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Investigation on Surface Roughness Parameters of Nickel Alloy A-286 by Extrusion Honing Process

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Abstract – *There are many finishing process or machining process in which Extrusion Honing (EH) Process is one of them. In a simple words extrusion honing is a process in which a tool of abrasive laden putty which is to some extent a firm consistency; semi-solid state, is made to flow across or through the work piece in a constant pressure to carry out the process like cleaning, polishing, remove recast layers etc. In this work the experimental process is conducted using one way extrusion honing machine and the process is carried out on Nickel Alloy A-286, one of the super alloy having high hardness and high strength properties which is machined to get good surface finishing. In this paper a thorough research is done on how the process parameters have its impact on surface roughness of Nickel Alloy A-286. The results are obtained by measuring and analyzing the extruded surface with the help of surface roughness measuring instrument and significant progress in surface finish is shown.*

***Key Words*: Nickel Alloy A-286, Extrusion Honing, Surface finish, Material removal, Abrasive media.**

1. INTRODUCTION

Extrusion Honing process is one of the non-traditional finishing process in which material removal process can be under taken by passing the abrasive laden putty in its more or less solid state, in a constant pressure across or through the work piece. This process is used for polishing the internal surface, to take off recast layer, to get rid of burrs and also in removal of material. Extrusion honing process makes it perfect for interior surfaces, passage through, slots and in further areas that may be hard to reach with other grinding or polishing series of action or methods in the fields of Automobile, Aerospace and Medical etc. Here one of the disadvantages in extrusion honing process is its low material removal rate. Due to its low productivity it requires more time to achieve good surface finish when compared to other machining process.

In extrusion honing process a tool plays an important role. Tool is made up of abrasive particle which blended with polymer based visco-elastic material matrix and additives. This means of blend tries to finish the work piece surface selectively. The design of tooling or fixture is done carefully. The property of the polymer is that polymer chain grips the abrasive particles and guides them to move in the direction of extrusion pressure. Thus the blend is used as the multipoint cutting tool, which begins abrading work piece surface to get fine surface finish.

In the field of manufacturing, extrusion honing process has the broad range of industrial practice. This machining or finishing methods decreases human effort and provides highly refined surface finish.

2. LITERATURE REVIEW

Lingaraju K N and Raju H P (2017) issued a journal on "Surface Finishing using Extrusion Honing Process on Monel-400", in which they concluded that Surface finish at the exit side is exceptional than the entry side due to more desirable contact of the abrasive particles in the media at the exit side.

Kavithaa T S et,al (2014) conducted a research on "Abrasive flow finishing process-a case study". The journal features the practical proficiency of the developed abrasive flow machining system which is outlined for effective nano metric finishing and burring of complex components from pharmaceutical, aerospace and bio-medical industries.

Loveless T R et.al (1994) reported a publication on "Study of effects of abrasive flow finishing on various machined surfaces" and explained event of viscosity of media on surface finish. They concluded that viscosity is the alone parameter which result in the surface finish.

Fletcher et.al (1990) reported a chronicle on "Computer modeling of the Abrasive Flow Machining process". They investigated the connection between medium rheological properties. They also concluded that fine finishing action could be reached as a development in longer piston stroke duration.

3. OBJECTIVE

The main goal of this paper is to analyze the different surface parameters of Nickel Alloy A-286 of dissimilar diameter hole i.e. 4 mm, 5 mm, 6 mm and 7 mm by utilizing extrusion honing process.

4. METHODOLOGY

4.1 Experimental arrangement

The arrangement that we used to carry out extrusion honing process is one way EH machine i.e., media is guided to flow in only one route or direction. This machine works on

hydraulic mechanism. A cylinder where abrasive media is loaded is coupled with hydraulic cylinder, thus restricting the tool or abrasive media to flow towards the end cap where a specimen is fixed. The abrasive media is stuffed into the cylinder by removing the end cap from cylinder setup and after stuffing the media the end cap is placed back to its earlier position. The abrasive media is forced out through the specimen and collected in the collector.

