A REVIEW ON IMPROVING SURFACE ROUGHNESS IN ELECTROMAGNETIC ABRASIVE MACHINING

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Abstract— *The magnetic abrasive machining process is developed as a unconventional machining process. It is frequently adopted in metal manufacturing industries for micro level surface finishing of workpiece with the help of Magnetic abrasive particles and magnetic force applied in the machining zone. It is accurate and more time saver than conventional machining methods and able to produce smooth and finished metal components. The objective of this paper to provide a comprehensive review on the recent advancement of EAM process carried out by different researcher in different mechanical or other fields. The effect of different mechanical as well as electrical parameters such as rotational speed of workpiece, voltage, magnetic flux density, abrasive particles size and their concentration with iron partials and stand of distance on the performances of Material Removal Rate and surface roughness (Ra).. On the basis of review, it is observed that the rotational speed of workpiece, voltage and mesh size of abrasive particles have a great effect on EAM process.*

Keywords— EAM; Abrasives; Abrasive Machining; MMR

1. INTRODUCTION

Electromagnetic Aversive Machining (EAM) is one of the non-conventional finishing methods, which produces a fine surface quality and it is controlled by a magnetic force. In EAM, the work piece is kept between the electromagnets. The standoff distance between the work piece and the magnet is filled with magnetic abrasive particles or the aversive mixture is filled in the hollow tube specimen. A magnetic abrasive flexible brush (MAFB) is formed, acting as a multipoint cutting tool, due to the effect of the magnetic field in the working gap.. In the application of ferromagnetic substance of work, for instance, work piece is also magnetized and the magnetic force acts on the top of the brush between the work piece and the abrasive particles resulting in pressing the abrasive grains to work surface. The EAM process removes a very small amount of material by indentation and rotation of magnetic abrasive particles.
Recent developments in industry have fueled the demand for products with very high surface finish in addition to dimensional accuracy. However, it is very difficult to improve the accuracy of such products with one simple finishing method. Therefore, many researchers have tried to adopt different processing methods to improve the surface quality of these products. Conventional methods for achieving high surface finish include lapping, grinding, honing, polishing, and burnishing

2. PRINCIPLE OF EAM

EAM is a process in which a cylindrical workpiece is inserted inside the gap between the two magnetic poles. The gap between the workpiece and the magnet pole is filled with magnetic abrasive particles (MAPs), which are composed of ferromagnetic materials, such as iron particles, and non-magnetic abrasive powders. The MAPs are joined magnetically between magnetic poles (N and S) along the lines of magnetic force and form a flexible magnetic abrasive brush (FMAB). The cylindrical magnetic abrasive finishing process is achieved when the cylindrical work piece starts to rotate at the same time as the cylindrical workpiece

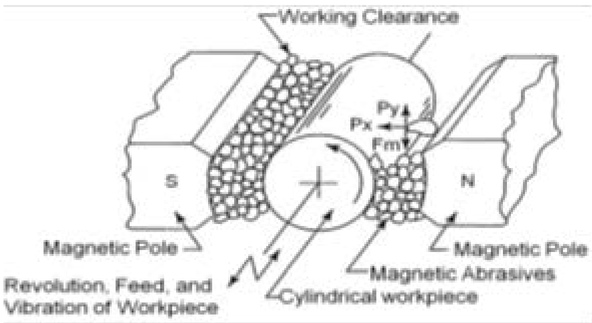


Figure 1.1Schematic diagram of the cylindrical magnetic abrasive finishing

3. LITERATURE REVIEW

The work done by several researchers signify the feasibility, effectiveness and economic aspect of EAM in various manufacturing domains.
Ramesh babu et al. (1998) investigated the effect of various input parameters on the surface quality of stainless steel workpiece. They observed preliminary roughness and hardness of the workpiece influencing the surface finish significantly. Yamaguchi and Shinmura proposed an internal magnetic abrasive finishing process for quality finishing of inner surface of the tubes.
Biing et al. discussed the principle of electrolytic magnetic abrasive finishing (EAM) in 2003. They also analyzed the

