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Internal Finishing of Aluminium Tube with Sintered Magnetic Abrasive

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ABSTRACT : **There has been a rapid growth in the development of harder and complex shapes to machine metals and alloys during the last few years. Conventional edged tool machining is difficult and uneconomical for such materials and degree of surface finish attainable is poor. In view of the seriousness of this problem, recently new non-conventional fine machining processes like Magnetic Abrasive Polishing, Magnetic Abrasive Flow Machining (MAFM), Magnetic Float Machining (MFM) and Magnetic Abrasive Machining (MAM), Magneto –Rheological Machining (MRM), Chemo-Mechanical Polishing (CMP) have been developed. Among these processes 'Magnetic Abrasive Finishing processes are widely used for obtaining quality finish on metallic (ferrous and non ferrous) as well as non metallic (ceramics) components. MAF process has been recently used in its variant forms such as Magnetic float polishing, Magneto-rheological machining, Electrolytic magnetic polishing but the problem of development of magnetic abrasive powders is still present and efforts are in continuous progress at global to remove this problem.**

In the MAF method, a magnetic field is used to generate cutting force to treat the surface of a machined part. The magnetic field helps to form a flexible magnetic abrasives brush for finishing of surface. Finishing force can be controlled with magnetic field and a low surface temperature is generated during finishing operations. Magnetic abrasives are not easily available. Very few studies have been reported till date on the development of alternative magnetic abrasives. The aim of study is to evaluate the performance of developed sintered magnetic abrasives for internal finishing of aluminium tubes using MAF process. PISF is calculated considering different variables like speed (rpm) , quantity of abrasive and gap of magnetic pole and work piece. Preparation of sintered magnetic abrasive was difficult and time consuming. The best result came at 425 rpm and quantity of abrasive used 6 gm. PISF value obtained in present case was 84 % .

1.1 INTRODUCTION

There are some materials used in high technology industries which are difficult to finish by conventional machining and polishing techniques with high accuracy and minimal surface defects, such as micro cracks, geometrical errors and distortions on the work surfaces. To solve this problem some new machining methods were developed which are known as 'Unconventional machining methods'. These were so called so as they do not use conventional edges tools for machining. One such method of machining called 'Magnetic abrasive machining' was developed to overcome difficulties of machining. Literature survey and various experimental results and industrial use have confirmed that MAF is more efficient and produces better surface finish than conventional methods of finishing.

1.2WORKING PRINCIPLE

Figure below shows the principle of magnetic abrasive finishing process. A magnetic force is generated between the inductor and work- piece. The magnetic force aligns magnetic abrasive particles from the inductor to the work piece along lines of magnetic force, thus it forms a flexible magnetic abrasive brush. The brush rotates in accordance with the inductor, presses down the work piece and then removes the surface material little by little. Fine surfaces like a mirror are easily obtained under this process.

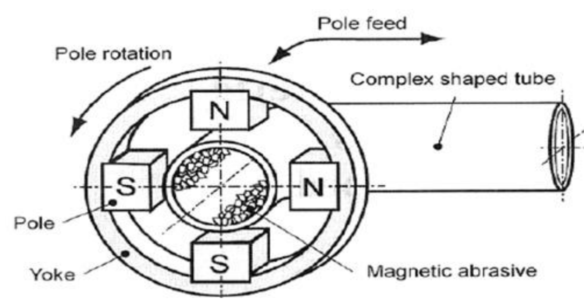

Fig 1.1: Working Principle of MAF Process

1.3 TECHNIQUE TO PREPARE MAGNETIC ABRASIVES

Sintering is the process by which metal powder compacts (or loose metal powders) are transformed into coherent solids at temperatures below their melting point. During sintering, the powder particles are bonded together by diffusion and other atomic transport mechanisms, and the resulting somewhat porous body acquires a certain mechanical strength. After the preparation of compacts they were sintered in a specially designed furnace to a temperature of 1100˚C in H_2 gas atmosphere and kept at selected temperature for 2 hrs. During Sintering the Alumia particles get cohered with the iron particles and are difficult to separate.

2. LITERATURE REVIEW

Feygin, et al. (1998) prepared magnetic abrasives by mixing iron powder, aluminum oxide and cyanacrylate glue an adhesive. Cyanacrylate glue is a strong adhesive which binds iron and abrasive particles strongly with each other.[15]

Kremen et al. (1999) also developed magnetic abrasives using the same technique in which an adhesive is used to bind magnetic component (iron powder) with abrasive component (diamond powder). All the three components are mixed thoroughly, dried and crushed into small particles of desired size for machining.[16]

Jain et al. (2001) carried out experiments on non-magnetic stainless steel with the use of loosely bounded abrasives by MAM process. The loosely bounded powder was obtained by homogeneous mixing magnetic powder (Fe powder of 300 mesh size), abrasive powder (Al_2O_3 of 600 meshes) and lubricant called servospin-12 oil. The experiments were performed to investigate the effect of working gap and circumferential speed on metal removal, changes in surface finish and percentage improvement in surface finish. They concluded that working gap and circumferential speed of the work piece are the parameters which significantly influence the material removal, change in surface roughness and percentage surface finish improvement. Metal removal decreased with increase in the working gap and decreasing circumferential speed. Change in surface finish increases with increase in circumferential speed of the work piece.

