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INFLUENCE OF BFS REINFORCED AA 2024 BY BALL BURNISHING TOOL ON SURFACE ROUGHNESS

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***Abstract**: A chip less finishing method which employs a rolling tool pressed against the work piece for achieving of the surface layer is known as Burnishing. Ball burnishing process is mainly considered in industrial cases to restructure surface characteristic. Roller burnishing process is employed on pure aluminum alloy (AA 2024) and aluminum with BFS (Blast Furnace Slag) work piece for current study.*

In this thesis, work the effect of burnishing parameter like speed, and feed and the number of passes is going to be examined on the surface roughness characteristics of aluminum with BFS (Blast Furnace Slag).

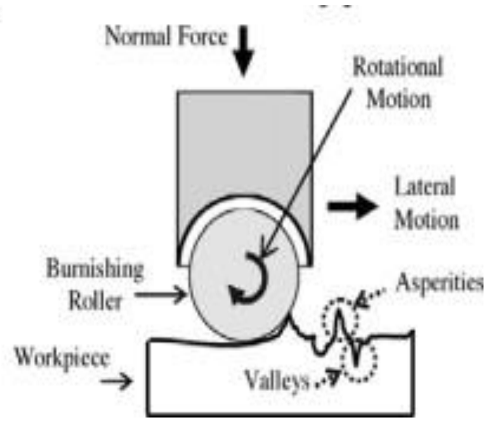
INTRODUCTION

Ever since the Wright brothers flew their „heavier-than-air "machine the aviation industry has growing great leaps and bounds. Because aircrafts were getting faster and/or bigger, the need to develop newer materials took center stage- the use of wood and fabric gave way to stronger metallic structures (built predominantly using aluminum and its alloys). Though, ceramics and composite materials are slowly substituting these too. Subsequently the need to develop more competent aircraft hasn't subsided the requirement for better resources is still in great demand. This paper explores the possibilities of one such material; aluminum- silicon carbide composite (Al-SiC). Initially, Necessary properties of a material that is to be used in the aerospace industry are to be identified. The reason for aluminum's extensive application in the aircraft industry will then be identified and the use of metal matrix composites (MMC) to counter the pure element's (aluminum)shortcomings will be advocated. Once a case for Al- SiC MMC has been made and the work is to look to explore and know the different factors that could have an effect on fabrication and also final properties of the composite.

BURNISHING TOOL

Burnishing is a post finishing operation, in which highly polished ball or roller burnishing tools are pressed against pre-machined surfaces to plastically deform peaks into valleys as shown in fig.1. Today it is becoming more beneficiary process among the conventional finishing operations in metal finishing processes in industries because of its many advantages. Inducing the compressive stresses in metal surface increases many properties associated with metal surface like surface finish, surface hardness, wear resistance, fatigue resistance, yield and tensile strength and corrosion resistance.

The conventional machining methods such as turning and milling leave inherent irregularities on machined surfaces and it becomes necessary to very often resort



to a series of concluding operations with high costs. However, conventional finishing processes such as grinding, honing and lapping are traditionally used processes, but these methods essentially depend on chip removal to attain the desired surface texture, these types of machining chips may cause further surface abrasion and geometrical tolerance problems.

Advantages of burnishing process

a. Fine finish: Roller Burnishing imparts a high finish to any machinable metal Surfaces that are bored, reamed or turned up to 3μRa or more can be finished to 0.05 to 0.2 μ Ra

b. Accurate sizing: Roller burnishing tool feature a built-in calibrated micrometer for adjustable size control in extremely small increments to cover the tolerance range of any part, Part size can be changed as slight as 0.002 mm in one pass in a matter of seconds.

c. Improved metallurgical properties: Burnishing is a process of 'cold-works the metal of a machined part Grain structure is summarized and distinguished, and compacted surface is smoother, harder and longer wearing than ground or honed surfaces. Rolling action greatly lessens surface porosity, pits and scratches which could hold reactive surfaces or contaminates.

LITERATURE SURVEY

Evaluation of Corrosion Property of Aluminum-Zirconium Dioxide (Alzro2) Nano composites. The Corrosion Property of Aluminum Matrix Nanocomposite of An Aluminum Alloy (Al-2024) Reinforced with Zirconium Dioxide (Zro2) Particles. The Zirconium Dioxide Particles are manufactured by Solution Combustion Method. The Nanocomposite Materials Are Prepared by Mechanical Stir Casting Method Experimental Investigation into Ball Burnishing Process of Brass Using Taguchi Approach Burnishing Is A Chip Less Finishing Process, Which Employs A Rolling Tool that is Pressed Against the Work Piece to Achieve Plastic Deformation of The Surface Layer. The Burnishing Process Increases the Hardness of the surface of Work Piece Which in Turn Improves Wear Resistance, Tensile Strength, along with the increase in Corrosion Resistance, Maintains Dimensional Solidity and also Improves the Fatigue Strength by Inducing Residual Compressive Stresses in The Surface of The Work Piece.

