International Journal of Applied Engineering Research ISSN 0973-4562 Volume 12, Number 19 (2017) pp. 8972-8975

Comparing the techniques for Magnetic Abrasives by Investigating the Surface Finish

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Abstract

Magnetically Assisted Abrasive Finishing (MAAF) processes are most suitable for obtaining quality finish on metallic and non-metallic surfaces. In these processes, the cutting forces are generated and controlled by magnetic field developed between the electromagnetic poles and magnetic abrasives. In spite of remarkable results of MAAF processes, the major constraint towards commercial adoption of this technology is the non-availability of magnetic abrasives. The manufacturing techniques for preparing magnetic abrasives are time consuming and complicated therefore the existing magnetic abrasives are very costly. The aim of the present study is to develop and explore the usage of alternative magnetic abrasives. In the present work, magnetic abrasives were prepared by mixing ferromagnetic powder, abrasive powder and a special type of adhesive for bonding. To compare the performance of developed magnetic abrasives, two more types of magnetic abrasives were prepared by using sintering and simple mixing. Brass pipes have been used as work pieces. The performance of various magnetic abrasives has been experimentally measured and compared. Best performance is shown by magnetic abrasives produced by sintering. Glued magnetic abrasives also performed well but simple mixing technique did not show very good results.

Keywords: Magnetic abrasives, Adhesive bonding, Sintering, Finishing, Surface finish

INTRODUCTION

Various industrial applications require very high surface finish upto the range of nanometers or even above with the development of modern manufacturing trends. Presently, it is required that the parts, used in manufacturing semiconductors, atomic energy parts, medical instruments and aerospace applications, have a very fine surface roughness. Amongst them, vacuum tubes, wave-guides and sanitary tubes are difficult to be polished by conventional finishing methods such as lapping, because of their shapes.

Working Principle

The Figure 1.1 shows the magnetic abrasive process for internal polishing. The principle of magnetic abrasive machining utilizes the machining force generated by the magnetic field strength as well as the gradient of the magnetic field.

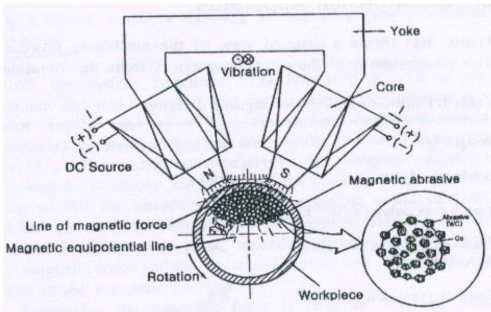

Figure 1.1. Schematic view of the internal polishing system using magnetic force and magnetic abrasives

General Introduction About techniques

Sintering is a method for making objects from powder, by heating the material in a sintering furnace below its melting point (solid state sintering) until its particles adhere to each other. Sintering is traditionally used for manufacturing ceramic objects, and has also found uses in such fields as powder metallurgy.

Adhesive bonding A special type of adhesive was selected for providing a strong bond between magnetic and abrasive component. The amount of adhesive in mixture of abrasive and ferro magnetic components was decided in such a way that adhesive completely wets the mixture and at the same time the mixture should not behave like a fluid.

Simple Mixed Magnetic Abrasives

In this technique of preparing magnetic abrasives, Iron powder and SiC powder is simply mixed without adding any bonding material. It is believed that iron particles sandwich SiC particles and under the influence of magnetic field, the mixture causes abrasion action on the workpiece surface.

LITERATURE REVIEW

The literature, which was reviewed for this project selection, was based upon various aspects of abrasive mixtures prepared by various techniques. The abrasives are non magnetic and it is required to attach these abrasives with any ferro magnetic material, so that the combination of abrasives and ferro magnetic material can be attracted by magnetic field. The various mixing techniques for this purpose were prepared by various researchers and tested for surface finish, finishing time, wear of abrasives mixture

Sakulevich et. al. (1980) developed a rotor type machine for abrasive machining of parts with ferromagnetic abrasive powders in magnetic field

Kurobe (1983) used magnetic field to finish silicon wafer, glass and copper. In this study the reasercher prepared magnetic fluid, which had the ability to move under magnetic field.

