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Optimization of Spraying Process in Thermal Power Plant using Robot

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Abstract: ***To synthesize the surface of the metal bodies, a thermal spray coating is used. There is a great need for this new coating technology in today's progressive world where modification of the substrate material is carried out a great deal. Thermal spray covering, electroplating, powder metallurgy and other metallurgical processes are used very quickly in the field of surface modification. We have presented the summary of all different types of thermal spray coating in this review paper and the advantages of high-speed oxy fuel coating. There is a literature review and an experiment was conducted on behalf of that to demonstrate the effect of coating on mild steel plate. Through Robot, we present a proposed optimization of the spraying process in a thermal power plant. We will explore the thermal spraying and oxidation effect on deposited aluminium and bronze in this research work. We present a detailed assessment of the robot kinematics and optimize the generation of the robot trajectory with a focus on the constant relative scanning speed. The results show that the motion behavior of each axis of robot permits to identify the motion problems in the trajectory. This approach enables the generation of robot trajectories in a limited working envelope to be optimised.***

Keywords**: *Spraying Process, Robot, Thermal Power.***

I. INTRODUCTION

The problem of spray optimization is inseparably connected with the improvement of coating properties and the increase in their area of application. The typical optimization issue can be subdivided as follows for the TSP, as for any complex multi-parameter process: I to determine the primary governing parameters to be optimized, i.e. those parameter values that have the greatest impact on the determination of the coating properties, and to determine the preliminary range of variance of parameters; (2) to determine the optimum values for the properties of the coating; and (3) to determine ways in which the process can be altered to further improve the properties of the coating. However, the review of the literature for the details mentioned in item 2 raises major problems due to a large number of detailed data on thermal spray coatings, along with the various different coating applications. In order to solve the second part of the optimization process, due to the complexity and number of the process parameters, a detailed experimental analysis of TSP will be prohibitively costly. In addition, different fields that are stochastic in nature define the primary physical characteristics of spray particles and their interaction with the substrate. Therefore, creating a model of the physical conditions should be a required step in a thorough analysis of the spraying process. This fact poses additional problems for the experimental optimization of TSR. In this we covered introduction of thermal spray technology, thermal spray automation, thermal sprayed coating, spraying Robot and Robot programming then mainly focusing the spraying process in thermal power plant. In this chapter we clearly stated that the detailed description of the title relevant contents. Mainly we focused problem statements and objective of the study.

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II. LITERATURE SURVEY

Thermal spray techniques were developed in the early 1900s in Zurich by Max Ulrich Schoop. Wire flame spray, which is also known as metallizing, was the very first type of thermal spray technique. At that time, the method was to first melt metal in the form of wire, either pure or alloyed, and then spray the metal on a substrate with a jet of high-speed compressed air. At the beginning, the main problem with this method was the high porosity and low bond strength of the coatings. Later, Max Ulrich Schoop developed electric arc wire spray. In the 1930s, power-form spray materials were introduced in this field. In the 1960s, the introduction of plasma spray, which could use both metals and refractory materials, was an important breakthrough. More thermal techniques were developed after that. As the use of thermal spray techniques is becoming increasingly widespread in many industries, interest in WTE plants has also increased.

Flame Spray

Flame spraying can use materials from feedstock in either powder, wire, or rod form (Flame Spray.). Figure 1. illustrates the approach of wire- or rod-form feedstock materials.

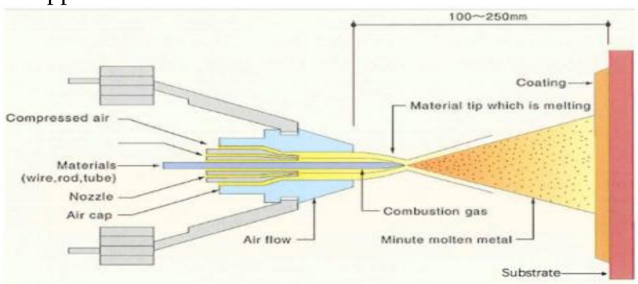

Figure 1: Schematic for flame spray with wire- or rod-form feedstock materials

(Wire Arc Spray vs. Wire Flame Spray.)