Fig -1: Extrusion honing machine

4.2 Experimental process

a) Test sample or specimen preparation.
b) Abrasive media preparation.
c) Carrying out extrusion honing trials.
d) Measuring different positions of the sample or specimen to find out surface parameters using surface roughness measuring instrument (Surfcom 130 A)

4.3 Specimen features

Nickel Alloy A-286 is selected as the test sample or specimen because of its high strength and high hardness. It is an iron based super alloy. Below tabular column show the Mechanical and physical properties of A-286 alloy.

Table -1: Mechanical and Physical properties

Properties	Metric
Density	7.94 gm/cm³
Tensile strength	1035 MPa
Hardness, Brinell	304
Melting point	1399°C
Yield strength	759 MPa

4.4 Test sample or specimen preparation

A four test specimens of Nickel Alloy A-286 is prepared of the diameter 25 mm and length of 12 mm. A hole is drilled by utilizing carbide drill bit of diameter 4 mm, 5 mm, 6 mm and 7 mm respectively for four specimens. The specimen is thoroughly scrubbed with acetone to expel the clogged particles. After that initial reading of surface parameters are noted down for each specimen

Fig -2: Test sample or specimen

4.5 Abrasive media preparation

Here silicon carbide (SiC) of 36 mesh size is selected as abrasive. This abrasive is thoroughly combined with silicon polymer medium using silicon media mixer machine. Here we have selected 40% volume fraction of silicon carbide abrasive with silicon polymer.

Fig -3: Silicon media mixer machine

4.6 Experimental extrusion honing trials

When the machine is started, due to the hydraulic pressure the ram will push the silicon polymer with abrasive at constant pressure of 60 bar through or across the specimen which is fixed at the end cap of the machine. The honed surface of the sample or specimen is then measured in the surfcom 130A and surface parameters are noted down at the two position i.e. entry side and exit side. This trail is repeated for the 5 passes.

Fig -4: Silicon polymer with abrasive is extruded through specimen

Fig -5: Surface roughness measuring instrument (Surfcom 130A)

5. RESULTS AND DISCUSSION

The main intention of this work is to get a fine surface finish operation through extrusion honing process of Nickel Alloy A-286 in terms of surface parameter. The results that we obtained after the experimental trials i.e. surface roughness parameters R_a, R_z, R_t and R_{pk} are plotted in graph for hole diameter of 4 mm, 5 mm, 6 mm and 7 mm specimens.

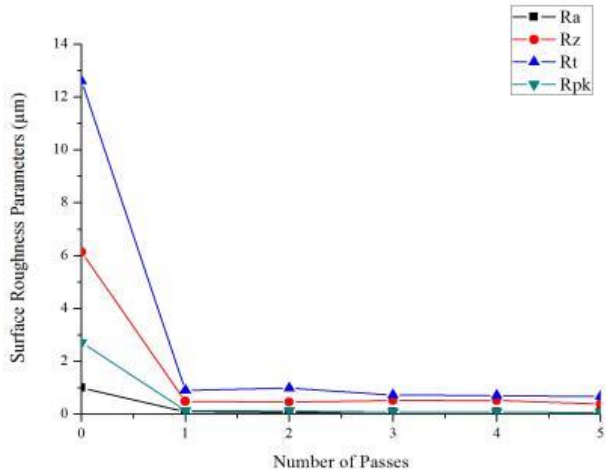

Fig -6: Effect of number of passes on surface roughness for Drill entry of 4 mm hole diameter

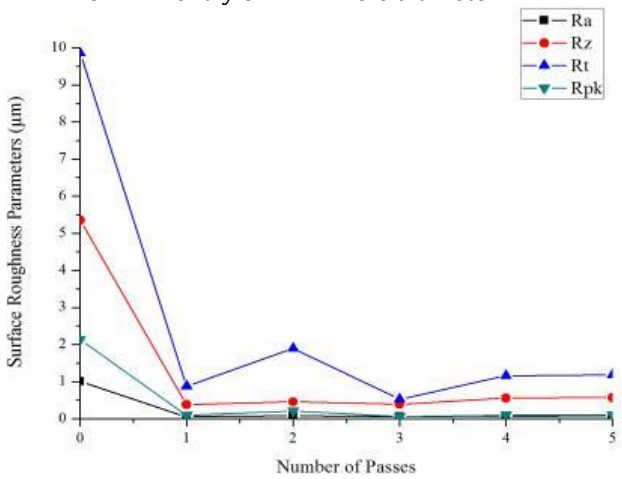

Fig -7: Effect of number of passes on surface roughness for Drill exit of 4 mm hole diameter

