TO STUDY THE EFFECTS OF DIFFERENT MECHANICAL PARAMETERS ON SURFACE ROUGHNESS IN ELECTROMAGNETIC AVERSIVE FINISHING (IN NON-FERROUS MATERIALS)

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Abstract— *The smoother surface is the first requirement in the field of metal cutting and fitting industries at present time and this requirement cannot be approachable with conventional finishing processes. Magnetic abrasive finishing is a modern approach to match our current requirements of surface finishing in metal part production industries. The value of surface finish is more important in the fields of petroleum, medical, electronics and lubrication industries. Electromagnetic abrasive finishing is a machining process in which the surface of the work piece is grinded by removing the material as micro-chips by abrasive particles mixed and suitable size of iron particles in the presence of magnetic field. To improve the surface quality of machined parts many other methods has been used earlier for better finishing but it did not produce much fine surface. To obtain a good finished surface a new method has been exercised which is known as electromagnetic abrasive finishing. This process has been developed for a wide variety of application including the manufacturing of components in the field of medical, fluid systems, optics, dies and molds, electronic, micro electro mechanical systems. Many mechanical as well as electrical researchers had worked to get better surface finish on magnetic abrasive machining w.r.t. different machining parameters like work rotation speed, standoff distance, concentration of mixture of powder and machining time. It is well known that magnetic flux density and work rotation speed has a great impact on surface finish. The much work has not been done on the mechanical parameters related with this machining process. Mixture contains iron particles (Fe particles 50 microns) and abrasive particles (Al2O3) of different mesh size. It has been observed that the increase in rotational speed, weight of abrasive and their size (iron particles and abrasive particles) improve the surface finish. So an experiment has been carried out to find out the optimum value of mechanical parameters at which better finishing can be achieved. In the present work, magnetic flux density is created by using the electromagnets. Magnetic abrasives mixtures were prepared by mixing ferromagnetic powder and abrasive powder. Brass, Cast Iron and SS-305 pipes have been used as work pieces. To find the optimum values of mechanical parameters a set-up is designed in which a lathe machine chuck is used as a work holding device and to rotate the work piece. Two electromagnets are arranged opposite to each other to create the magnetic force. Work piece is kept between these electromagnets.*

Keywords— ***MRR; MFD; MFP; (AL2O3); FMAB; SS-305; Standoff Distance***

1. INTRODUCTION

The first research is done on magnetic abrasive finishing (MAF) by Er. H. Coats in Japan. His research is about to get better surface finishing of flat surfaces during 1911's. Magnetic abrasive finishing (MAF) can be defined as a process by which surface is grind by removing the material in the form of micro- chips by abrasive particles (AL2O3) in the presence of magnetic field. Electromagnetic abrasive grinding (MAF) is one of the advanced surface finishing processes, which produces a smooth surface quality and can be controlled by a magnetic field, and other parameters like machining time, stand of distance from work zone. Magnetic abrasive finishing (MAF) set up has two electromagnets to produce strong magnetic field which is used for force the aversive mixture towards the wall of workpiece. The method was originally introduced in the Soviet Union, with further fundamental research in various countries including Japan. Nowadays, the study of the mechanical as well as electrical parameters is being conducted at industrial levels around the world.

In this research abrasives particles AL2O3 and iron particles is used to do grinding operation with different parameters i.e. work rotation speed, standoff distance and machining time. In this process the iron particles are magnetically attracted to the walls of work, and abrasive particles are trapped with them

2. LITERATURE REVIEW

Tayal et al. (24) had proposed some experimental investigation in precision internal finishing process that controls the surface integrity of internal surface of these components. This process utilizes magnetic pins for finishing the surface. An experimental set-up was developed to test the processing principle. This study characterizes the relationships between the magnetic field and other process parameter. It was included that Magnetic flux density is another influential parameter which affects the surface finish of the component. More the magnetic flux density, more improvement in surface finish takes place and with increase in machining time, there is an improvement in surface finish but improvement gets stabilized after a certain span of time.

D. Tudor et al. (25) had presented two examples of magneto-abrasive finishing installations, one for machining spur or helical cylindrical gears, the other for finishing bearing balls. Both pieces of equipment are characterized by simplicity and high performance. The two installations for magneto-abrasive finishing described in this paper are characterized by constructive simplicity and high performance. If series produced and added as accessories to universal milling machines, such installations will extend the range of possible machining provided by the latter.