The feedstock materials are inserted through the spraying torch's centre hole where the surrounding combustion gas melts them. The molten particles are then sprayed with high-speed compressed air on the surface of the selected substrates (Wire Arc Spray vs. Wire Flame Spray.). The powdered feedstock material mechanism is shown in Figure 2.

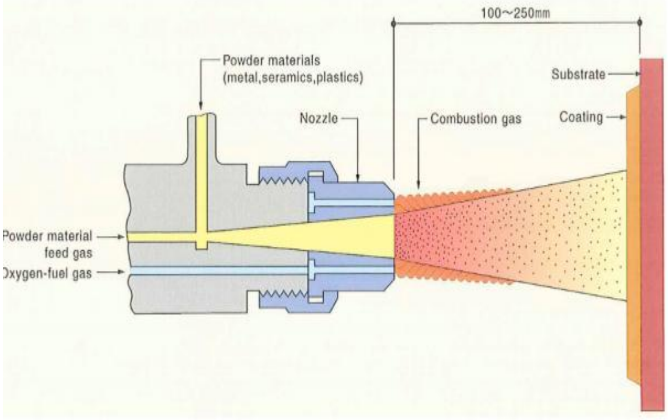

Figure 2: Schematic for flame spray with powder -form feedstock materials (Wire Arc Spray vs. Wire Flame Spray.)

The powder-form feedstock materials are carried into the torch by the carrier gas stream, instead of inserting the feedstock into the spray torch (Wire Arc Spray vs. Wire Flame Spray). Hydrogen, acetylene, propane, natural gas, etc., may be the fuel gas (Flame Spray). The benefits of this technique are lower cost of equipment and flexibility to apply on-site (Wire Arc Spray vs. Wire Flame Spray.). In comparison to other thermal spray techniques (What are the disadvantages of flame spraying?), the disadvantages are high porosity (10-20 per cent), low density, and high oxide occlusion (10-20 wt per cent) of the coating; and lower bond stretch between coatings and substrates.

For metallic materials, high velocity oxy-fuel spraying is commonly used because its higher temperature generates denser and well-adherent coatings with a strong bond to the substrate in combination with the high particle velocity at the impingement on the substrate. HVOF spray can also produce coatings with less than 0.5 percent porosity[1].

There are two types of HVOF: one is a liquid-fueled high-speed oxy-fuel (HVOFLF) spray that uses liquid fuel and a Carbide Jet Spray (CJS) gun; the other is an oxy-fuel gas-fueled (HVOFGF) high-speed spray that uses gaseous fuel and a Diamond Jet (DJ) gun. DJ guns generate higher temperatures and lower speeds than the CJS process and have been found to be more suitable for very tiny particle feedstock[2].

The high velocity air-fuel (HVAF) spray that uses air instead of oxygen is another thermal spray technique, similar to the high velocity oxy-fuel spray process, so it is less expensive to operate. The high velocity air-fuel process is exactly the same as the spray of high velocity oxy-fuel. The lower HVAF temperature, however, results in lower residual tensile and compressive stress coatings [3].

III. PROPOSED WORK

In the field of thermal spray, industrial robots are commonly used nowadays. Due to their high-precision and programmable versatility characteristics, it is possible to spray on complex geometrical work pieces in the fitted spray space. In certain cases, however, the process parameters specified by the robot's movement, such as the scanning trajectory, the angle of spray, the relative velocity between the torch and the substrate, etc., cannot be guaranteed by the robots, which have distinct effects on heat and mass transfer during the generation of any thermally sprayed coatings. An inquiry into robot kinematics was suggested in this paper to find the rules of motion in a common case. The results show that each axis of the robot's motion behavior allows the motion problems in the trajectory to be defined. This method enables the generation of robot trajectories in a small working envelope to be optimized. In order to achieve a more constant relative scanning speed that is represented as a key parameter in thermal spraying, it also minimizes the effect of robot efficiency.

