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ENHANCEMENT OF SURFACE ROUGHNESS AND METAL REMOVAL RATE BY USING COMBINED ABRASIVES DURING MAGNETIC ABRASIVE FINISHING

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ABSTRACT

Magnetic abrasive finishing (MAF) is one of advanced finishing process which play a major role in important applications (medical, aerospace, dies). This paper was focused on using combined abrasives instead of single abrasive which included two types of abrasives were added to iron powder and mixed together to perform mixture of magnet. parameters were used (concentration of abrasive and type of abrasive, gap, speed) in experiments then show that the surface roughness of work material enhanced from 1.58µm to1.05µm when using double abrasives instead of single abrasive (silicon carbide and boron) also the metal removal rate was enhanced from 0.050gm to 0.077gm.

KEYWORDS: *Double Abrasive, Sic + B, MAF, Surface Roughness, MRR*

INTRODUCTION

Magnetic abrasive finishing (MAF) is one of important process which is used to enhance the surface of work material by removing a small amount of chips. The principle of (MAF) is based on magnetic poles (N & S) and the work piece is usually kept between the two magnets. Mithlesh Sharma and etal (2013) study SS305, SS316 and brass as workpiece and the maximum efficiency in terms of material removal rate. Magnetic abrasive finishing as an efficient tool for internal finishing of bent tubes to enhance cylinder surface using is a mixture of Al2O3 abrasive and ferromagnetic particles. Rishi Dev Joshietal (2014) study maximum efficiency in terms of material removal rate with respect to magnetic flux density with respected to the different types of coils for SS 304 using the sintered magnetic abrasive is a mixture of A l2O3 abrasive and ferromagnetic particles and the results showed maximum efficiency on a medium range of magnetic flux density. Also saadshather et al (2015) developed and predicted the surface roughness of stainless steel workpiece. Rui Wangetal (2017) they proposes an optimized magnetic abrasive machining process that uses.

An ultra-high-speed system to perform precision machining on a workpiece. The results obtained after machining have been analyzed to determine the effect of different process parameters such as machining speed, machining time, machining frequencies, inert gas in/out, Magnetic pole types,, when machining AISI 304 bar Here, the best conditions are a machining speed of 80,000 rpm, 60 sec of machining time, a 10 Hz vibrational frequency, inert gas injection, a sharp magnetic pole type, and a 0.5µm diamond particle mesh size. Lei Maetal (2017) they focused on observing the control factor of the pressing force for using three different iron particle shapes and different particle numbers, using a force sensor and a high-speed camera. The relationship between the iron particle shapes. It is found that the force variation can be reduced by adjusting the particle shape and number, which effectively reduces the damage caused when the brush approaches the workpiece surface.

Chinu Kumarietal (2018) they studied the magnetic assisted abrasive finishing (MAAF) processes which are the precision material removal processes that have been applied to a large variety of materials from brittle to ductile and from magnetic to non magnetic carrier medium like silicone oil, mineral oil or water. The MRAFF process gives better results as compared to results of MRF because it has additional reciprocating motion of MR fluid.

Experimental Procedure

Taguchi's L9 orthogonal array was used to design the experiments. Next, machining experiments were conducted for the 9 combinations to get the power consumption values. In the next phase,

The experiments were done.

Work piece: Medium carbon steel was used as workpiece according to the chemical composition shown in table (1).

Machine

Milling machine type was used to carry out experiments and the spindle speed was 400 rpm as shown in figure (1).

Abrasives

first method was used to prepare the abrasives by mixed two types of abrasive instead one which added to iron powder with resin then put in furnace to 250 Cº, gap =1mm, machining time was 13min after that crushed to small size.

Table 1: The Chemical Composition of Work piece

C%	Mn%	Si%	S%	Pb%	Mo%	Cr%	Al%	Co%	Ni%	Cu%	Fe%
0.40	0.605	0.200	0.006	0.005	0.20	0.035	0.002	0.006	0.070	0.098	97.484

Figure 1: Machine of MAF Process.

Figure 2: Fe powder.

Metal removal rate (MRR): metal removal rate can be calculated through the following formula:

MRR = (Wt before MAF-Wt after MAF)/time (1)

Wt – Weight before machining, gm

Wt – Weight after machining, gm

Time – Time of machining, min

Vertical milling machining equipped with magnet was used in experiments; time of machining was constant (20 minutes) to achieve each specimen.

The Taguchi experimental design involved three stages, a Taguchi orthogonal array L9 was used for experiments to ensure consideration of the most significant factors and levels, therefore, optimizing the surface finishing MAP.

Different concentration of abrasives were used in experiments, table (3) explicates that:

Measurements

Surface roughness device used to measure the surface integrity of machined surface as shown in figure (3).

