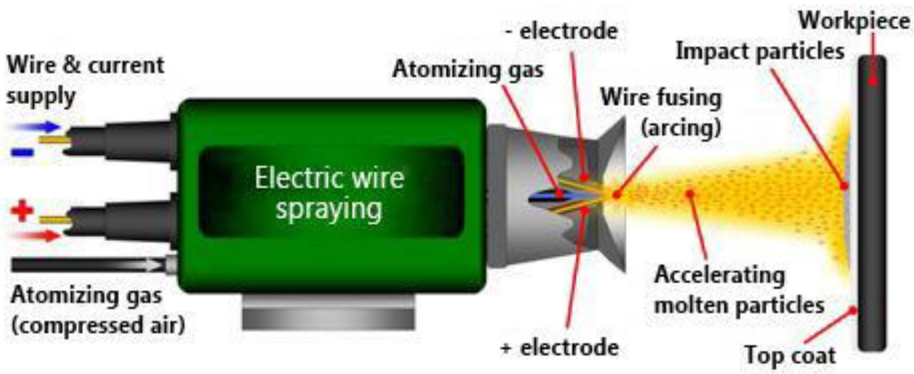


Fig no: 2.2 –Cold Spraying

(b) Electric Arc Wire Spray

In the electric arc spray process, two consumable wire electrodes connected to a high-current direct-current (dc) power source arc fed into the gun and meet, establishing an arc between them that melts the tips of the wires. The process is energy efficient because all of the input energy is used to melt the metal. [9]

The molten metal is atomized first and then propelled toward the substrate by a stream of air. Spray rates are driven primarily by operating current and vary as a function of both melting point and conductivity. No hot jet of gas is directed toward the substrate, so the substrate temperature is very low. Electric arc spraying also can be carried out using inert gases or in a controlled-atmosphere chamber [10] [11]



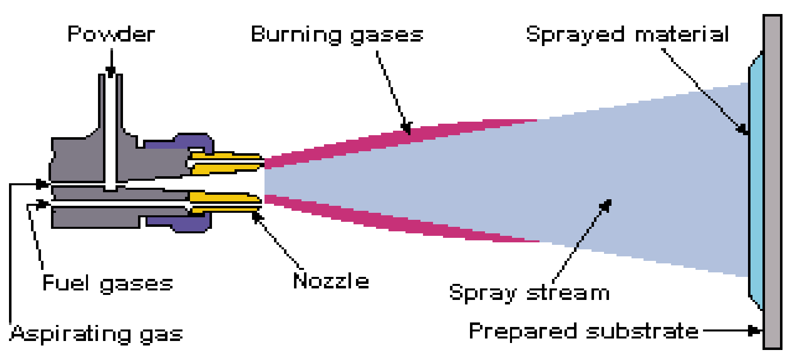
Schematic diagram of electric arc wire spray process

Fig no: 2.3-Electric Arc Wire spray

(B) Flame Spray

Flame spraying is the oldest of the thermal spraying processes, characterized by low capital investment, high deposition rates and efficiencies, and relative ease of operation and cost of equipment maintenance. Flame spray uses combustible gas as a heat source to melt the coating material. A wide variety of materials can be deposited in wire, or powder form as coatings using this process [14]. Flame spray guns and vast majority of components are sprayed physically.

Most flame spray guns can be modified to use several combinations of gases to balance operating cost and coating properties. Acetylene, propane, methyl – acetylene – propidine (MAPP) gas, and hydrogen, along with oxygen, are commonly used flame spray gases. Flame temperatures and features depend on the oxygen-to-fuel gas ratio and pressure. Low velocity powder flame and wire flame processes and high velocity processes such as HVOF and detonation gun are hold in flame spray [15].