3. Working Principle

MAF is prepared by sintering of ferromagnetic particles and abrasive particles. The magnetic abrasive particles join each other along the lines of magnetic force and form a flexible magnetic abrasive brush (FMAB) between the work piece and the magnetic pole. This brush behaves like a multi-point cutting tool for finishing operation. When the magnetic N-pole is rotating, the Magnetic Abrasive Finishing Brush (MAFB) also rotates like a flexible grinding wheel and finishing is done according to the forces acting on the abrasive particles. In external finishing of cylindrical surface, the cylindrical work piece rotates between the magnetic poles, with the MAF filled in both the gaps on either side, whereas in internal finishing of cylindrical surface, the work piece rotates between the magnetic poles and the MAF as shown in (Figure1.5). The magnetic field generator can be either electromagnetic coils or permanent magnets. The relative motion between the induced abrasive particles of the FMAB and workpiece generates the necessary shearing action at the abrasive work-piece interface to remove material from the work-piece in the form of miniature chips.

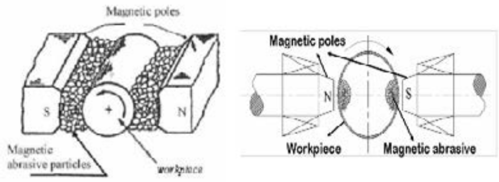

Figure 3.0: External cylindrical finishing & internal cylindrical finishing

4. Objectives

1. To determine the suitable parameters for surface finishing with respect to mechanical parameters i.e. RPM, MFD, Rotation Speed of Workpiece and machining time.
2. To predict the material removal rate due to magnetic abrasive finishing on above said materials using lathe chuck.
3. To determine optimum value of standoff distance of electromagnetic coil from work piece at which optimum value of maximum flux density is obtained to finish the desired work piece.
4. To study the effect of magnetic flux density w.r.t. to time of machining.
5. To determine the optimum revolution per minute where machining will be optimum.

5. Description and Working of Magnetic Abrasive Testing Apparatus

Figure 5.0: Working model of electromagnetic abrasive finishing

In the present study it has been proposed to develop a set up for carrying out investigation of effect of mechanical parameters on magnetic abrasive finishing process on the hollow tubes of different materials i.e. Brass, Cast Iron and SS-305. The electromagnets are prepared according to the specifications of work piece. The abrasive mixture prepared for carrying out finishing was composed of aluminum oxide and ferrite particles with an average diameter between 155 and 200 µm. The magnetic aversive finishing testing has been carried out, on these samples with respect to various mechanical i.e. rpm, standoff distance and machining time**6.**

6. Observations

The data is obtained by using the Surface Roughness Tester. By putting the different range values of magnetic flux density and voltage w.r.t. other parameters like standoff distance, concentration of mixture, speed, finishing time, we obtained the data.

6.1 Surface Roughness W.R.T. Magnetic Flux Density

TABLE 6.1: SURFACE ROUGHNESS W.R.T. STANDOFF DISTANCE

Sr. No.	**Materials**	**MFD (Gauss)**	**Roughness before Testing**	**Standoff distance(in mm)**		
				15	***10***	***5***
1	Cast Iron	5320	9.80	8.52	7.63	6.09
2	Brass	5320	1.51	1.46	1.39	0.99
3	SS-305	5320	1.01	0.87	0.65	0.38

TABLE 6.2: SURFACE ROUGHNESS W.R.T. MACHINING TIME

Sr. No.	**Materials**	**MFD (Gauss)**	**Roughness before Testing**	**Machining time (in minutes)**		
				15	***30***	***45***
1	Cast Iron	5320	8.01	6.93	5.74	4.03
2	Brass	5320	2.08	1.74	1.24	1.0
3	SS-305	5320	1.50	1.20	1.00	0.90

6.2 Surface Roughness w.r.t. R.P.M

TABLE 6.3: SURFACE ROUGHNESS W.R.T. STANDOFF DISTANCE

Sr. No.	**Materials**	**RPM**	**Roughness before Testing**	**Standoff distance(in mm)**		
				15	***10***	***5***
1	Cast Iron	670	7.11	6.79	6.01	5.59
2	Brass	670	2.85	2.00	1.65	1.00
3	SS-305	670	1.90	1.77	1.49	1.35