Table (2) Relationship between abrasive concentration and surface roughness.

Table 2: Parameters and Their Levels

Parameters	Units	Level
Rotational speed (P1)	rpm	350, 400,450
Working gap (P2)	mm	1, 1.5. 2
Concentration (p3)	gm	20,25,30

Table 3: Machining Time and Abrasives Concentrations

	Current, A	Abrasive Type	Machining Time, Min	Gap, Mm	Abrasive Concentration %
1-	10	SiC +B	20	1	20
2-	10	SiC +B	20	1.5	25
3-	10	SiC +B	20	2	35

Figure 3: Digital Weight Device.

Table 4: Surface Roughness (Ra)With Single And Combined Abrasives

No	Concentration of Abrasive Sic And Boron %	Surface Roughness With Single Abrasive (Ra)µm	Surface Roughness With Combined abrasive (Ra) µm
1	20%SiC +80%Fe	1.61	1.58
2	25% SiC +75% Fe	1.61	1.54
3	30% SiC +70% Fe	1.61	1.43
4	35% SiC +65% Fe	1.61	1.38
5	40% SiC +60% Fe	1.61	1.36
6	20% SiC +20% B + 60%Fe	1.61	1.30
7	20% SiC +25% B+ 55%Fe	1.61	1.28
8	20% SiC +30% B + 50%Fe	1.61	1.12
9	20% SiC +35% B + 45%Fe	1.61	1.09

Figure 4: Surface Roughness Device.

Table 5: Metal Removal Rate (MRR)

No	Weight of Work piece Before Machining, Gm	Weight of Work piece after machining, Gm	Metal Removal Rate (MRR), Gm
1	161.543	160.950	0.050
2	161.764	160.724	0.040
3	162.544	162.509	0.035
4	162.663	162.623	0.040
5	161.872	161.832	0.040
6	161.223	161.171	0.052
7	161.332	161.271	0.061
8	160.888	160.815	0.073
9	161.112	161.037	0.075

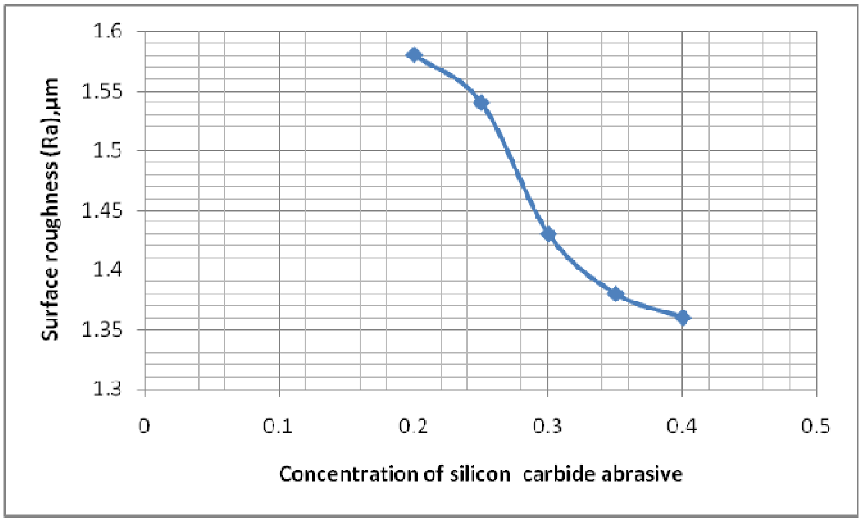

Figure 5: Relationship Between Silicon Carbide Concentration and Surface Roughness.

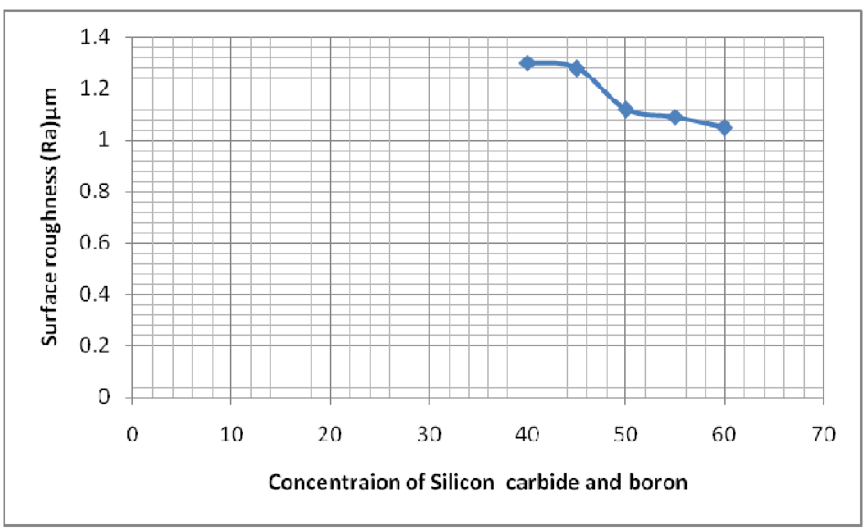

Figure 6: Relationship Between Combined Abrasive and Surface Roughness.