Schematic diagram of flame Spray

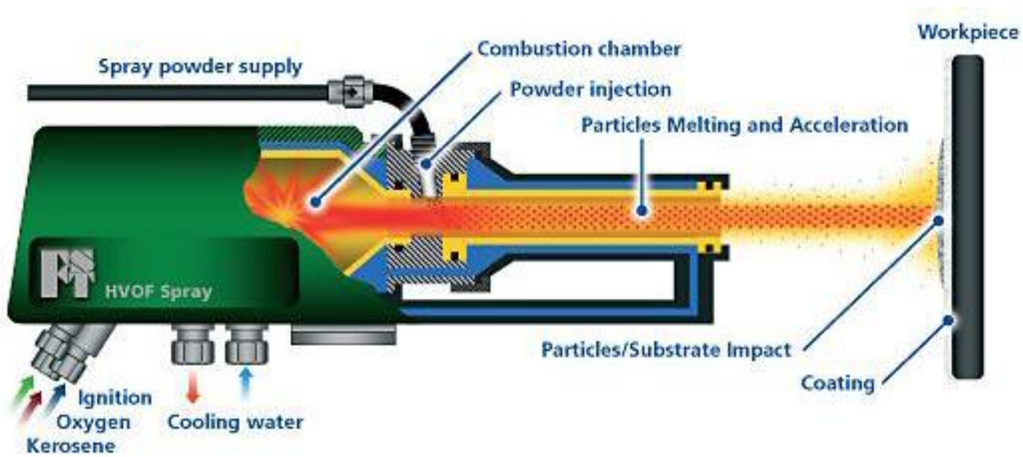
Fig no: 2.4-Flame spray

(d) High Velocity Oxy-Fuel Spray (HVOF)

In the early 1980s Browning and Wit field, using rocket engine technologies, introduced a unique method of spraying metal powders, the technique was referred to as High Velocity Oxy-Fuel (HVOF). The process utilizes a concoction of oxygen with various fuel gases including hydrogen, propane, propylene, hydrogen and even kerosene. [16]

The spray powder fuel and oxygen are introduced to the combustion chamber together with in the HOVF process. The combustion of the gases produces a high temperature and high pressure in the chamber, which causes the supersonic flow of the gases through the nozzle. The powder particles melt in the disturbance chamber and during the flight through the nozzle. The flame temperature varies in the range of 2500 °C to 3200 °C, depending on the fuel, the fuel gas/ oxygen ratio and the gas pressure [17]. In the HVOF process the grain melt completely or only by degrees, depending on the flame temperature, particle dwell time, material melting point and thermal conductivity. As it uses a hypersonic jet, setting it alone from conventional flame spray, the speed of particle impacts the substrate is much higher, resulting in improved coating bearing. The mechanism differs from flare spraying by a development of the jet at the exit of the gun. The benefits of this process are the process temperature is acceptable but the particle velocity on impact is very high. [18] [19]. The resultant coatings are generally very dense, adherent and contain few oxides. These processes are suited to spraying high quality metallic coatings as well as cermet's. The quality of the coatings makes them very agreeable as an application method for a bond coat within a TBC system. The HVOF process, having high kinetic energy and comparably low heated energy, results in a positive effect on the coating characteristics and is favorable for spray materials such as tungsten carbide coatings. [20]

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. normal HVOF devices operate at plodding gas expedition, i.e. greater than MACH 5. [21] The extreme velocities animated energy which help outcome coatings that are very dense and very well be attached in the build sprayed condition. The capability to produce dump coatings with low amount of degradation, oxidation of metallic materials, and phase transformations is the main feature of the HVOF process. This is due to the short dwell time of the particles in a relatively cold flame. It is generally used to produce cermet and alloy coatings, but the HVOF process has also been demonstrated to be able to deposit dense ceramic coatings. However, the drawback of this technique is that coating is not 100% crystalline. Afterward table shows comparison of heat cause, flames temperature, gas expedition porosity and coating grip in various thermal spray coating processes. [23]



Schematic diagram of high velocity oxy-fuel spray (HVOF) process

Fig no: 2.5- High Velocity Oxy-Fuel Spray

CONCLUSION

Surface coating is the process which enhances the existence of the product and minimizes the frequent substitution of the components. The main objective of surface technology is to protect the physical properties like abrasion resistance, breathability and safeguard from loss or destruction of materials. Thermal spray coating acts as the best methodology for the surface coating. This study gives knowledge regarding the important techniques of Thermal Spray Coating. We can conclude that High Velocity Oxygen Fuel (HVOF) is the best suitable method. By this method, the opacity, rigidity, abrasion resistance and constant covering of surface is possible. The main purpose is to increase the durability, firmness, permeability, abrasion resistance and corrosion.

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