Optimization of Wedm Process Parameters of En47 Spring Steel Based on Roughness Using Taguchi Method the Present Paper Deals with The Experimental Study of Roughness (Ra) Characteristics of En 47 Spring Steel in Wedm And Optimization of The Machining Process Parameters Based on L27 Orthogonal Design. Here the experiments are Carried Out by Utilizing the Combination of Four Process Parameters Namely, Pulse on Time (Ton), Pulse Off Time (Toff), Wire Feed (Wf) And Gap Voltage (V). The Optimum Combination of Process Parameters for Minimum Roughness Is Obtained as Ton3toff3wf1v1 I.E., Highest Levels of Pulse on Time and Pulse Off Time Along with Lower Level of Wire Feed and Gap Voltage.

Effect of Burnishing Process Parameters on Surface Quality- A Review in Present Era of Globalization for Every Industry, Surface Quality of Machined Components Is of Utmost Importance. The Product Functionality and Reliability be subject to the Surface Quality. Whatever May Be the Manufacturing Process Used, It Is Impossible to Produce Perfectly Smooth Surface. The Imperfections and Irregularities Are Bond to Occur in Some Form of Peaks and Valleys on The Machined Components. In Burnishing, A Hard and Highly Polished Ball or Roller Is Used to Flatten This Rough Peak into The Valleys by Plastic Deformation. Burnishing Is A Very Simple, Effective and Chip Less Manufacturing Method.

MATERIAL AND METHODS ALUMINUM ALLOY

Aluminum alloys are alloys in which aluminum (Al) is the predominant metal. The typical alloying elements are the following, copper, magnesium, manganese, silicon, tin and zinc. There are two principal classifications, namely casting alloys and wrought alloys, both of which are further subdivided into the categories heat-treatable and non-heat-treatable. About 85% of aluminum is used for wrought products, for example rolled plate, foils and extrusions. Cast aluminum alloys yield cost-effective products due to the low melting point, although they generally have lower tensile strengths than wrought alloys. The extreme important cast aluminum alloy system is Al–Si, where the high levels of silicon (4.0–13%) subsidize to give good casting characteristics.

BF Slag Composition:

(a) Ca O: 30 to 38 %

(b) Si O_2: 30 to 40%

(c) Al $_2$ O_3: 15 to 222%

(d) Mg O: 8 to 11%

(e) Fe O: 0.49 %

(f) Mn O: 2%

Depending on the composition of the raw materials in the iron production process the chemical composition of a slag varies considerably. Silicate and aluminate impurities from the ore and coke are combined in the blast furnace with a flux which lowers the viscosity of the slag. In case of pig iron production, the flux consists generally of a mixture of limestone and forsterite or in few cases dolomite.

Sand casting

Sand casting, also known as sand molded casting is a metal casting process characterized by using sand as the mold material. The term "sand casting" can also refer to an object produced via the sand-casting process. Sand castings are produced in specific factories called foundries. Over 60% of all metal castings are produced through sand casting process.

Molds made of sand are relatively cheap, and sufficiently refractory even for steel foundry use. In addition to sand, a suitable bonding agent (usually clay) is mixed or happens with the sand. The mixture is moistened, naturally with water but sometimes with other substances to develop the strength and plasticity of the clay and to make the aggregate appropriate for molding. The sand is typically contained in a system of frames or mold boxes that is known as a flask.

DESIGN OF BURNISHING TOOL IN 3D MODEL

As it is decided to carry out the ball burnishing process in present work by two process of burnishing, the first and foremost work is to design and develop the ball burnishing tool by selecting appropriate materials, dimensions and proper design such that the process and the tool is simple, cheaper and requires lowest time consumption and with minimum cost. The tool developed during this work can be used on convectional machine tools like lathe. Fig.4 shows the tool developed in this work to carry out ball burnishing process with inter-changeable roller

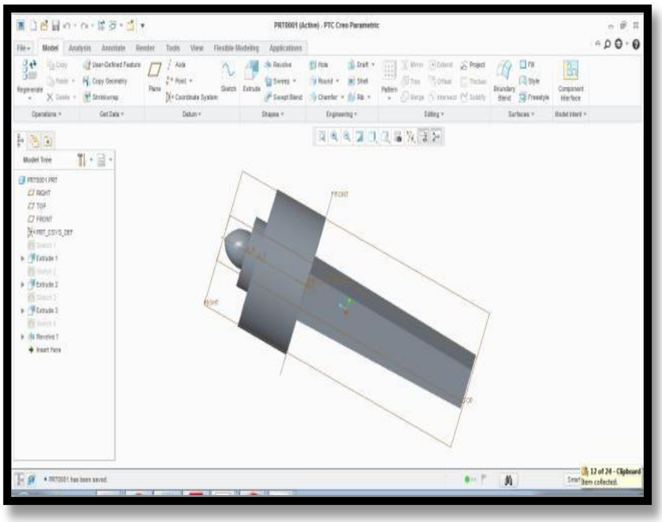


Fig: 3D model of ball burnishing tool

EXPERIMENTAL INVESTIGATION

It is a striking and economical casting technique which allows conventional metal processing route.