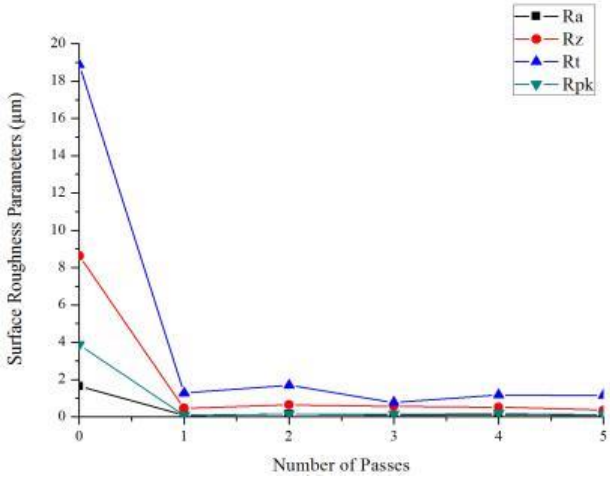

Fig -8: Effect of number of passes on surface roughness for Drill entry of 5 mm hole diameter

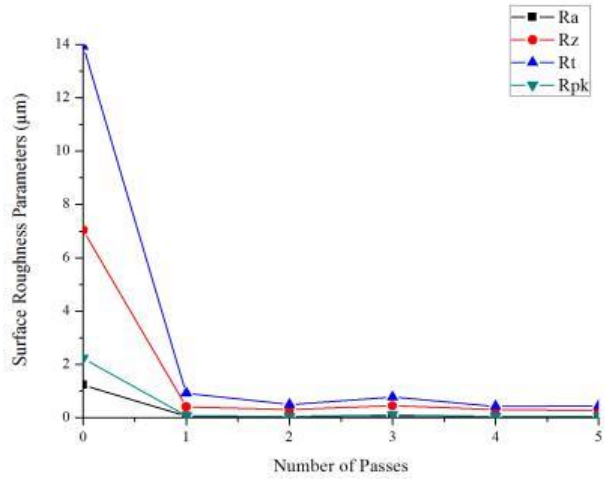

Fig -9: Effect of number of passes on surface roughness for Drill exit of 5 mm hole diameter

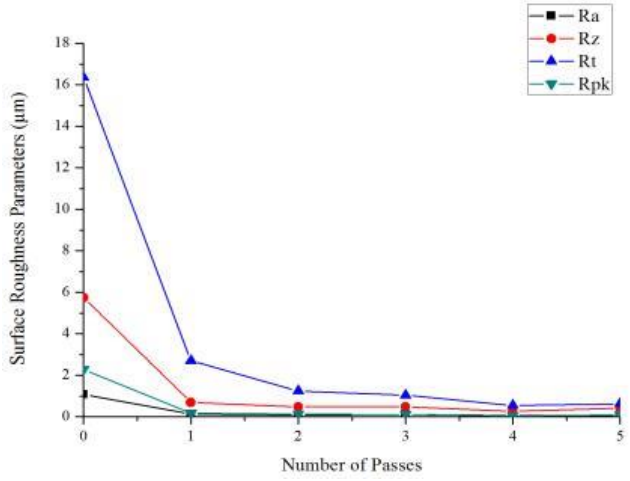

Fig -12: Effect of number of passes on surface roughness for Drill entry of 7 mm hole diameter

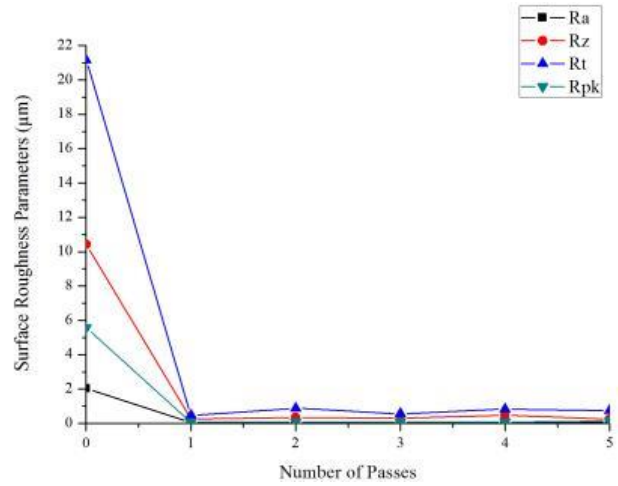

Fig -10: Effect of number of passes on surface roughness for Drill entry of 6 mm hole diameter

