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Surface Finishing using Extrusion Honing Process on Monel- 400

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ABSTRACT
Extrusion Honing (EH) also known as Abrasive flow machining (AFM) is a unconventional machining process which is used to deburr, radius, polish and remove recast layer of components in a wide range of applications by flowing pressurized semisolid abrasive laden visco-elastic media over those surfaces of Monel- 400. . In the present study Monel- 400 has been extrude honed in an indigenously built hydraulic operated extrusion honing setup using a select grade of polymer as a carrier medium and SiC abrasives of 54 Mesh size. The internal surface finish results are evaluated in terms of surface finish parameters (R_a, R_z, R_t, R_{pk}) for 7, 8, 9, 10 mm hole diameters. The results showed that surface parameters and material removal were mainly influenced by abrasive concentration and abrasive Mesh size.

Keywords*: *Extrusion honing, Monel-400, Surface finish, Abrasive Flow Machining, Silicone.

I. INTRODUCTION

Jain and Adsul [1] investigated on the effects of different process parameters, such as number of trials, concentration of abrasive, abrasive mesh size and media flow speed, on material removal and surface finish are studied. The dominant process parameter found is concentration of abrasive, followed by abrasive mesh size, number of cycles, and media flow speed. Experiments are performed with brass and aluminium as work materials. Experimental and theoretical results were compared. The machined surface texture is studied using scanning electron microscopy. Results showed that Material removal (MR) is governed by initial surface finish and workpiece hardness. Soft work material has higher material removal and more improvement in surface finish as compared to hard work material. As the percentage concentration of abrasive in the medium increases, material removal increases while the surface finish decreases.

Kursad Gov et al. [2] investigated the effect of workpiece hardness on the AFM process has been investigated. An experimental study was carried out on AISI D2 tool steel hardened to 31, 45 and 55 HRC. The specimens were cut by using wire electro discharge machining (WEDM) and then finished with AFM. The results showed that the white layer formed during WEDM is successfully removed by AFM in a few cycles. The removal of this layer eliminates surface cracks and thus the fatigue strength may increase. Surface roughness of the WEDM'ed surfaces significantly changed in the first 20 cycles and then settled to a saturated level gradually. The surface roughness after 50 cycles is decreased slightly. Also results show that hard work material has more surface improvement than the soft work materials.

Harlal singh and Alakesha Manna [3] presented the use of artificial neural networks (ANN) for modeling and simulation of response characteristics during AFM process in finishing of Al/SiCp metal matrix compo- sites (MMCs) components. A generalized back-propagation neural network with five inputs, four outputs, and one hidden layer is designed. Based upon the experimental data of the effects of AFM process parameters, e.g., abrasive mesh size, number of finishing cycles, extrusion pressure, percentage of abrasive concentration, and media viscosity grade, on performance characteristics, e.g., arithmetic mean value of surface roughness (R_a micrometers), maximum peak–valley surface roughness height (R_t, micrometers), improvement in R_a (i.e., ΔR_a), and improvement in R_t (i.e., ΔR_t), the networks are trained for finishing of Al/ SiCp-MMC cylindrical components. ANN models are compared with multivariable regression analysis models, and their prediction accuracy is experimentally validated.

Rajendra Jain and Jain [4] worked on simulation model determine the active grain density on the media surface which is in contact with the work surface and correlated to experimental observations determined by a microscopic method. Simulation enabled prediction of the active grain density at any concentration and mesh size. A microscopic technique showed that Grain density increases with increase in abrasive mesh size and percentage concentration of abrasives. Also they concluded that proposed stochastic simulation can be extended for simulation of surface generation in abrasive flow machining.

Sandeep Chouhan and Sushil Mittal[5] investigated on the surface finishing of die steel with the use of abrasive flow machining against the traditional grinding process. Results showed that as the abrasive loading increases, the improvement in surface roughness increases. But at the high percentage (above 78%) of abrasive loading, the flow becomes difficult as well as carrier acts as inefficient binder for abrasives. Similarly as hardness of work piece increases, the number of cycles to achieve better Surface roughness also increases. FAX increases linearly with passage length and applied piston pressure. The change in surface roughness, Δ Ra increases with the increase in length of the work-piece and decreases with the increase in cross section of the work-piece. It can also be seen that work piece having single vent for media outflow have higher material removal and more improvement in surface roughness and the performance measures decrease with increase in the number of vents for media outflow.