Gandhi et al. (2013) stated that Magnetic Abrasive Finishing (MAF) is an advanced finishing method, which improves the quality of surfaces and performance of the products. Surface is finished by removing the material in the form of microchips by abrasive particles in the presence of magnetic field. The material is removed in such a way that surface finishing and deburring are performed simultaneously with the applied magnetic field in the finishing zone. This paper deals with the detailed parametric study in super finishing of stainless steel SUS304 thick tube internally.

Singh Lakhvir (2010) developed an alternating magnetic abrasive (Al_2O_3 + iron powder) with the application of mechanical alloying & also developed an experimental setup for manufacturing as well as for performance evaluation of proposed magnetic abrasive. He used brass and stainless steel as work piece and concluded that MAF is capable to produce surface finish in nano meters.

Singh Lakhvir et al. (2010) studied the performance of Al_2O_3 based bonded magnetic abrasives in dry and wet conditions when used for the internal finishing of brass tubes. To make the abrasive wet high speed diesel (20 % by weight) was used as the lubricant. It was concluded that PISF and MRR was more in the case of wet magnetic abrasives.

Singh Lakhvir et al. (2010) highlights major existing technologies that are used to manufacture magnetic abrasives. Main performance characteristics of magnetic abrasives have also been reviewed as regards to manufacturing of various surfaces and concluded that amongst all available varieties of magnetic abrasive, the sintered magnetic abrasives give highest surface finish on most of the work materials. Irrespective of type of magnetic abrasives used, the PISF over original finish of the surface varies in 75% to 99%.

3 STATEMENT OF THE PROBLEM

1. Magnetic abrasives are not commercially available easily; if available their cost is high so we work on them.

2. Not enough literature is available on finishing of aluminum using aluminum oxide based magnetic abrasive.

3.1 OBJECTIVE

1. To prepare Al_2O_3 + iron, based sintered magnetic abrasives.

2. To study the effect of Al_2O_3 based sintered magnetic abrasive on internal finishing of Aluminium tubes using MAF process.

3. To compare the effectiveness of machining by other factor like Quantity of abrasive , Gap of magnetic pole from work piece , Speed(rpm) .

4 EXPERIMENTATION AND RESULTS

Taking into consideration the result of preliminary experimentation and range of factors on the design setup, different experiments are performed for final experimentation. the quantity of abrasives used is 4 to 10 gm and the rotational speed of magnetic poles is varied from 350 to 650 rpm.gap between the poles and work pieces is 5mm .Different experiments were performed to evaluate the performance of magnetic abrasives prepared by sintering method . Table 5.1 shows the effect of varying the rotational speed on PISF by using 4gm of abrasive for experimentation. All other factors are fixed as shown below.

Table 5.1 Results of Rotational Speed of Magnetic Poles

Rotational Speed (r.p.m)	Grit Size (µm)	Gap (mm)	%age of abrasive (%age)	Quantity of Magnetic Abrasives (g)	PISF (%age) of sintering
350	163	3	30	4	59.77
425	163	3	30	4	64.7
500	163	3	30	4	70.02
575	163	3	30	4	75.1
650	163	3	30	4	78.9

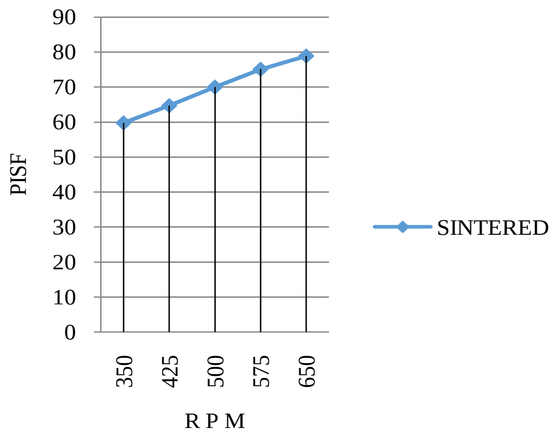

Figure 5.1

The results of the table 5.1 are plotted in the form of graph to get clear picture of the effect of rotational speed of the magnetic poles on the surface finish of the work piece during MAF process. The rotational speed is plotted along horizontal axis and PISF is plotted along vertical axis as shown in graph 5.1. Graph shows that PISF increases as we increase the rotational speed of poles.