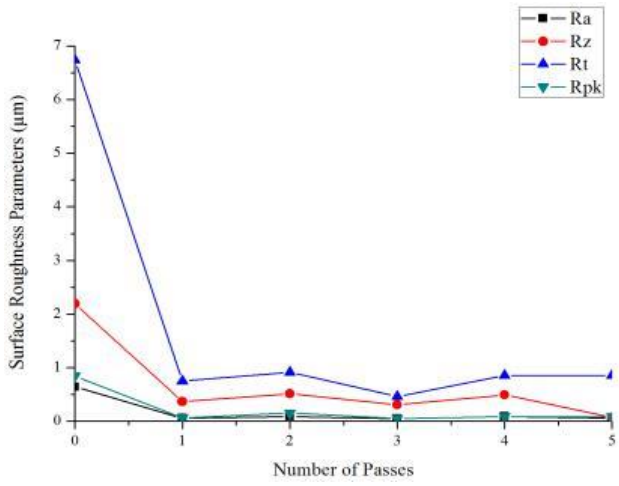

Fig -13: Effect of number of passes on surface roughness for Drill exit of 7 mm hole diameter

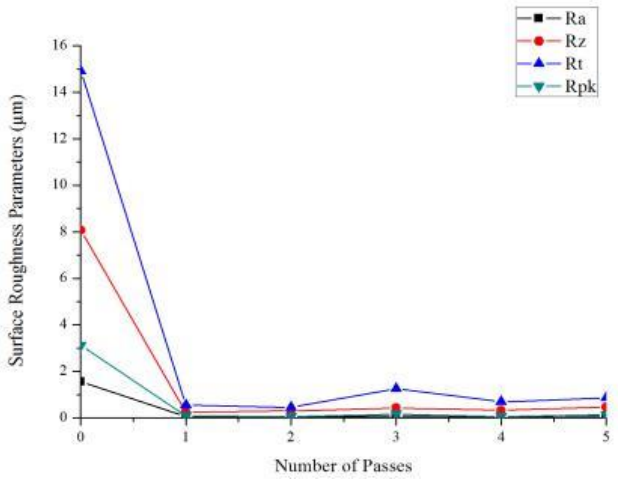

Fig -11: Effect of number of passes on surface roughness for Drill exit of 6 mm hole diameter

From the entire above graph we can see that during the process there is an extreme change in surface parameters in the first pass. As the number of passes increases there is gradual development in the surface roughness. The improvement in surface roughness of the specimen is seen from 4th to 5th pass.

5.1 Scanning electron microscope (SEM) images of extrusion honing trials

SEM images are taken to observe the images of drilled hole and extruded hole of Nickel Alloy A-286 specimen.