Al 2024 melted above 850 ºC in a graphite crucible and the reinforcements were preheated up to same temperature for proper mixing. Preheated BFS were mixed in the metal slurry manually at 850 ºC. The molten metal poured in preheated mould and allowed to cool. Casted metal matrix was machined to remove cluster formation on the surface and then cut into required dimension by using fan-saw cutting machine.

Fig: raw material heated at furnace

Fig:heated up to 8500C

Fig: pouring the molten metal

Fig: casting specimens

Table :1 input parameters

FACTORS	PROCESS PARAMETERS	LE VEL1	LEVEL2	LEVEL3
A	CUTTING SPEED(rpm)	100	120	140
B	FEED RATE (mm/rev)	0.55	0.66	0.77

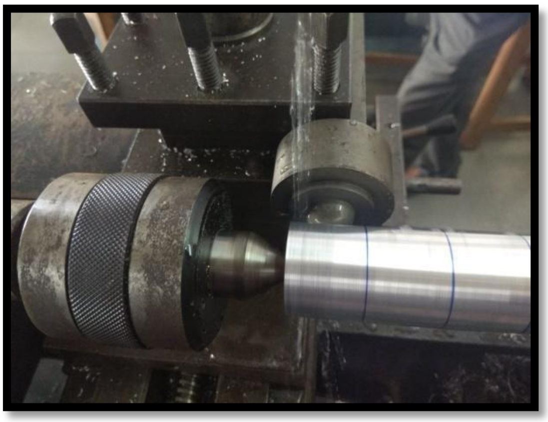


Fig: extermination with burnishing tool

Table :2 Orthogonal array

FEED RATE(mm/min)	SPINDLE SPEED (Rpm)
0.55	100
0.55	120
0.55	140
0.66	100
0.66	120
0.66	140
0.77	100
0.77	120
0.77	140

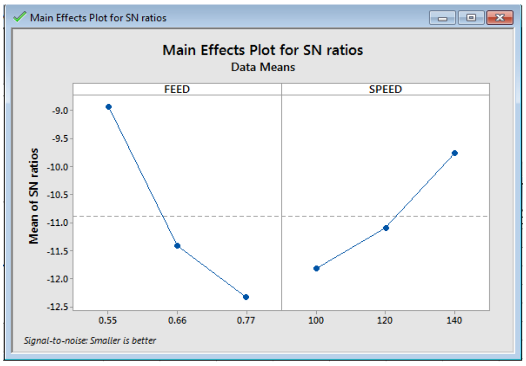
RESULTS AND DISCUSSIONS

Surface Roughness Values

FEED RATE(mm/min)	SPINDLE SPEED (Rpm)	SURFACE ROUHNESS(µm
0.55	100	3.53
0.55	120	2.92
0.55	140	2.12
0.66	100	4.04
0.66	120	3.94
0.66	140	3.23
0.77	100	4.15
0.77	120	4.01
0.77	140	4.25

INTRODUCTION TO TAGUCHI TECHNIQUE

Genichi Taguchi could be a Japanese Engineer and United Nations agency has been active within the improvement of Japans industrial product and processessincethelate1940‟s. He has developed each philosophy and methodology for the method or product quality improvement that depends principally on applied mathematics ideas and tools, particularly statistically designed experiments. several Japanese companies achieved nice success by applying his strategies. Taguchi has received a number of the Japan's most prestigious awards for quality action together with the Deming Prize throughout the year 1986, he received the foremost prestigious award from the International Technology Institute-



Graph: Effect of Burnishing parameters on force for S/N ratio

Conclusion

In this thesis an attempt to make use of Taguchi optimization technique to optimize cutting parameters during ball burnishing process of AA 2024 MMC using Ball burnishing tool. The cutting parameters are cutting speed and feed rate.

In this work, the parameters of cutting speed are 100rpm, 120rpm and 140rpm, feed rate are 0.55mm/min, 0.66mm/min and 0.7 7mm/min and. Experimental work is conducted by considering the above parameters.

The Surface roughness is principally plagued by feed rate and speed. With the rise in feed rate the surface roughness conjointly will increase because the spindle speed increase surface roughness decreases. The optimum setting of cutting parameters for prime quality turned elements is as: -

1. Spindle speed = 140rpm
2. Feed rate = 0.55 mm/ min

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