In the present study, extrusion honing process were performed on super alloy Monel- 400 at laboratory using indigenously built EH set up. A selected grade, polymeric material as medium and silicon carbide as abrasive particles has been used for finishing process. Extrusion honed surface of Monel- 400 have been evaluated in terms of surface finish parameters. Material removal were taken from the work piece before and after the EH process and the results show positive response.

II. EXPERIMENTAL PROCEDURE

Extrusion honing experimentation was conducted in an indigenously built EH set up at laboratory and surface parameters, material removal were evaluated after each trial. Surface roughness measurements were taken at different positions.

2.1 Material details

2.1.1 Work material

Monel-400 is one of the most important nickel based alloys that contains about 60-70 percent nickel, 20-29 percent copper and small amounts of iron, manganese, silicon and carbon. It is a solid solution alloy that can only be hardened by cold working. Monel-400 is characterized by its good corrosion resistance, good weldability and high strength. Therefore, it has been used extensively in many applications such as chemical processing equipment, gasoline and fresh water tanks, crude petroleum stills, valves and pumps, propeller shafts, marine fixtures and fasteners, electrical and electronic components, process vessels and piping, boiler feed water heaters and other heat exchangers. The chemical composition and mechanical properties Mone -400 is shown in Table 1.

Table 1: Chemical Composition and Mechanical Properties of Monel- 400.

Element	Concentration [wt.%] Monel 400
Nickel	63 Min
Carbon	0.3 Max
Manganese	2.0 Max
Iron	2.5 Max
Sulphur	0.024 Max
Silicon	0.5 Max
Copper	28-34 Max

Mechanical properties	
Density	8.83 g/cm^3
Tensile strength	55MPa
Yield strength	250MPa
Brinell Hardness	180

2.1.2 Carrier medium

In the present study, a selected grade of polymer was used as working medium and commercially available silicon carbide of 54 Mesh size was used as abrasive. Silicon carbide (35% vol.) was thoroughly mixed with polymer medium using a laboratory built silicone media mixer. The details of carrier medium are shown in table 2.

Table 2: Extrusion honing process parameters

Parameters	Details
Pressure	60 bar
Volume fraction of abrasive	35%
Temperature	Ambient
Stroke length	600 mm

2.2 Specimen preparation

Monel 400 specimens of Ø25 mm and length of 12 mm were used for experimentation. The specimens were initially prepared by drilling for different hole sizes of 7, 8, 9 and 10mm. Surface roughness parameters such as R_a, R_z, Rt, R_{pk} were measured initially. After washing the specimen with acetone, extrusion honing trials were conducted.

2.3 Experiment trials

The experiment setup was designed and fabricated in the laboratory to perform extrusion honing. This set up used is a one way type of EH process that is the medium flows in only one direction. It consists of an abrasive media cylinder coupled to a hydraulic cylinder; to control the actuation the directional control valve has been utilized. Abrasive media cylinder is a piston cylinder arrangement with end cap which has a fixture for housing the work piece. The fixture is designed to mount the work piece easily to the end cap of the extrusion cylinder. Abrasive media enters the work piece from one side and extrudes out at the other side. The extruded abrasive media is collected in the collector. The parameters used in the trials are presented in Table 2. The specimen was honed for 10 passes under similar conditions and after each trial surface was cleaned with acetone and surface finish parameters were measured at three different locations on the work piece. The surface roughness measurements were taken with skidless surface roughness tester, Surfcom 130A. The cut-off length chosen for measurement was 0.8mm with 4 mm traverse length. Care was taken to measure the roughness at the same location before and after the experiments. The material removal was measured before and after the experiments with Afcoset ER-200A electronic balance having a least count of 0.001mg.

III. RESULTS AND DISCUSSION

The extrude honed surface of Monel - 400 is evaluated in terms of surface finish parameters. Fig 1,2,3,4 shows the roughness parameter shows the roughness parameters of 7, 8, 9, 10mm specimens respectively. It is observed that there is a drastic reduction in surface roughness parameters at the initial passes and progressive reduction afterwards and attains core roughness between 3^{th} to 6^{th} pass, later surface deterioration sets in. Fig 5, 6, 7, 8 shows the material removal of 7, 8, 9,and 10 mm specimens. Initially 7, 8, 9 and 10 mm specimens were extrude honed with 35% abrasive concentration. It can be clearly observed that MR decreases after every trial due to cutting edges of abrasives getting worned out. It can also be seen that MR increases with increase in abrasive concentration which in turn decrease surface finish.