The SEM images are shown below

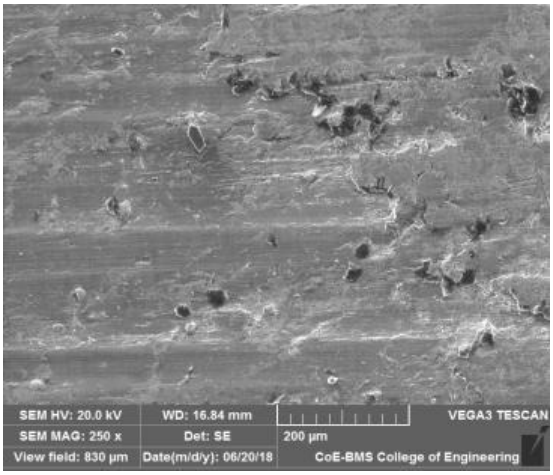

Fig -14: SEM image for zero pass of 250 magnification

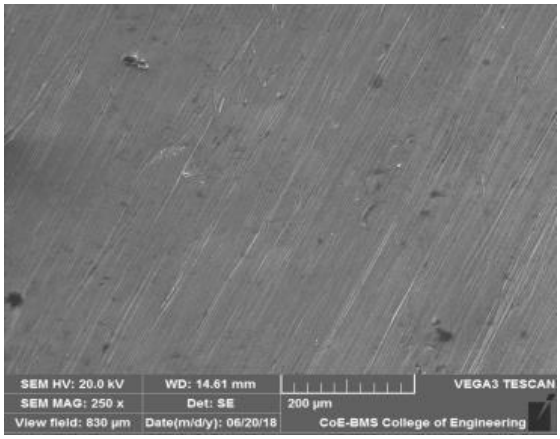

Fig -15: SEM image, hole diameter 4 mm for five pass of 250 magnification

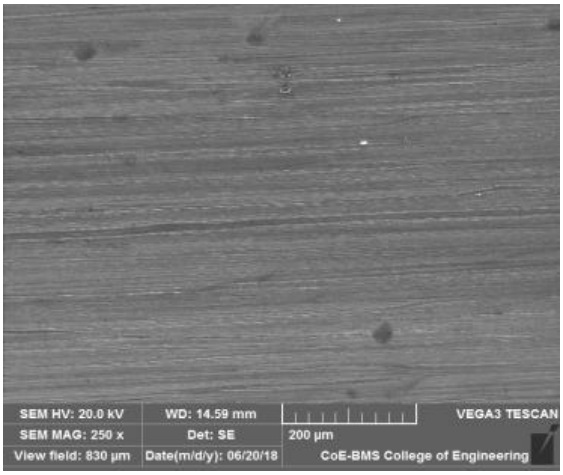

Fig -16: SEM image, hole diameter 5 mm for five pass of 250 magnification

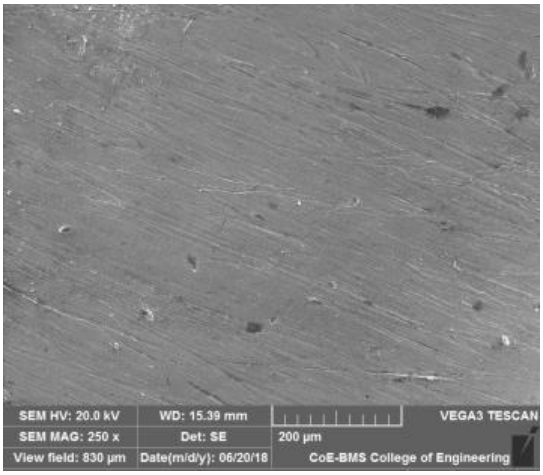

Fig -17: SEM image, hole diameter 6 mm for five pass of 250 magnification

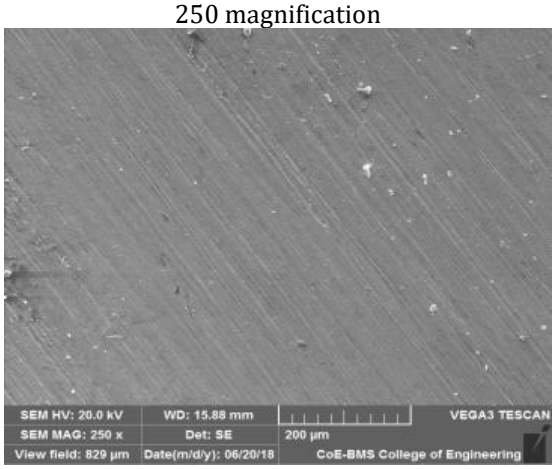

Fig -18: SEM image, hole diameter 7 mm for five pass of 250 magnification

The SEM is taken for 5 passes of hole diameter 4 mm, 5 mm, 6 mm and 7 mm of the test sample. The bored layer pattern is shown in fig-14. A progressive improvement is shown in fig-15, fig-16, fig-17 and fig-18.

6. CONCLUSIONS

From this work a conclusion can be drawn based on tool or media of silicon polymer with (SiC) abrasive for the extrusion honing of Nickel Alloy A-286 which is as follows

a) The selected grade for polymer medium to carry out extrusion honing process can be utilized as abrasive carrier medium.
b) The abrasive (silicon carbide) that we chose gives fine surface finish for 5 passes at constant pressure of 60 bar.
c) Fine or progressive surface finish is seen in 4^{th} to 5^{th} pass.
d) Better surface finish is seen in exit side rather than entry side of the test sample.

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