Experimental development Surface preparation

The substrates used were 12.5 mm phosphor bronze diameter, 3 mm thick cylinders polished on the surface preparation of the substrate with 80 um grain sand in order to clean the surface and to achieve sufficient roughness for enhanced coating adhesion. The following planning techniques were used. Shot blasting requires Al_2O_3 in two steps. Alumina with a particle size of 100 um, a particle size of 100 psi for 10s, then 500 um for the same pressure and time conditions was used in the first step. The surface was also prepared by sand blasting using industrial sand with 200 um particle size, 100 psi pressure and 10s.

The surface was prepared for 10 seconds using an abrasive disc grinder. After surface preparation, a degreaser was applied and dried with pressurised air.

Coating deposition

21021 Proxon coatings were produced by thermal flame spray (using powder) with a CastoDyn 8000 gun (i.e. modular acetylene equipment). The coatings were deposited on phosphor bronze and on the Ni-Al base layer deposited on phosphor bronze used in industry, in order to improve system adhesion. Different deposition situations were used for base layer deposition and the coating. Four bars were used for oxygen pressure, 0.7 bar for acetylene pressure, 0.6 bar for compressed air pressure and 150 mm for projection size. The substrate temperature was about 120°C. With the coatings, about 80 um thickness and 10 to 15 um base layer were deposited.

Microstructural characterization

The coatings were structurally characterized by x-ray diffraction using PANalytical X-pert Pro equipment operating at 45 kV and 40 mA at a grazing angle with copper Ka (1.540998 Å). Leco light microscope with convex lens, measured thickness and porous content by coatings' cross-section. Electron microscopy scanning with FEI QUANTA 200 in high vacuum and running at 30kV voltage has tested the surface of the coatings. In order to find Ra and Rsa roughness values, the confocal laser microscope obtained a morphological study of the coating surface using a Zeiss LSM 700 method.

IV. RESULTS

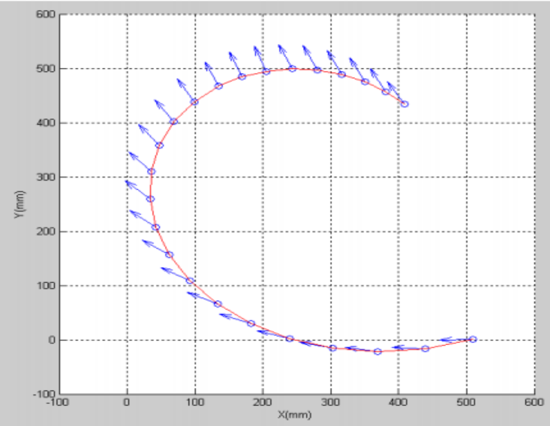

Fig.3 The robot's trajectory for approach II.