3.1 surface roughness parameters

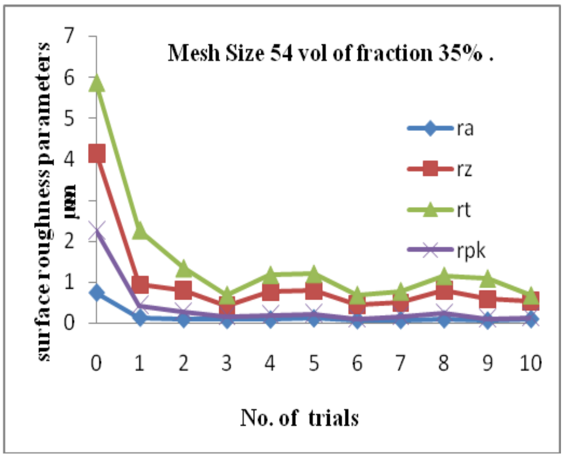

Fig.1 Surface Roughness v/s Number of trials for Ø 7mm.

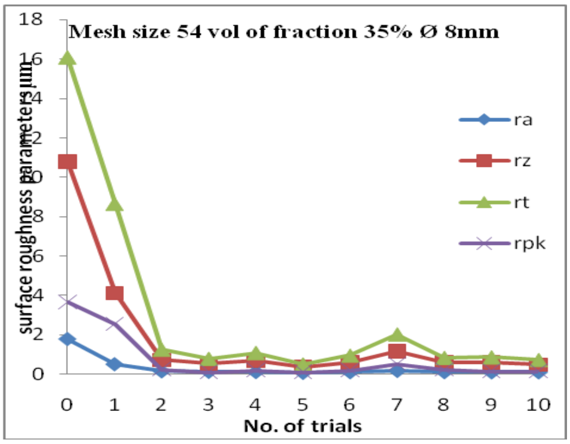

Fig.2 Surface Roughness v/s Number of trials for Ø 8mm.

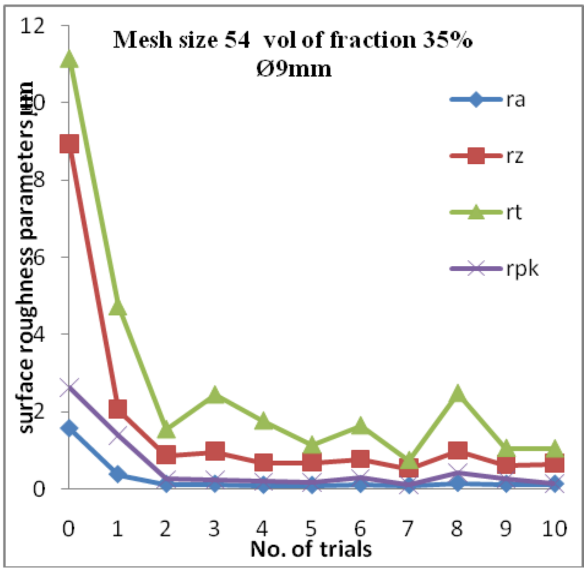

Fig.3. Surface Roughness v/s Number of trials for Ø 9mm.

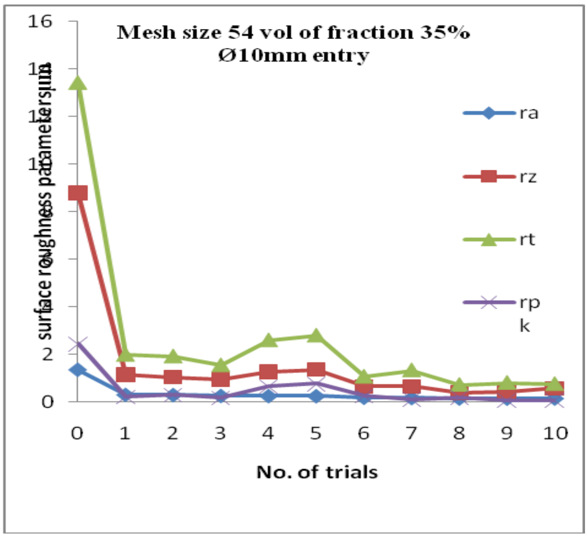

Fig.4 Surface Roughness v/s Number of trials for Ø 10mm.

