Experimentation of Abrasive flow machining

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ABSTRACT

Abrasive flow machining (AFM) is a non-traditional finishing process used to deburr, chamfer, polish, remove recast layers, and to produce compressive residual stress. AFM can be mostly used to polish and deburr internal parts, through holes, intersecting holes and freeform surfaces which are difficult to finish with other traditional finishing processes. It can be a high potential candidate in the simultaneous finishing of the workpiece, instead of separately finishing of internal and external surfaces of the workpiece with other non-conventional processes. The percentage improvement in surface roughness of the internal of the ring-shaped workpiece are observed in this study are 35, 37 and 27% respectively. The main objective of the simultaneous finishing is achieved by the specially designed fixture and the same objective may be applied for simultaneous finishing of the workpiece, specifically deep groove ball bearing in one go instead of separately finishing of internal surfaces with traditional finishing processes. The present research initiatives are based on the simultaneous finishing of the ring-shaped cylindrical aluminum alloy workpiece. A pneumatic system is used for actuation of the media piston in the present work. The present study initiatives identify the process parameters such abrasive mesh size, concentration of abrasives in media and number of passes that significantly affect the change in surface roughness of the inner surfaces and the amount of material removal.

Keyword – *abrasive flow machining, concentration of abrasive, number of passes, material removal, surface finish.*

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1. INTRODUCTION

Smart engineering materials namely, ceramics, polymers, composites, and super-alloys are developed because of the advancement of the material science. These materials have large uses in the modern manufacturing industries such as aircraft, automobiles, cutting tools, dies and mould manufacturing industries. Machining of these materials are difficult and costly besides this tight tolerances are utmost important in the modern era. Precision machining of complex and complicated shapes and/or sizes, machining of unable to reach surfaces at micro or Nano levels with narrow tolerances leads to the development of new advanced non-conventional machining process.

2. OBJECTIVES

To understand the material removal rate in simple abrasive flow machine, within specific number of experimental cycles. To create an empirical relation between surface roughness value obtained and the process parameters.

3. EXPERIMENTAL PROCEDURE

3.1 Experiment - study of depth of cut, material hardness on surface roughness with other process parameters and set constant.

3.2 Procurement of material - Synchronizer hub provided by an private automobile workshop, 2.5-inch Aluminum round of 25 mm thickness bought from RTC,Nagpur .

3.3 Machining - Abrasive Flow machining (AFM) is a non-traditional machining process that may be used to deburr, radius, polish, remove recast layers, and to produce compressive residual stresses. It is a process of polishing and smoothening internal surfaces and thereby producing controlled radii. The abrasive media is flown across the surface to be super-finished either in a single direction or two-way and this extrudes through the workpiece thereby finishing and smoothening the surfaces. At a given time, it can process a number of components or different areas of the identical work piece. The areas which are not accessible and such complicated internal passages can also be very effectively finished. AFM is particularly helpful where such intersecting surfaces occur within the internal part of a work piece that cannot be finished by the standard methods of grinding, lapping or the usual best-known types of honing. The end use of many products in the aero motive, aircraft and aerospace industries is such that a little particle of metal could cause failure to the whole engine or another operating system. The flaking off of a projecting burr, therefore, is a risk that's always present within the assembly of these products.

3.4 Abrasives - The medium used for this study consists of a silicon based polymer, hydrocarbon gel and the abrasive grains. Silicon Carbide is a ceramic material with an outstanding hardness, only surpassed by diamond, cubic boron nitride and boron carbide. Due to its high abrasion resistance and relatively low cost, Silicon Carbide is used as a loose- or fixed-abrasive material in a wide variety of applications.

3.5 Specifications of SiC used during experimentation: -

- Grade: - 600
- Part: - SI1701N
- Abrasive: 70% (silicon carbide)
- Oil: 30% (cutting oil)

4. Working

Firstly, the lower nylon piston is kept at BDCand upper nylon piston is kept at TDC. Abrasive is on the upper part of the lower nylon piston.

Again when the DCV is operated, both the pistons, consequently move to their prior position and one cycle is thus completed.

When the lower piston moves to TDC and at the same time the upper piston move to BDC. Abrasive media moves through the Workpiece .

5. Data Collection

The process measures are collected and noted down for the further analysis. The data collected in this study is explained listed below

Inner surface									
Size of Abrasives	Concentration of Abrasives	Number of passes							
		0	20		40		60		
		Ra (µm)	Ra (µm)	∆Ra (µm)	Ra (µm)	∆Ra (µm)	Ra (µm)	∆Ra (µm)	
70	50	0.82	0.68	0.14	0.62	0.2	0.58	0.24	1
	65	0.83	0.68	0.15	0.61	0.22	0.56	0.27	2
	80	0.98	0.78	0.2	0.69	0.29	0.63	0.35	3

Compiled form of results: -

Experiment No.	Abrasive Mesh Size	Concentration of Abrasives	Number of Passes	∆Ra
1	70	50	20	0.14
2	70	50	40	0.2
3	70	50	60	0.24
4	70	65	20	0.15
5	70	65	40	0.22
6	70	65	60	0.27
7	70	80	20	0.2
8	70	80	40	0.29
9	70	80	60	0.35

6. CALCULATIONS

A. Change in Surface Roughness (ΔRa)

Change in Surface Roughness (ΔRa) =

$$\boldsymbol{InitialSurfaceRoughness}(\boldsymbol{Ra})\boldsymbol{i} - \boldsymbol{FinalSurfaceRoughness}\ (\boldsymbol{Ra})\boldsymbol{f}$$

= 0.98 – 0.63

=0.35 µm (after 60 passes)

