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A Hardness Survey on AA 6063 over MS 1020 by Friction Surfacing

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ABSTRACT

Friction surfacing is the plastic deformation of metallic consumable rod over the base metal .The consumable rod AA6063 is coated over the MS1020 plate. In this process three parameters are involved Plunge feed, Traverse speed, Depth of coating. In DOE, regression model method is used to optimize the above parameters in a systematic manner. Then finally, hardness for the AA6063 coated material can be investigated and also check the corrosion resistance for coated material is examined.

Keywords-- Friction Surfacing, AA 6063, MS 1020, Hardness Testing

I. INTRODUCTION

Friction surfacing (FS) is a solid state technology with increasing applications in the context of localized surface engineering. FS has been investigated mainly for producing fine grained coatings, which exhibit superior wear and corrosion properties. The technique used to improve the performance of an underlying metallic surface.

The process involves rotating a solid consumable rod with one of its ends pressed hard against a substrate material like plate. Frictional heat is generated between the consumable rod and plate producing a plasticized layer. Lateral movement of the plate, relative to the rotating consumable rod depend upon the coating material.

Friction surfacing is related to the friction welding process, utilize the technology joining the two dissimilar materials while avoiding the temperature below the melting point and microstructure to be varied.

This paper to be present on consumable rod takes place Aluminium alloy (AA6063) and work material take place mild steel (MS1020).

The friction surfacing of Aluminium alloys presents an essential problem due to the high thermal conductivity of the metal. However with Aluminium heat quickly escapes upwards through the rod material. Effectively the cooling rate of the plate is increased to achieve the thermal balance between the rod and the plate to retain more heat in the metal transfer zone.

II. LITERATURE SURVEY

Ashok Kumar, Laxminarayana. P et al [1]: In demand to improve more ecofriendly and energy effective alternatives to fusion-based welding and cladding processes, Friction surfacing process, had been successfully developed over the past decade. The process is used for corrosion and wear resistant coatings and for reclamation of worn engineering components. The major requirement is for flexibility to enable rapid changes of process parameters in order to develop new applications, with variations of materials and geometries in term of cost and reliable manner. So, the present work deals with the solid state coating by friction surfacing process of various materials coated over substrate materials.

K. Chandrasekhar Reddy et al [2]: In this survey, an effort is made to develop linear regression models to evaluate reference evapo transpiration (ET 0) in Rajendranagar region of Andhra Pradesh, India. ET 0 estimated by the standard FAO-56 Penman-Monteith(PM) method was correlated linearly with the most influencing climatic parameters such as Temperature(T), Sunshine hours(S), Wind velocity(W) and Relative Humidity(RH) in the region of the study area for daily, weekly and monthly time steps. The enactment of linear regression models sustained was verified based on the evaluation criteria.

U. D. Gulhane , S. B. Mishra , P. K. Mishra et al [3]: In the present work, effect of Low Plasticity Burnishing (LPB) parameters in improving surface roughness of 316L Stainless Steel and Ti-6Al-4V have been investigated. Complete factorial DOE have been used to imagine the effect of LPB process parameters such as speed, pressure, ball diameter and number of passes on surface roughness.

Hiroshi Tokisue and Kazuyoshi Katoh et al [4]: 5052 aluminum alloy used for substrate and consumable rod, was friction surfaced using a numerical controlled full automatic friction welding machine. Effects of the surfacing conditions on some characteristics of deposits were investigated. It was clearly observed that the circularly pattern appeared on the surface of deposit by the rotation of consumable rod. The deposit has a affinity to incline near the advancing side additional than center of deposit for the feed direction of useable rod.

G.D. Janaki Ram, G. Phanikumar et al [5]: Tool steel H13 was friction surfaced on low carbon steel substrates. Mechtrode (consumable rod) rotational speed and substrate traverse speed were varied, keeping the axial force constant. The effects of process parameters on coating characteristics and integrity were evaluated. A process parameter window was developed for satisfactory deposition of tool steel coatings.

Margam Chandrasekaran, Andrew William Batchelor , Sukumar Jana et al [6]: Friction surfacing of (i) tool steel, inconel, aluminum and titanium rods onto mild steel substrates and (ii) stainless steel, mild steel and inconel onto aluminum substrates was investigated. It was found that tool steel and inconel were efficiently deposited onto steel to form a dense strong coating while aluminum was only deposited at high contact pressures.

K.PrasadRao, H.KhalidRafi, G.D.JanakiRam, G.Madhusudhan Reddy et al [7]: This work reports a feasibility study on producing friction surfaced coatings on nonferrous substrates. Commer- cially pure aluminum, copper, magnesium (ZM21), Inconel800, and titanium alloy (Ti-6Al-4 V) were chosen as the substrates. Low carbon steel, aluminum alloy (AA6063), commercially pure copper and titanium were chosen as the consumable rods. Friction surfacing was tried with all consumable rods on every substrate. In some cases metallur-gically bonded coating was obtained readily over the substrate and in some other cases coating was obtained with a start-up plate.

Satyaduttsinh P. Chavda, Jayesh V.Desai, Tushar M.Patel et al [8]: The MIG welding factors are the most significant factors affecting the cost of welding, productivity and quality. This paper presents the influence of welding parameters like welding current, welding voltage, Gas flow rate, wire feed rate, etc. on weld pool geometry and weld strength of Medium Carbon Steel material during welding. By using DOE method, the parameters can be optimize and having the best parameters combination for target quality.