Kremen, Z., (1993) prepared diamond and non diamond carbon poly crystalline composites particularly useful as abrasives are made by conventional sintering diamond particles at temperature above about 1440 K but at pressures below which diamond is stable or metastable with respect to its conversion to graphite.

Tzong et al. (2003) in their study on Electrolytic magnetic abrasive finishing, Electrolytic magnetic abrasive finishing (EMAF) is a compound finishing process, involving traditional magnetic abrasive finishing (MAF) and an electrolytic process.

Dixit (2004) carried out experiments upon MAF having a slotted magnetic pole. This study deals with the effect of a slot made in the electromagnet on the forces and surface quality during MAF.

Problem Formulation

Earlier studies on Magnetic Abrasive Machining were only to utilize this machining process in different operations. Only different types of material workparts are processed upon this machine by various research personnel and organizations. But the cost can also be reduced by maximizing the production rate and by making the best quality product in shortest time. This can be achieved also by making an optimum abrasive grain-workpart combination, which takes least processing time and the quality of the processed component will be best. Therefore the present study was to develop a suitable combination of abrasives and workpart materials by taking different material abrasive particles. By which the whole process will become optimum.

OBJECTIVES OF STUDY

1. To find the suitable combination of workpiece – abrasive i.e prepared by different techniques with the fixed process parameters of the Magnetic Abrasive Machine so that to find the optimum machining conditions at which there will be maximum material removal rate and maximum surface finish.
2. To study the surface finish produced by the optimum combination of workpart and abrasive grains and to compare under the different conditions (dry & wet)

XPERIMENTATION

Table 4.1. Composition of Magnetic Abrasive forAdhesive Bonding (Each Sample 100 gm) (Adhesive taken- 30 ml for each)

Sample Number	Percentage of ferromagnetic component (By weight)	Percentage of abrasive component (By weight)
1.	90	10
2.	85	15
3.	80	20
4.	70	30
5.	60	40

Table 4.2. Composition of Magnetic Abrasive and sintering Conditions (Time taken – 1 Hour) (Temperature maintained – 1250 ºC)

Sample Number	Percentage of ferromagnetic component	Percentage of abrasive component
1.	90	10
2.	85	15
3.	80	20
4.	70	30
5.	60	40

RESULTS AND DISCUSSION

Table. 5.1. Simple Mixed Abrasives

S. No.	Initial surface finish in µm	Final surface finish in µm (Dry condition	%age improvement (Dry condition)	Final surface finish in µm (wet condition)	%age improvement(Wet condition)
1.	4.05	3.70	8.49	3.53	12.60
2.	4.08	3.68	9.63	3.49	14.40
3.	4.10	3.50	14.49	3.44	16.00
4.	4.11	3.46	15.59	3.40	17.05
5.	4.19	3.66	12.46	3.58	14.32

Table. 5.2: Adhesive Bonded Abrasives

S. No.	Initial surface finish in µm	Final surface finish in µm (Dry condition)	%age improvement (Dry)	Final surface finish in µm (wet condition)	%age improvement (Wet condition)
1.	4.16	3.63	12.60	3.01	27.53
2.	4.12	3.15	23.54	2.72	33.84
3.	4.13	2.99	27.56	2.53	38.60
4.	4.08	2.70	33.59	2.34	42.53
5.	4.05	2.82	30.33	2.43	39.86

Table 5.3: Sintered Abrasives

S. No.	Initial surface finish in µm	Final surface finish in µm (Dry condition)	%age improvement (Dry)	Final surface finish in µm (wet condition)	%age improvement (Wet condition)
1.	4.19	2.85	23.29	2.66	32.50
2.	4.21	3.03	27.46	2.82	36.64
3.	4.23	2.68	36.58	2.43	42.53
4.	4.20	2.57	38.59	2.12	49.34
5.	4.22	2.63	37.45	2.18	48.12

PERCENTAGE IMPROVEMENT IN SURFACE FINISH

The effect of three input parameters (Proportion of Ferromagnetic / Abrasive Powder, Condition of Application, Type of Magnetic Abrasive) on percentage improvement in surface finish (ΔRa) has been discussed in the following points:

- The developed magnetic abrasives (By adhesive bonding) are able to machine fine of brass surface with reasonable percentage improvement in surface roughness of the work piece .
- Type of magnetic abrasive is a significant factor. On comparison of magnetic abrasives made up by Adhesive bonding, sintering and with simply mixed iron powder and abrasive powder, it is found that there is discernible improvement in surface roughness of workpiece by using developed magnetic abrasives, under all other similar conditions.
- In case of simply mixed magnetic abrasives and Silicon Carbide, the percentage improvement in surface roughness is not very good. But in case of Adhesive bonded iron-SiC, this value was upto the mark. In case of sintered iron-SiC, this value was maximum.
- The trend of variation of percentage improvement in surface roughness remains same for the three type of iron-SiC i.e. simple mixed, glued and sintered.

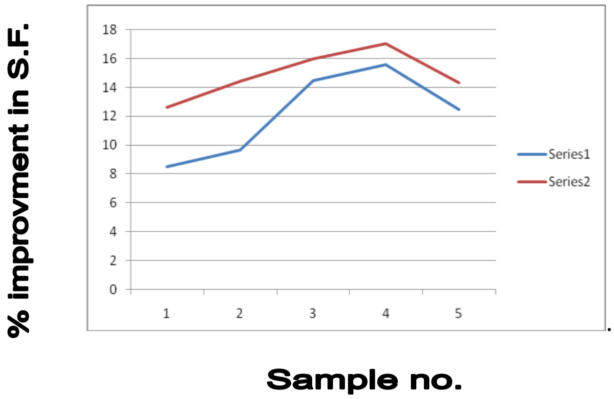

Figure. 5.1 Percentage improvement in surface finish under dry and wet conditions

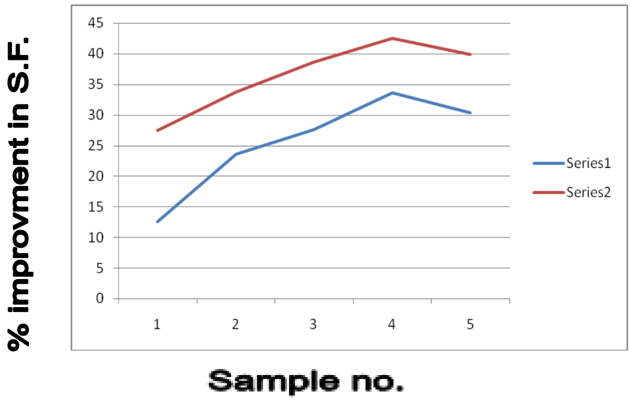

Figure 5.2 Percentage improvement in surface finish under dry and wet conditions for adhesive bonded abrasives

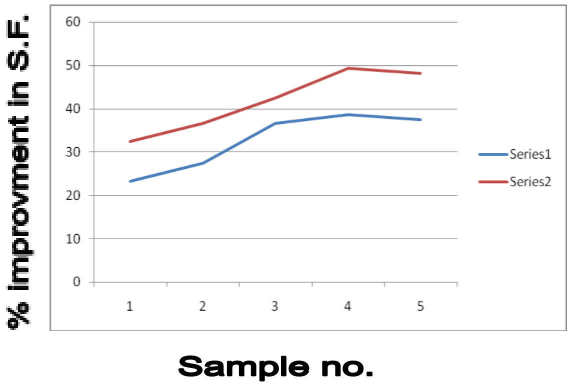

Figure 5.3: Percentage improvement in surface finish under dry and wet conditions for sintered abrasives

CONCLUSIONS

1. The developed magnetic abrasives (By adhesive bonding) are able to fine machine of brass surface with reasonable percentage improvement in surface roughness of the work piece (Approximately 49%) .
2. Type of magnetic abrasive (categorical factor) is a significant factor. On comparison of magnetic abrasives made up by Adhesive bonding, sintering and with simply mixed iron powder and abrasive powder, it is found that there is discernible improvement in surface roughness of workpiece by using developed magnetic abrasives, under all other similar conditions.
3. In case of simply mixed magnetic abrasives and Silicon Carbide, the maximum percentage improvement in surface roughness is approximately 18%. But in case of Adhesive bonded iron-SiC, this value was upto 42 %. In case of sintered iron-SiC, this value was 49%.

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