Table 5.2 Results of Rotational Speed of Magnetic Poles

Rotational Speed (r.p.m)	Grit Size (μm)	Gap (mm)	%age of abrasive (%age)	Quantity of Magnetic Abrasives (g)	PISF (%age) of sintering
350	163	3	30	6	65.6
425	163	3	30	6	84.03
500	163	3	30	6	78.98
575	163	3	30	6	76.1
650	163	3	30	6	71.4

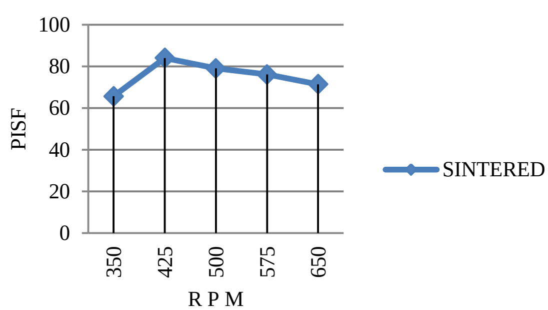

Figure 5.2

Table 5.2 shows the effect of changing rotational speed of magnetic poles on PISF by using 6gm of magnetic abrasive for experimentation. All other factors are fixed as shown. The result obtained from the table 5.2 is plotted in the form of graph. as shown in figure 5.2 figure shows that PISF in case of sintered magnetic abrasive PISF increases up to 425 rpm and then start decreasing.

Table 5.3 shows the effect of changing rotational speed of magnetic poles on surface finish in terms of PISF by using 8 gm of magnetic abrasive for experimentation. All other factors are as shown below.

Table 5.3 Results of Rotational Speed of Magnetic Poles

Rotational Speed (r.p.m)	Grit Size (μm)	Gap (mm)	%age of abrasive (%age)	Quantity of Magnetic Abrasives (g)	PISF (%age) of sintering
350	163	3	20	8	53.50
425	163	3	20	8	57.2
500	163	3	20	8	72.02
575	163	3	20	8	51.1
650	163	3	20	8	41.11

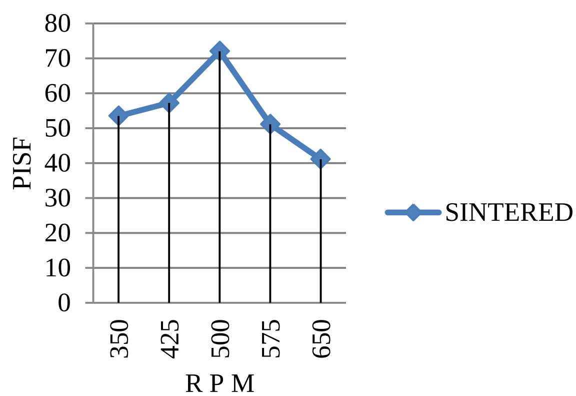

Figure 5.3

The results obtained from the table 5.3 are plotted in the form of graph as shown in figure 5.3. In case of sintered magnetic abrasive PISF increase up to 500 rpm and maximum value is reached at this value after this the PISF starts decreasing.

Table 5.4 shows the effect of changing rotational speed of magnetic poles on surface finish in terms of PISF by using 10 gm of magnetic abrasive for experimentation. All other factors are fixed as shown below.

Table 5.4 Results of Rotational Speed of Magnetic Poles

Rotational Speed (r.p.m)	Grit Size (μm)	Gap (mm)	%age of abrasive (%age)	Quantity of Magnetic Abrasives (g)	PISF (%age) of sintering
350	163	3	30	10	36.76
425	163	3	30	10	46.39
500	163	3	30	10	62.69
575	163	3	30	10	49.4
650	163	3	30	10	47.07

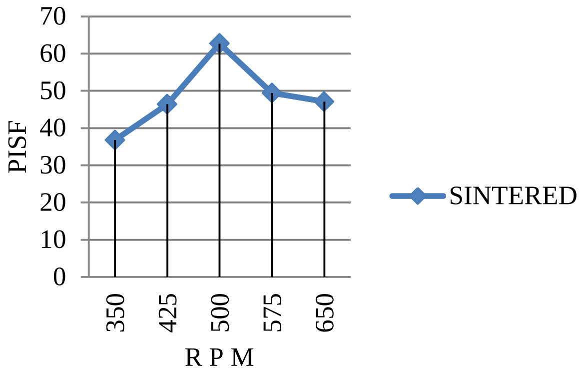

Figure 5.4

The results obtained from the table 5.4 are plotted in the form of graph as shown in figure 5.4. the trend of graph in figure 5.4 is also similar to the graphs drawn earlier. Here the PISF increase initially to some value and then starts decreasing with further increase of rpm. In case of sintered magnetic abrasives PISF increase up to 500 rpm and then decreases.

5 CONCLUSIONS

After carrying out the internal finishing of aluminium tubes with MAF process by using sintered magnetic abrasive, conclusion that came out are that the magnetic abrasives influence the percentage improvement in magnetic abrasive finishing process. The maximum value of PISF obtained was 84%. Except in experiments of 4g quantity of magnetic abrasives, the PISF first increases and then decreased as rpm of magnetic poles are increased in MAF process of Aluminium tubes.

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