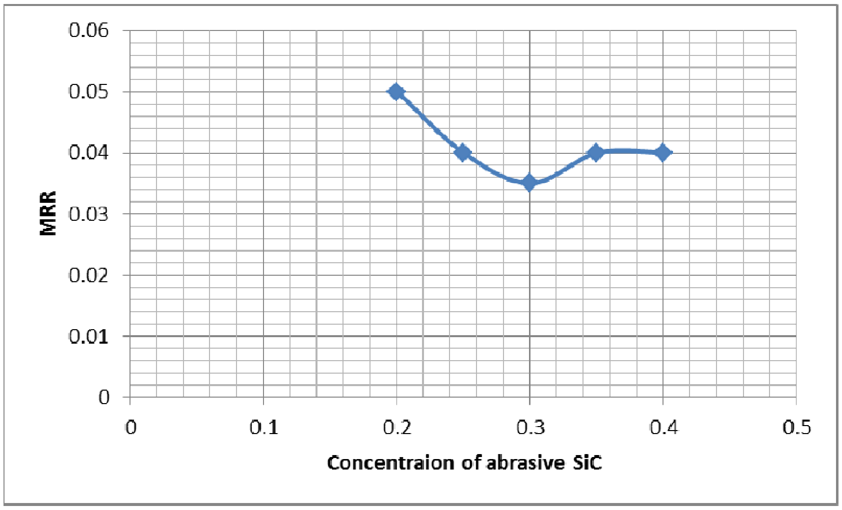

Figure 7: MRR from Abrasive Sic.

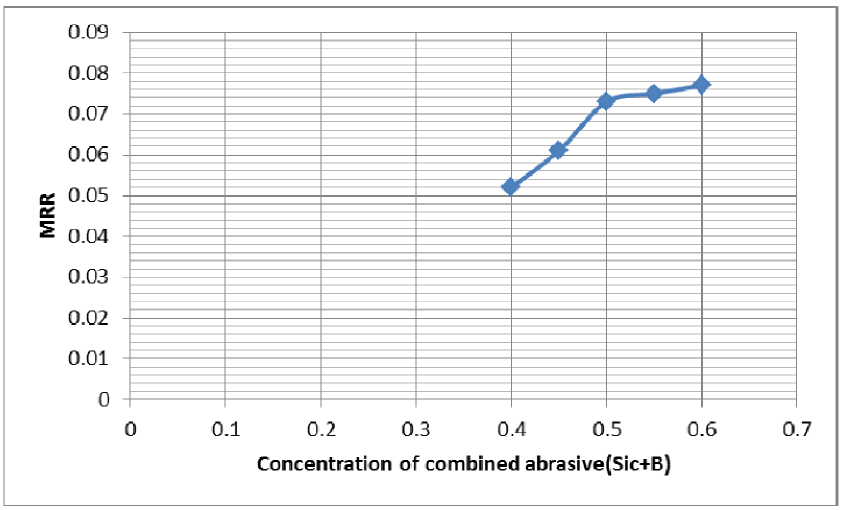

Figure 8: MRR from Combined Abrasives (Sic+B).

RESULTS AND DISCUSSIONS

From the values of table (2,3) the effect of adding boron abrasive to silicon carbide led to enhance the surface roughness and metal removal rate during the concentration of boron and can be reach to good value of surface roughness 1.05µm at concentration 40% B when comparing with surface roughness value 1.58µm without boron otherwise the metal removal rate improved and reach to maximum value 0.077gm at concentration 40% boron carbide while the metal removal rate was 0.035gm without boron carbide. When comparing figures (4,5) for surface roughness can concluded that the roughness gradually decreased from 1.58µm at concentration 55% (silicon carbide and Iron) to 1.05µm at concentration 60% moreover figure (5) show that adding of boron to silicon carbide improve and reduced the surface roughness to 1.05µm when using combined abrasives instead of single abrasive. The same case for metal removal rate boron play important role in developing the metal removal rate and therefore reach to 0.077gm when using combined abrasives (Silicon carbide and boron).

CONCLUSIONS

From all above can be concluded that the combined abrasives from silicon carbide and boron are more significant than single abrasive (silicon carbide) in surface roughness and metal removal rate moreover abrasives concentration can be achieved the acceptable result for level and values of smooth surface increasing the concentration of abrasives percent improving the surface roughness and metal removal rate.

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