TABLE 6.4: SURFACE ROUGHNESS W.R.T. MACHINING TIME

Sr. No.	Materials	RPM	Roughness before Testing	Machining time (in minutes)		
				15	*30*	*45*
1	Cast Iron	670	7.42	6.85	6.17	5.75
2	Brass	670	2.02	1.78	1.05	0.89
3	SS-305	670	1.45	1.25	1.09	0.99

7. RESULTS AND ANALYSIS

It is not possible that all the times mechanical parameters have positive contribution in surface finish. Some of the mechanical parameters may be very much significant than other electrical parameters like MFD, Current and voltage.

To fine the optimum parameters in the respect of MAF, the experiments were conducted by selecting the mechanical parameters. So that a relation can establish to predict the response of surface finish improvements w. r. t. to magnetic flux density. In this study, the rpm of 670 and 780 are taken with duration of machining as 15-30-45 minutes were taken for experimentation. It was observed that the improvement in surface finish is more with the minimum range of magnetic flux density. In the case of machining time at 45 minutes the improvement in surface finishing increase with incensement in magnetic field, which responsible for attracting more number of iron particles with aversive particles towards the wall of our work piece. As they grind wall of work piece with more force

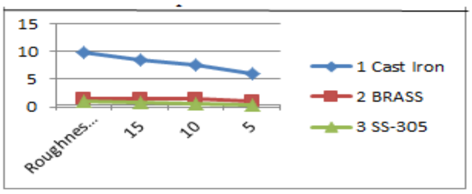

Figure Shows improvement in surface finish w.r.t standoff distance of coil from work piece.

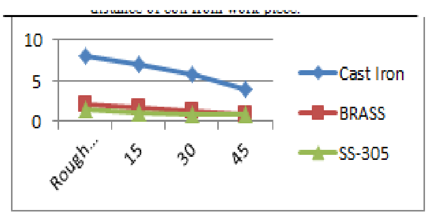

Figure: Shows improvements in surface finish w.r.t. time of machining.

Effect of R.P.M. To establish the feasibility of usage of Magnetic Abrasive Machining, the experiments were conducted by selecting the mechanical parameters. Here we study the range of rpm for comparative study has been taken i.e. 670 and 780 rpms. With respect to these rpms study was carried out to find the effect on surface roughness with standoff distance and machining time of work piece is taken. In this study, the rotational speeds of 670-780 rpm and the duration of machining of 15, 30 and 45 minutes were taken for experimentation. It was observed that the improvement in surface finish is more with the last range of rpm. As the rpm increases, more improvement in surface finish occurs.

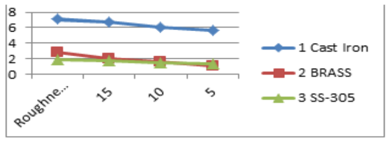

Figure: Shows improvement in surface finish w.r.t standoff distance of coil from work piece

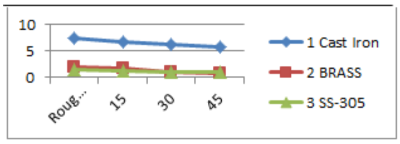

Figure Shows improvements in surface finish w.r.t. time of machining.

8. CONCLUSIONS

1. From these studies it was found that magnetic flux density around 0.6-0.10 Tesla give a significant fine improvement in surface finish with magnetic abrasive machining.
2. It was also found that at 810 rpm in machining give a significant improvement in surface finish.
3. This study shows that on various mechanical parameters improvement in surface finish is more in case of brass as compared to other materials like SS-306.
4. It has been found that with the increase in number of turns in an electromagnetic coil magnetic flux density also increases as a result of which maximum material removal rate will be occurring.
5. An effort has been made out to find out the best electrical as well as mechanical parameters for electromagnetic abrasive machining with respect to various machining parameters so that maximum surface finishing can be achieved.

9. FUTURE SCOPE

In future study we can use other engineering materials like aluminum, copper etc. that can be super finished by this MAF. Different speeds and magnetic flux density effects can be study out in future. The effect of surface roughness, roundness, micro diameter change w.r.t. Concentration of mixture can be seen. Study can be conducted further for finding out the optimum range of various mechanical as well as electrical parameters to find improvement in surface finish.

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