Effectiveness of Sintered Abrasives in Magnetic Abrasive Finishing -AReview-

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Abstract-

In the era of nanotechnology, deterministic high precision finishing methods are of utmost importance and are the need of present manufacturing scenario. The need for high precision in manufacturing was felt by manufacturers worldwide to improve interchangeability of components, improve quality control and longer wear/fatigue life. Various industries and production of various products required various kinds of finishing operations for manufacturing of precise parts owing to their most critical, labor intensive and least controllable nature. The machining processes are classified into two categories on the basis of achievable finishing viz. Conventional machining and Non- conventional machining (Ultra precision). Ultra-precision machining are the processes by which the highest possible dimensional accuracy has been achieved at a given point of time. MAF is one such process in which machining/finishing is done by abrasives under the influence of controlled magnetic field. Necessarily, the quality of finish depends upon various factors including the type of abrasives and the techniques to prepare them such as loosely bound, sintering, mechanical alloying, adhesive bonding etc. Numbers of research papers are available which shows the utilization of different type of abrasives prepared with different techniques. The aim of this paper is to summarize the finishing effectiveness of abrasives prepared by sintering technique considering the effect of other parameters.

Keywords--Magnetic abrasive finishing (MAF), surface roughness, magnetic abrasives, magnetic abrasive brush, Percentage improvement in surface finish (PISF)

I. INTRODUCTION

Magnetic abrasive finishing

InMAF, the work piece is kept between the two poles of a magnet. The working gap between the work piece and the magnet is filled with magnetic abrasive particles. A magnetic abrasive flexible brush isformed, acting as a multipoint cutting tool, under the effect of the magnetic field. The MAF process removes a very small amount of material by indentation and rotation of magnetic abrasive particles in the circular tracks.

Magnetic Abrasive Particles (MAP)

The iron particles in the mixture are magnetically energized using a magnetic field. The iron particles form a lightly rigid matrix in which the abrasives are trapped. This is called Flexible Magnetic Abrasive Brush, when given relative motion against a metal surface, finish that surface. Some common types of magnetic abrasives are: e.g. diamond, carbides, nitrides, borides, oxide powders.

Sintering Method

Sintering of the green compact is metallurgical process which is carried out in a furnace under a controlled atmosphere to bond the particles Sintering is carried out at temperature about 70% of the absolute melting point of the material. Bonding occurs by diffusion of atoms, giving integrity to the compact. In other words, sintering serves to consolidate the mechanically bonded powder into a coherent body having the desires service properties. Shrinkage occurs during sintering resulting in densification of the part. This densification enables significant improvement in the physical and mechanical properties of the part. Sintering can be carried out in a protective atmosphere and temperature up to 1200C variety of furnaces.

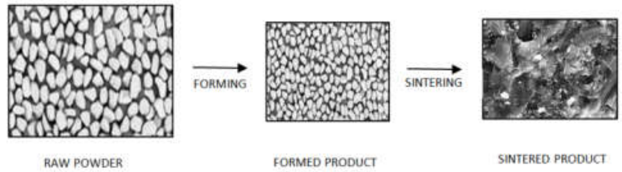

Fig:-1 Sintering Method

II. LITERATURE SURVEY MAGNETIC ABRASIVE FINISHING USING SINTERED MAGNETIC ABRASIVES

1-.Yan Wang , Dejin Hu (2004) studied the inner surface finishing of tubing by magnetic abrasive finishingwith four kinds of magnetic abrasives, which areAl_2O_3/Fe(Al_2O_3 percentage by weight is 20%), TiC/Fe (TiC percentage by weight is 20%), TiC/Fe (TiC percentage by weight is 35%) and TiC/Fe (TiC percentage by weight is 7%)prepared by sintering and observed that the MRR increases with the increasing of the rotational speed of magnetic pole. They almost keep a linear relationship under given experimental conditions .**There is an optimal magnetic abrasive particle size 30–50% for TiC/Fe (35%), which results in maximum material removal rate**. Similarly, **there is also an optimal magnetic abrasive volume that results in maximum material removal rate.** The MRR only increase initially in the magnetic finishing without liquid. However, after the surface roughness is saturated, the increase of MRR gradually slows. Finally the MRR reaches a stable value.

The internal magnetic abrasive finishing of three kinds of metals with or without liquid experiments were carried out. The results showed that the free cutting machinability of the work piece material is critical factor which effects material removal rate in dry finishing process. Whereas the chemical reaction is critical factor which effects material removal rate in the finishing area with finishing liquid. **The material removal rate(MRR) of H62 work piece is highest regardless of four kinds of magnetic abrasives,** which are Al_2O_3/Fe(Al_2O_3 percentage by weight is 20%), TiC/Fe(TiC percentage by weight is 20%), TiC/Fe(TiC percentage by weight is 35%) and TiC/Fe(TiC percentage by weight is 7%).This study showed the feasibility of using a magnetic abrasive finishing with a mixture of conventional abrasives and ferrous particles for the internal finishing of three kinds of metal tubes, such as **Ly12 aluminum alloy, 316L stainless steel and H62 brass** and gained an understanding of the mechanism involved.