B. % improvement in Surface Finish

$$\frac{(Ra)i - (Ra)f}{(Ra)i} \times 100$$

$$\frac{0.98-0.63}{0.98} \times 100 = 38\%$$

C. Amount of Material Removal (MR)

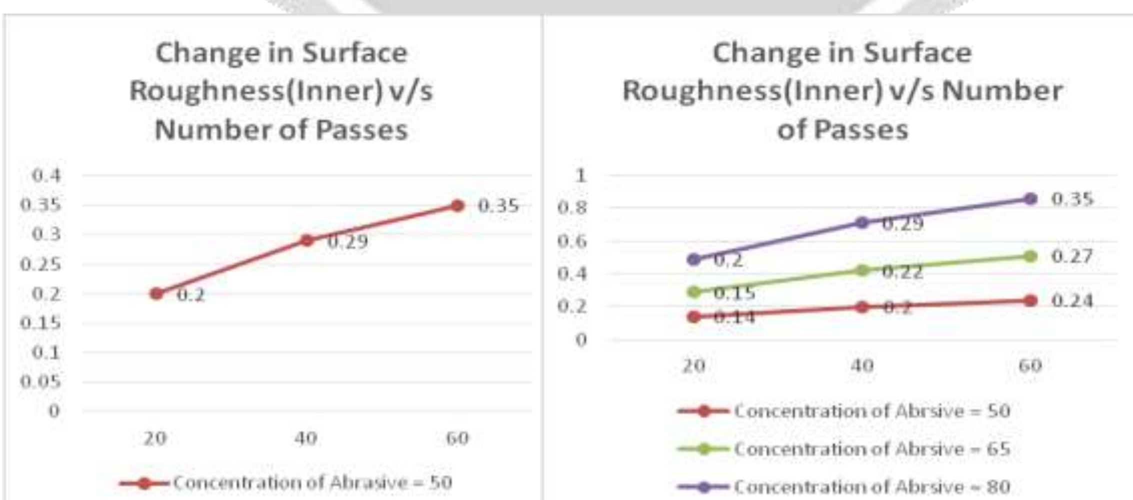
Amount of material removal =Initial Weight of the Workpiece (Wi) – Final Weight of the Workpiece (Wf)

D. Change in Surface Roughness -

Since initial surface roughness of each work piece is different, therefore the result is discussed by considering the change in surface roughness value with respect to input parameters.

Inner Surface - In this section data is analysed to measure the effect of input parameters on the change in surface roughness of the inner surface of the workpiece.

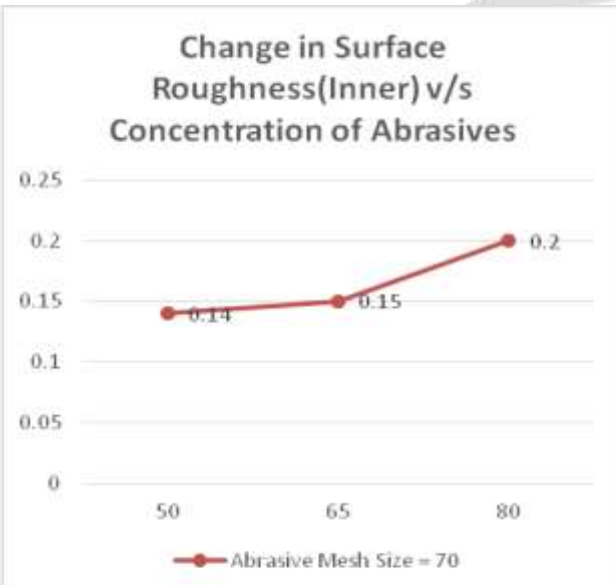
Change in Surface Roughness v/s Number of Passes

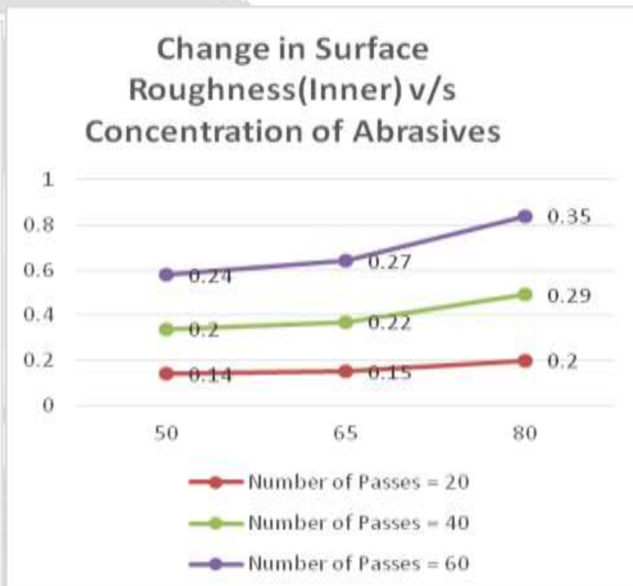


As soon as the number of passes increases the change in the surface roughness is increased as shown in figure in initial passes, change in the surface roughness per pass is high, but, after certain passes the trend is shallow. This is owing to high hills in the starting which are chipped off easily. After the cutting down of the hills, the amount of material plastically removed from the workpiece is decreased considerably.

Change in Surface Roughness v/s Concentration of Abrasives

If the concentration of abrasives in the media increases, the change in surface roughness is increased as shown in figure





7. CONCLUSIONS

The initial surface roughness range of the inner surface is 0.82-0.99 µm; after experiments obtained surface roughness range is 0.56-0.75 µm. The initial and final surface roughness range of the outer surface of the workpiece are 0.81-0.97 µm and 0.59-0.74 µm respectively. For side surface, the initial and final surface roughness ranges are 0.81-0.98 µm and 0.59-0.74 µm respectively.

8. REFERENCES

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