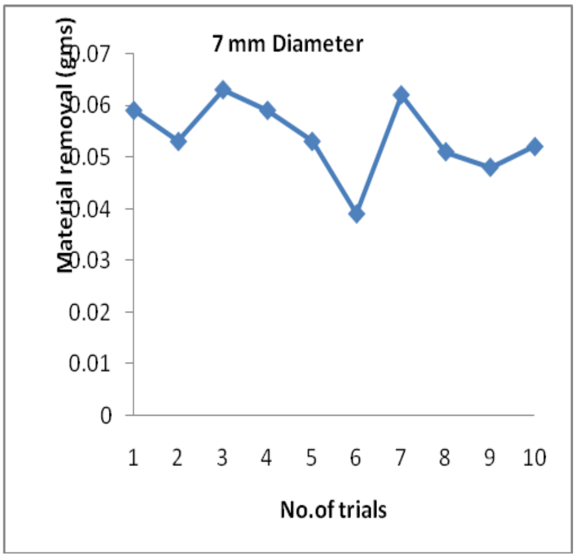

Fig.5 Material removal for Ø 7mm.

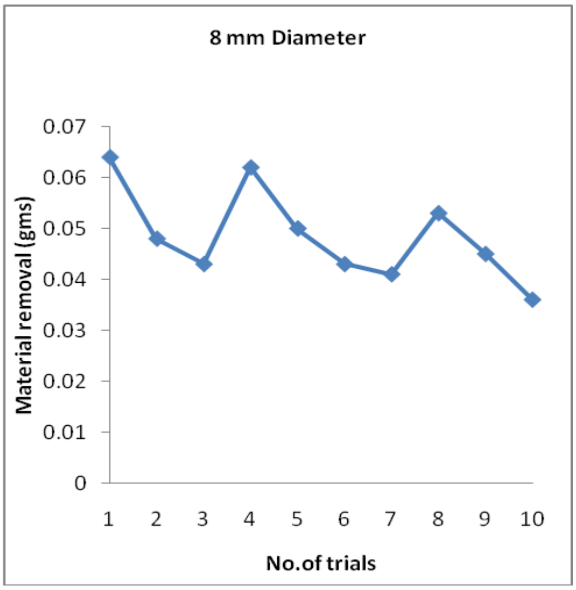

Fig.6 Material removal for Ø8mm.

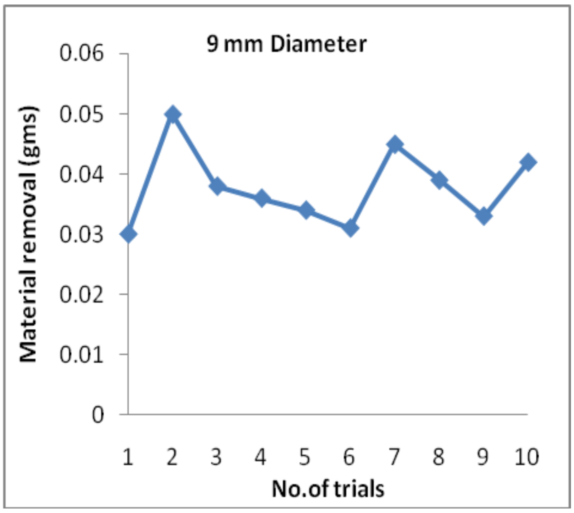

Fig.7 Material removal for Ø9mm.

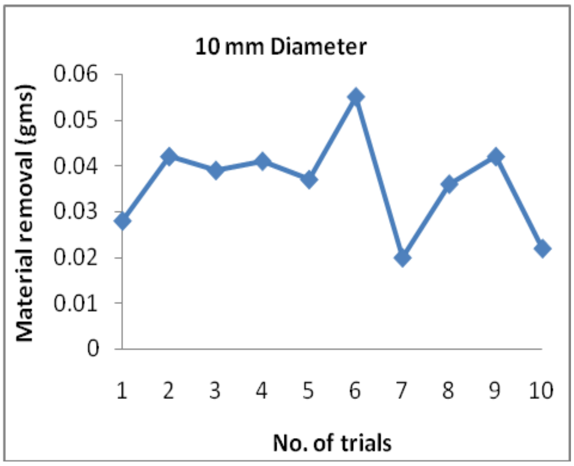

Fig.8 Material removal for Ø 10mm.