impact of different process parameters with different range as 1) in Ra and MRR. This experimental result also shows that with a high electrolytic current EMAF process produces excellent finishing characteristics In 2004, Sing et al. conducted experiments on stainless steel during EAM process using Taguchi design experiment and found the optimum input parameters. They explained how Ra is impact by input parameters namely voltage, revolution speed of the electromagnet, abrasive particles size and working gap. They also designed force transducer for inspection of the finishing process and fabricated to calculate the force during EAM process.
In 2012, Yadava and Judal introduced a hybrid machining known as cylindrical electrochemical magnetic abrasive machining(C-EMAM), which is used in cylindrical work surface for effective surface finishing which is tough by other machining processes. Experiment was performed on self-developed C-EAMM process setup of magnetic stainless steel (AISI-420) using unbounded MAPs. They explained the impact of process parameters on MRR and finishing. They also observed that for magnetic steel, how Ra and MRR are influenced with the electro-chemical dissolution and magnetic abrasion respectively
Judal et al. designed and developed cylindrical EAM setup to produce high grade of surface finish quality which are needed on advanced manufacturing industries. They explained how current on electromagnet influenced the magnetic field. In this experiment they also studied the effect of main critical parameters which effect on the finishing quality. Ra decrease from 1.3 µm to 0.24 µm after machining process in their experiment. They observed that to improve the finishing quality, magnetic poles are rotated
Madarkar and Jain investigated the new technique namely magnetic abrasive deburring (MADe) method. They studied the effect of input parameters with different range as on output parameters such as surface finishing. They also explained that magnetic abrasive deburring method had most effective improvement on hole-edge quality and burr reduction in 2016,

4. OBJECTIVE OF THIS PAPER

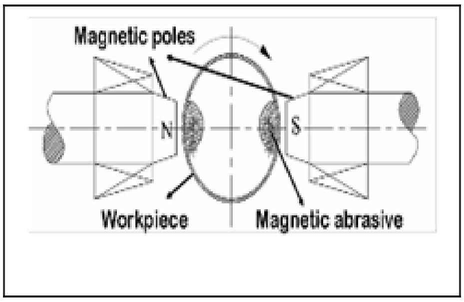
The objective of this paper to provide a comprehensive review on the recent advancement of EAM process carried out by different researcher in different mechanical or other fields. The effect of different mechanical as well as electrical parameters such as rotational speed of workpiece, voltage, magnetic flux density, abrasive particles size and their concentration with iron partials and stand of distance on the performances of Material Removal Rate and surface roughness (Ra).. On the basis of review, it is observed that the rotational speed of workpiece, voltage and mesh size of abrasive particles have a great effect on EAM.

5. CLASSIFICATION OF EAM PROCESSES

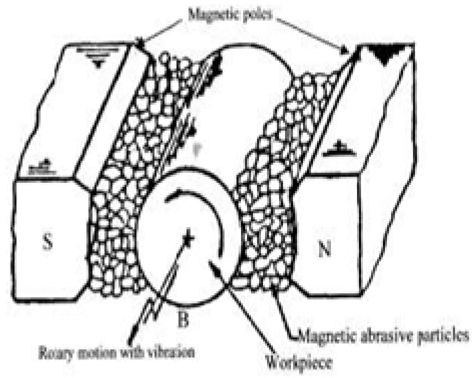
- Magnetic abrasive finishing can be categorized according to the type of magnetic field in which the work piece is to be held as
- Magnetic Abrasive Finishing With Permanent Magnet
- Magnetic Abrasive Finishing With Direct Current
- Magnetic Abrasive Finishing With Alternating Current