S V Subrahmanyam , M. Sarcar et al [9]: Better finish, low tolerance, higher production rate, miniaturization, complex shapes and profiles of the harder, newer, latest materials like hardened steel, titanium, high strength temperature resistant alloy, fiber-reinforced composites and ceramics is the present demand of the manufacturing industries such as Aerospace, nuclear, missile, turbine, automobile, tool and die making. To satisfy these needs a different class of modern machining echniques, unconventional in nature, like Wire Electrical discharge Machining (WEDM) emerged.

A.Vairis and M.Petousis et al [10]: Identification of important process parameters using experiments desires to be formulated carefully as it can be a resource demanding process. Using appropriate statistical techniques such as the Taguchi method of factorial design of experiments, the number of necessary experiments can be reduced and the statistical significance of parameters can be safely identified. The occasion of linear friction welding it was seen that the frequency of oscillation, power input and forging pressure are statistically insignificant for the range of friction pressures studied.

Ved Prakash Singh, Vijay Patel et al [11]: Gas tungsten arc welding is a fusion welding process having wide applications in industry. In this process, suitable selection of input welding factors is necessary in order to control weld distortion and subsequently increase the productivity of the process. In order to obtain a good quality weld and control weld distortion, it is therefore, necessary to control the input welding parameters. In this research work, experiments were carried out on Austenitic stainless steel 304 plates of 5mm thick using gas tungsten arc welding

III. MATERIALS AND METHODS

A mild steel plate of 150mm length, 100 mm width, and 10 mm thickness was taken as base material and Aluminium alloy AA6063 of 20 mm diameter & 150 mm length as consumable rod for friction surfacing. Friction surfacing process is carried out in vertical milling machine in RV machine tool industry, Coimbatore.

3.1 MATERIAL SELECTION

The main goal of material selection is to minimize cost while meeting product performance goals. Systematic selection of the best material for a given application begins with properties and costs of candidate materials. So the material AA6063 and MS1020 has been selected.

3.2 IDENTIFICATION OF PROCESS PARAMETER

Friction surfacing process parameters influences the quality of bonding of the material. It also affects the mechanical properties of the coating.

The important three process parameter are

- Spindle speed (N)
- Traverse speed (S)
- Plunge feed (Z)

The model Table 1 using various parameter value in given below.

Table 1 Process parameter value

S.NO.	PROCESS PARAMETER PARAMETER	NOTATION	UNIT	LEVEL		
				-1	0	+1
1	Spindle speed	N	rpm	1800	2000	2200
2	Traverse speed	S	mm/min	100	150	200
3	Plunge feed	Z	mm	30	40	50

3.3 DESIGN OF EXPERIMENTS

Design of experiments (DOE) is a efficient method. It is to determine the connection between features affecting a process and the output of that process. In other words, it is used to find cause-and-effect relationships. This information is needed to manage process inputs in order to optimize the output.

3.4 DEVELOPMENT OF DESIGN MATRIX USING DOE

Design of experiments helps to identify the optimum combination of process parameters that gives the best output. Factorial design is used for investigating a fraction of all combinations which are formed from the factors under some investigation.

.Table 2 Development of Design Matrix Using DOE

O	INDLE SPEED (rpm)	TRAVERSE SPEED (mm/min)	PLUNGE FEED (mm)
1	1	0	1
2	-1	1	0
3	0	0	0
4	1	-1	0
4	0	1	1
6	1	1	0
7	-1	0	-1
8	0	-1	-1

The Table 2 shows the 8 sets of coated conditions used to form design matrix. All the 8 sets are conducted in Design Expert software to optimize the favor parameter condition for surfacing.

IV. RESULTS AND DISCUSSION

4.1 INFLUENCE OF PROCESS PARAMETERS

The Table 3 shows the identified parameter value for coating purpose. These values are extracted from design expert software and it is applied for coating on mild steel. If there is any undefined coating found in any trail, again the parameter optimization has been revised.

Table 3 Parameters load value by using DOE

S.NO.	SPINDLE SPEED (rpm)	TRAVERSE SPEED (mm/min)	PLUNGE FEED (mm)
1	2200	150	50
2	1800	200	40
3	2000	150	40
4	2200	100	40
5	2000	200	50
6	2200	200	40
7	1800	150	30
8	2000	100	30

4.2 HARDNESS TESTING

One of the earlier standard method of measuring hardness was the brinell test. In the test, a hardened steel bar indenter is forced into the surface of the metal to be tested. The diameter of the hardened steel indenter is 5 mm. standards load range between 500 kg to 2000 kg. During the test, a load is maintained constant for 30 seconds

Table 4 Calculation of Uncoated Specimen in Different Loads

S.NO	Trial	Load(F)	Diameter of steel ball indenter D (mm)	Diameter of indentation D(mm)	Brinell Hardness Number (BHN)
1	Trial 1	250	5	2.6 (Uncoated area)	39.788
		500		2.9 (Coated area)	68.4538

From Table 4 it seems that, hardness for coated area is quite higher than uncoated area because of tight bonding between base metal and mechtrode material.

V. CONCLUSION

It has been found from Friction surfacing that tremendous bonding is obtained with no defects such as porosity, oxidation. The material properties like Corrosion strength, bond integrity and hardness distribution will not change and there is an increase as compared with before the F.S process. The DOE method has become an influential tool for improving output during research and development. The mathematical models are used to establish the relationship between the input and output parameters in coating processes. Hence it is that seems that AA6063 on mild steel coating is best efficient when compared to past results.

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