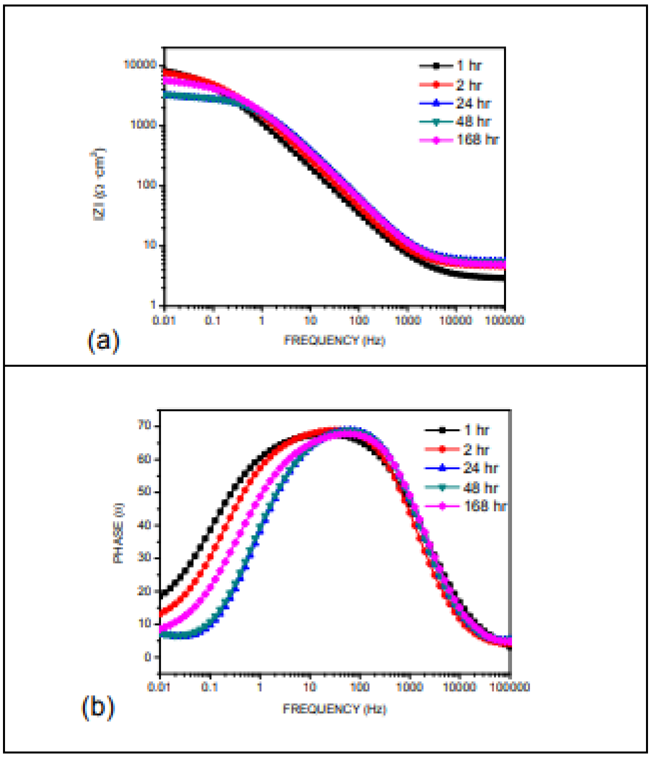

Fig.4 Bode plots compared to frequency for brass coating prepared with grit alumina and base layer (a) impedance. (b) Angle of phase relative to frequency.

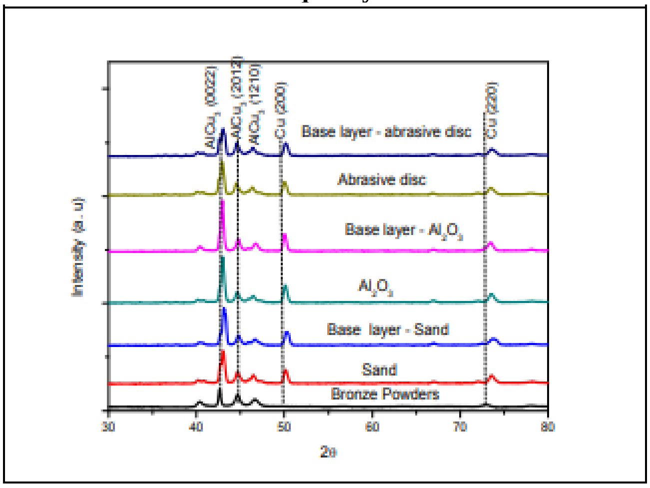

Fig.5 Pattern of X-ray diffraction Cu-Al coating accumulated on various surface preparations

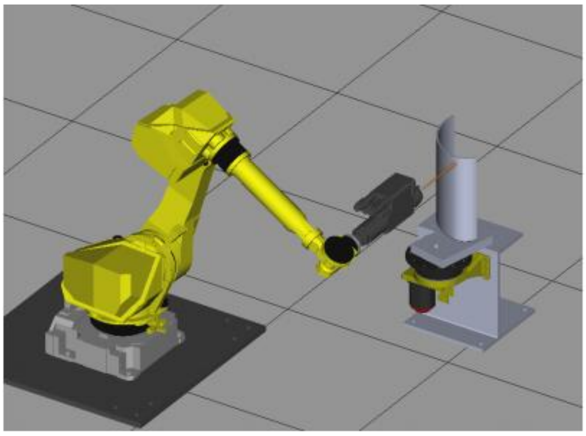

Fig. 6 Roboguide screen with a blade shaped by two arches and the outer axis

V. CONCLUSION

In the area of thermal spray, robots have been deemed reliable manipulators to conduct spray operations. On the one hand, the versatility and high precision of the robot provide improved efficiency and high quality of coating. On the other hand, the performance constraint and difficulty of the robot are some invisible concerns, such as failures to comply with trajectory and speed. Often, these errors can be avoided by choosing an acceptable location of the workpiece that modifies the robot's movement actions. In this research, the robot's kinematic analysis was suggested to investigate the relationships between workpiece placement and robot movement in this location. In this method, the weighted mean of standard deviation of joint velocity was chosen as an OP to calculate the complexity of a robot trajectory. Using spline interpolation on the recorded data, the best positioning of the workpiece on the restricted area of the worktable was finally determined. The outcome of the trajectory simulation on this position was then tested and validated in order to show that this method was feasible and applicable to the optimization of the robot trajectory for thermal spray applications during the off-line programming process.

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