6. TYPE OF EAM

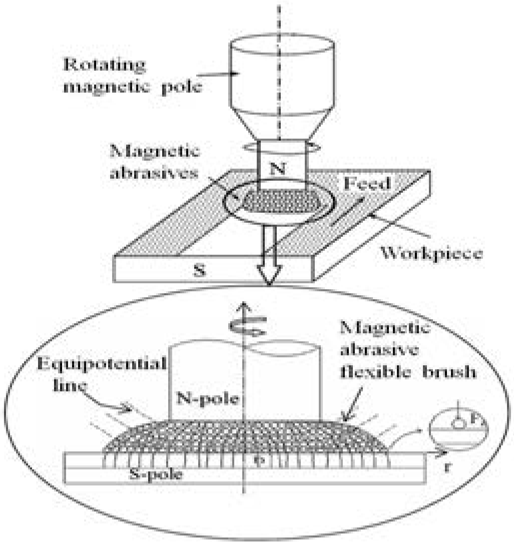
1. *Magnetic Abrasive Finishing Internal*



2. *Magnetic Abrasive Finishing External*



3. *Plane Magnetic Abrasive Finishing*



7. ADVANTAGES OF EAM

Because EAM uses very low forces and loose abrasive particles, the damages to the surface can be minimized. The advantages of EAM over other alternative processes such as super finishing, lapping, and honing are listed below:

- The simultaneous machining of mutually perpendicular surfaces (such as cylindrical and conical surfaces), other combinations (such as finishing the outer diameter and radii of a piston ring), and similar parts is possible.

- Material surface is free of buns and thermal defects.
- Low energy consumption.
- Simple to implement.
- Ecologically safe.
- Self-adaptability.
- Controllability

8. Effects of different Parameters

The impact of various input parameters on process characteristics namely Ra and MRR of EAM during machining of different engineering materials has been analyzed using the experiment and are discussed below:

1. *Effects of Voltage*

The Ra and MRR rate are also increases. It creates much line of magnetic force so there is increase in magnetic flux density on the working zone. With the decrement of working area the strength and contact area of FMAB with workpiece increase. By that there is increment in Ra.

2. *Effects of Mesh Size of Abrasive Particles*

Particles size there is decrease in surface finish With the decrease in abrasive particle size, there is increase in a contact area of workpiece with abrasive particles size. So, much surface got sheared off so that there is increase in surface finish but it is not possible to larger abrasive particle size because in FMAB it is hard to trap between abrasive particles size. Thereby, it impact in finishing, result on improper Ra and MRR.

3. *Effects of Rotational Speed of Electromagnet on*

Increase which guide to the better surface finishing due to increment of Rotational speed Furthermore Rotational speed supply additional energy to abrasive to penetrate workpiece, thereby there is better Ra and MRR. But there is decrement in surface roughness with increment in rotational speed. Increment of centrifugal force is corresponding to the increment of rotational speed. The mixtures of MAP is cast away from the machining zone with increment of force, thereby magnetic flux density decrease in the machining zone as well as there is available of less MAP used for the shearing with the surface of workpiece. So, there is reduction in Ra with more increase in rotational speed of electromagnet.

4. *Effects of Magnetic Flux Density*

When there is increase in magnetic flux density. Ra and MRR are increased due to the increment in flux density of magnetic; thereby increase in tangential finishing force which is the crucial cutting force required for smoothening of surface by removing materials as microchips. Magnetic flux density and different parameters should be used according to the properties of operating workpiece materials.

5. *Effects of Stand of Distance*

With the increment of working zone, surface finish is decreased because magnetic field generated is minimum so that ferromagnetic particle is weakly magnetized therefore it produce lesser amount of pressure force in FMAB during workpiece boundary by that abrasive particle size doesn't have exact indentation with large working zone. So, Ra and MRR are decreased.

9. Conclusions

This paper contributes the understanding EAM is one of the finest surfaces finishing unconventional machining process for all types of engineering materials and it is suitable for the surface finishing with high accuracy and efficiency. It is always not necessary that there should be significant contribution of input parameters on output parameters like surface finish and MRR. Some of the parameters are significant as compared to others.

Magnetic abrasive finishing process can be used for surface finishing as well as surface modification of hard to finish Surfaces such as brass, stainless steel, etc. Magnetic abrasive finishing can be successfully used for finishing of internal as well as external surfaces of complicated design In magnetic abrasive finishing process, magnetic force is affected by the material, shape and size of work, and shape and size of magnetic pole, work-pole gap distance, and composition of magnetic abrasives.

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