2-Ching-Tien Lin.Lieh-Dai Yang. Han-Ming Chow (2006) studied the magnetic abrasive finishing in free-form surface operations using sintered **Fe+Al_2O_3 non-ferromagnetic SUS304)** the factors that significantly affected the surface finish include the working gap, feed rate, and the abrasive. **The optimal operation condition was a working gap of 2.5 mm, a feed rate of 10 mm/min, and an abrasive mass of two grams**. Even though the finishing lubricant and spindle speed were not significant factors affecting the surface finish, the finishing lubricant (liquid, HD-233A) and spindle speed (1000 rpm) were applied to the confirmation tests due to convenience and cost. (4). an average surface roughness of 0.158 μm is achieved from the finishing operations, the researcher has found that the working gap has the largest impact on the finishing quality. Accordingly, a proper working gap (in this case, 2.5 mm) can reduce surface imprints and increase quality.

3- BerhanuGirmaa,Suhas S. Joshi a, M. V. G. S. Raghurama & R.Balasubramaniam(2007)observed that the surface roughness is significantly influenced by the MAP grain size, size-ratio,(Al_2O_3 and iron powders),feed rate and current. **Thelarger grain size of MAP was found to improve the surface finish significantly in finishing of plane surfaces**. This effect is explained by the possible difference in the mechanics of material removal in MAF of plane and cylindrical surfaces. At higher levels of MAP grain size, improvement in the surface roughness is influenced by size-ratio (lower the better), feed (higher the better) and current (higher the better).

In general, improvement in the surface roughness is directly proportional to feed rate and current. An improvement of 54% in surface roughness over its initial value could be achieved. 3. The material removal is significantly affected by the MAP grain size, sizeratio and current. The higher magnetic force and more number of cutting edges are the advantages of using larger MAP grain size, which causes higher stock removal. Again, this effect is further enhanced with the smallest size-ratio, i.e., 1.5. The average stock removal under these conditions is 13.25mg in 10 minutes.. It is evident that the ideal parameter settings to achieve these could be MAP gain size: 180–210mm; size-ratio: 1.5–2.0; and current: 3.0–3.5A for the process and material in this study. The feed rate can be maintained in the range of 0.01–0.045mm=rev. The experimentation with these parameters setting results in more than 50% reduction in surface roughness from its initial value and an average stock removal of 14.0mg. (SS304 stainless steel plate).

4-Lieh-Dai Yang &Ching-Tien Lin & Han-Ming Chow (2008)Optimization in MAF operations using Taguchi parameter design for AISI304 stainless steel**&(V60% iron powder and 40% aluminum oxide)**This research used a magnetic abrasive size of 150 μm to obtain a surface roughness of R_{max} of 0.153 μm (Ra= 0.015 μm). If a magnetic abrasive size 75 μm is applied, a surface roughness of R_{max} of 0.100 μm (Ra= 0.008 μm) could be obtained. 3. In this study, four parameters (feed rate, working gap, pole rotation speed, and abrasive) had a significant effect on MRW.

5- LakhvirSingh,Sehijpal Singh Khangura (2010)
1.Amongst all the available varieties of magnetic abrasives, the sintered magnetic abrasives give highest surface finish on most of the work materials. The best surface finish (8 nm) value is obtained on silver steel. 2 Irrespective of type of magnetic abrasive used, the percentage improvement in surface finish over original finish of the surface varies in 75% to 99%. However, the parameters required to achieve maximum improvement need to be optimized and are dependent upon material and configuration of the work surface. 3 The life of a particular magnetic abrasive for giving consistent results need to be ascertained for a given work piece material. 4 Diamond based spherical magnetic abrasives prepared by plasma spray technique give maximum surface finish for internal finishing of capillary tubes. But, the life of magnetic abrasive is quite low. 5 The adhesive based (glued) magnetic abrasives have been used for finishing of ceramics (particularly Si3N4). The average improvement in surface finish is about 85%. 6 The unbounded magnetic abrasives have been used for many applications. One important observation is that the abrasives particles resting in valleys did not participate in the finishing process and take long time to achieve the desired surface finish as compared to bonded magnetic abrasives. 7 In magnetic finishing with gel abrasive (MGFA), the reuse of the magnetic abrasives is possible and efficiency in recycling is also above 90%. The improvement in surface finish is also better as compared unbounded abrasives. **Wet abrasives give better finishing results as compared to dry abrasives.**