IV. CONCLUSION

In this paper, an investigation has been made on Monel-400 work piece to study the surface roughness parameters characteristics of extrusion honed surface. The samples that were processed with EH have been pre-machined by drilling process of different diameter drill bits. Basic one-way extrusion honing was performed using a silicone polymer with SiC abrasive particles. The surface finish was measured on work piece at three different locations on entry side and exit side of the abrasive media flow.

The results of this study led to the following conclusions:

1. The extrusion honing process with 60 bar pressure, abrasive particle size of 54, volume fraction of abrasive 35% and 10 EH trials shows good results in finishing of Monel- 400.
2. Core roughness is achieved between 6^{th} to 8^{th} trial, beyond which the surface starts deteriorating due to ploughing of abrasives.
3. Surface finish at the exit side is better than the entry side due to better contact of the abrasive particles in the media at the exit side.
4. As the abrasive concentration increases, material removal increases and surface finish reduces.

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REFERENECES

[1]. Jain V K and Adsul S G "Experimental investigations into abrasive flow machining (AFM)", International Journal of Machine Tools & Manufacture 40 (2000),pp 1003–1021.

[2]. Kursad Gov, Omer Eyercioglu and Mehmed Veysel Cakir "Hardness Effects on Abrasive Flow Machining" Journal of Mechanical Engineering 59 (2013)10, pp 626-631.

[3]. Harlal Singh Mali and Alakesh Manna "Simulation of surface generated during abrasive flow finishing of Al/SiCp-MMC using neural networks" Int J Adv Manuf Technol (2012), pp 1263–1268.

[4]. Rajendra K. Jain and Jain V K "Stochastic simulation of active grain density in abrasive flow machining" Journal of Materials Processing Technology 152 (2004), pp 17–22.

[5]. Sandeep Chouhan and Sushil Mittal "Abrasive Flow Machining: Major Research Areas &Analysis" International journal of research in aeronautical and mechanical engineering, Vol 2 Issue 1 (Jan 2014), pp 77-83.

[6]. Jain V K, Rajani Kumar, Dixit P M and Ajay Sidpara "Investigations into abrasive flow finishing of complex workpieces using FEM" Wear 267 (2009), pp 71–80.

[7]. Mamilla Ravi Sankar, Jain V K and Ramkumar J "Experimental investigations into rotating workpiece abrasive flow finishing" Wear 267 (2009),pp 43–51.

[8]. Raju H P , Narayanasamy K , Srinivasa Y G and Krishnamurthy R "Characteristics of extrude honed SG iron internal primitives" Journal of Materials Processing Technology 166 (2005), pp 455–464.

[9]. Kenda J, Pusavec F, Kermouche G and Kopac J "Surface Integrity in Abrasive Flow Machining of Hardened Tool Steel AISI D2" Procedia Engineering 19 (2011), pp 172 – 177.

[10]. RaviSankar M, Jain V K, Ramkumar J and Joshi Y M "Rheological characterization of styrene-butadiene based medium and its finishing performance using rotational abrasive flow finishing process" International Journal of Machine Tools & Manufacture 51 (2011), pp 947–957.

[11]. Jung D, Wang W L, Knafl A, Jacobs T J, HU S J and Assanis D N "Experimental investigation of abrasive flow machining effects on injector nozzle geometries, engine performance, and emissions in a diesel engine" International Journal of Automotive Technology, Vol. 9, No. 1 (2008), pp 9-15.

[12]. Saad Saeed Siddiqui and Hameedullah M "Abrasive flow machining performance measures on work-piece surfaces having different vent/passage considerations for media outflow" International Journal of Computer Communication and Information System (IJCCIS) – Vol2. No1. ISSN: 0976–1349 (July – Dec 2010).

[13]. A.C. Wang and S.H. Weng "Developing the polymer abrasive gels in AFM processs " Journal of Materials Processing Technology 192–193 (2007),pp 486–490.

[14]. E. Uhlmanna, M. Doitsb and C. Schmiedela "Development of a material model for visco-elastic abrasive medium in Abrasive Flow Machining", Procedia CIRP (2013,pp 351 – 356.

[15]. Jayakumar T Mukhopadhyay C K,Venugopal S Baldev Raj S L, "A review of the application of acoustic emission techniques for monitoring forming and grinding processes",Journal of Materials processing Technology 159, (2005),pp 48-61.

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