6- Palwinder Singh, Partap Singh Samra, Lakhvir Singh(2011) Internal Finishing of Cylindrical Pipes using Magnetic Abrasives Al_2O_3(15%) and iron powders (85%) This research work showed the feasibility of using Al_2O_3 based sintered magnetic abrasive particles for the internal finishing of cylindrical brass pipes and gained an understanding of the mechanism involved. (Weight,time,temp, speed, abrasive mess size, tolerance, revolution)

7- RohitRampal (2012) Comparing the Magnetic Abrasives by Investigating the Surface Finish (iron-SiC 90:10,85:15,80:20 70:3060:40)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%) .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 work piece by using developed magnetic abrasives, under all other similar conditions. **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 up to 42 %. In case of sintered iron-SiC, this value was 49% (time, temp, weight)**

8-Z. Q. Liu & Y. Chen and Y. J. Li & X.Zhang(2013)Comprehensive performance evaluation of the magnetic abrasive particlessiliconcarbideabrasive(meshno.600) and ferromagnetic ironparticles (mesh no. 300) in the ratio of 25:75. In thisstudy, based onthecombination ofthe theory analysis, the measurement results of particle surface morphology, themagneticfluxdensity,andthe**MHcurvesofboththesintered MAPs and the simply mixed MAPs explain the different finishing quality**. The following conclusions were drawn. Both the magnetic susceptibility χ and the magnetic flux density B of the sintered MAPs are bigger than the simply mixed MAPs; therefore, both the magnetic force of the sintered MAPs and the finishing pressure of the sintered MAPs produced are greater than that of the simply mixed MAPs. After the MAF experiments, both the **ferrous and nonferrous workpiece surface textures produced by different MAPs are extremely different.** Through the motion analysis and the above measurement results of the different MAPs, **the sintered MAPs with good magnetic properties and finishing ability can improve the finishing efficiency and get high material removal rate compared with the simply mixed MAPs.** Although the finishing efficiency is low, the simply mixed MAPs with tiny cut marks are appropriate for finishing the relatively smooth surface, so that using the sintered MAPs in rough finishing process then using the simply mixed MAPs in precise finishing process for getting both high finishing efficiency and better finishing quality can be proposed.

9-Mithlesh Sharma, Devinder Pal Singh (2013) To Study the Effect of Various Parameters on Magnetic Abrasive FinishingAl2O3 (10%) of 300 mesh size (74 µm) and iron powders (90%) of 300 mesh size (51.4µm)), This research work showed the feasibility of using Al2O3 based sintered magnetic abrasive particles for the internal finishing of cylindrical brass, SS305 and SS316 pipes and gained an understanding of the mechanism involved. The experimentation with these process parameters reduced the surface roughness value on a cylindrical component from an initial Ra value of 0.257µm to 0.075µm Ra over a machining duration of 3 minutes with Aluminum Oxide, 220 grit semi magnetic abrasives.

10- Baljinder Singh and Charanjeet Singh Sandhu (2014)
A Study of Various Techniques of Preparing Magnetic Abrasives (Fe 60% + Al_2O_3 40%). It is reported that **microwave sintering** technology possesses excellent capabilities in producing parts within very short time and at very low energy consumption. Microwave sintering process can be used for producing magnetic abrasives and the magnetic abrasives produced by this process may show better performance in terms of surface finish and material removal rate.

11- Sehijpal Singh, Parmjit Singh, H.S Shan (2014)Comparative Evaluation of Mechanically Alloyed and Sintered Magnetic Abrasives for Fine Finishing (15% SiC and 85% Fe) The magnetic abrasives prepared by mechanical alloying and sintering process are able to fine finish SS304 tubes when used in Magnetic Abrasive Finishing. The best achieved range of surface roughness value in **both the cases is 0.01**The manufacturing process for preparing the magnetic abrasives and mesh size of the abrasives has dominant effect on the performance of magnetic abrasive finishing of a selected surface. **The life of magnetic abrasive prepared by mechanical alloying is better as compared to sintered magnetic abrasives**. In mechanically alloyed magnetic abrasives, the SiC particles were embedded into the Iron matrix while a layer of SiC particles was observed around Fe particles in case of sintered magnetic abrasives. To achieve best finishing results when all other parameters of MAF are kept same, the **mesh size 130 and 180 is suitable for sintered** magnetic abrasives and **mesh size of 52 is the best for mechanically alloyed** magnetic abrasives (internal surface of SS 304 tube).

III. CONCLUSIONS

1. Sintered Magnetic Abrasives have greater life and provides higher MRR thus improve Finishing efficiencies than simply mixed MAPs (except magnetic abrasive prepared by mechanical alloying.)

2. Amongst all the available varieties of magnetic abrasives, the sintered magnetic abrasives give highest surface finish on most of the work materials.

3. Wet abrasives give better finishing results as compared to dry abrasives.

4. 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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