COMPARISON OF PERFORMANCE OF THE BONDED AND LOOSELY BONDED MAGNETIC ABRASIVES

Avtar Singh Dhillon[1], Lakhvir Singh[2], Amardeep[3]

[1]*M.Tech Student*
[2]*BBSBEC, Fatehgarh*
[3]*BBSBEC, Fatehgarh*

Abstract

In modern industry presently requirement of finely finished surface has been the major demand as per the technological advancements. in comparison to conventional machining methods the unconventional machining methods provide better surface finish .Magnetic abrasive finishing is a process which is able to remove the material at micro/nano from the metallic and non metallic surfaces . The magnetic abrasives play the major role in MAF. Literature reveals different techniques such as sintering, plasma, chemical etc. for manufacturing of bonded magnetic abrasives in present paper the bonded abrasives are prepared by sintering and is used for internal finishing of brass tubes. The rough bored brass samples are finely finished by newly developed magnetic abrasives and loosely bonded abrasives prepared by silicone gel and the comparison of performance was studied. The material removal rate was also studied.

---***---

1. INTRODUCTION

Magnetic Abrasive Finishing (MAF) process is the one in which material is removed in such a way that surface finishing and deburring are performed simultaneously with the applied magnetic field in the finishing zone. Magnetic abrasive finishing as an efficient tool for internal finishing of bent tubes. The process principle and the finishing characteristics of magnetic abrasive finishing of cylindrical pipes using sintered magnetic abrasives are described in this research work. The sintered magnetic abrasive is a mixture of Al2O3 abrasive and Iron ferromagnetic particles. The sinterted magnetic abrasives have been used by many researchers [1,2,3,4]. The review of various methods has been presented by Singh et.al [4]. In sintering technique, the magnetic abrasives were prepared under high temperature and pressure conditions in inert medium. The solid mass of iron and abrasive formed by sintering was crushed into desired size. The complexity of the process makes it expensive. Shinmura et.al [7] studied the effects of magnetic abrasives prepared by chemical reaction on finishing characteristics. Feygin et.al [8] prepared magnetic abrasives by mixing iron powder, Al_2O_3 and strong adhesive glue. This method is simple as compared to other methods for preparation of the magnetic abrasives.

Anzai et.al [9], Yamaguchi et.al [10] and Handa et.al [11] used plasma spray technique to produce the spherical magnetic abrasives. The production cost reduces if unbounded magnetic abrasives are prepared in place of magnetic abrasives. Some researchers used either bonded or loosely bonded magnetic abrasives for finishing of materials and shapes [14, 15, 16,]

1. PREPARATION OF MAGNETIC ABRASIVES

1. Mixing of iron powder and Al_2O_3 powders.

The Alumina (Al2O3) based sintered magnetic abrasives were prepared by blending of Al2O3 of 300 mesh size and iron powders of 300 mesh size in different concentration by weight as 10 %, 15 % ,20% ,25% by weight.

2. Preparation of mixed powder compacts.

The cylindrical compacts were prepared using die and hydraulic press. A layer of paste (Zinc Stearate in Methanol) was applied to inner surface of bore of die and end surface of each plunger for lubrication purpose. The dimensions of compacts prepared were 20mm in diameter and 25mm in length approx. A load of 2 Ton/cm^2 was applied for 20 seconds to make compacts.

3. Sintering of compacts and crushing

For annealing, the compacts were placed in the stainless steel (AISI 310) tube. The length of tube filled with the compacts was equal to the heating zone of the furnace (8″). The annealing of these compacts was done in hydrogen gas environment at 1100 ^{0} c for 2 hours. The stainless steel tube was removed from the furnace and cooled in air. The compacts were removed from the tube. The compacts were observed and noted that the colour of the compacts changed from black to dark grey for annealing temperature & crushing the compacts into small particles and then sieving to different ranges of sizes. In case of loosely bonded silicone gel was used for bonding the Fe and Al_2O_3 powders.

4. Sieving of crushed powder-

After crushing the magnetic abrasives a Sieve shaker was used to separate out the powder grains which were having different size in microns . The sieves of size 600, 300, 150, 75 microns were used in present study.

1.1 Brass samples

Brass tube of 38 mm diameter and 1mm thickness were taken from the local market and with the help of boring tool the internal surface of the tube was prepared.

2. EXPERIMETAL SET UP FOR MAF

The set up used for finishing the inner surface of brass tubes is as per the Fig -1 .the set up was designed in keeping the factors in view i.e magnetic flux density , speed of work piece rotation , working gap ,current etc. an electromagnet was designed to produce magnetic flux density upto 1 Tesla . Magnetic flux density can be varied by the current supplied to magnetic coils. The working gap of 1mm was kept in the present experimentation between work piece and tip of the pole. The set up is capable of finishing of tubes from 25mm to 50mm by simply changing work piece holding fixture.

2.1 INDEPENDENT VARIABLES FOR EXPERIMENTATION

The variables for experimentation study have been taken by preliminary experimentation and from the literature review.

1. **Ratio of abrasives concentration by weight-** The ratio of abrasives refers to the concentration of aluminium oxide powder in iron powder as the ratio by weight as 10 %,15%,20 % and 25 % by weight out of 100 % mixture .
2. **Current supplied –** Current refers to the amount of DC current supplied in amperes to generate magnetic filed in the set up for finishing of the materials. The supply was controlled by Ammeter and the values were varied from 2Amp – 5 Amp.
3. **Machining time –** Machining time refers to the time for which the work piece is machined in the set up to generate the desired results. The machining time in present study has been fixed 45 min from the pre experimentation for 4-set of experimentation and varied for 1 set from 15 min -60 min.
4. **Average size of grit –** Grit size refers to the size of sintered abrasives powder prepared after crushing for the experimentation. It has been observed that the small size provide better results as compared to large size of grains. In present study the average size used was 150 µm was used for all set of experiments.
5. **Rotational Speed -** Rotational speed refers to the speed at which the work piece is rotated during the experimentation and it is measured by use of Tachometer and fixed at 600 rpm for 4 set of experiments ant in one set it was varied from 300 rpm – 1200 rpm.
6. **Quantity of abrasive powder -** Quantity of abrasive powder is the actual weight of powder which is used for machining of the work piece. In the present study for 10gm was taken as the quantity and for 1 set it was varied from 5 gm – 20 gm.

3. RESULTS

In every set of experiment one variable is varied and the other variables and kept constant and the study of PISF & MRR were studied.

3.1 Effect of abrasive concentration by weight on PISF & MRR

In this set up the abrasive concentration is varied as 10 %,15%,20 %,25 % for both powder mixtures and the constant variables were current 4 Amp ,rotational speed 600 rpm ,machining time 45 minutes and the quantity of abrasive used was 10 gm .

The figure 3.1(a) shows the effect of abrasive concentration on Percentage increase in surface finish , it has been observed that the sintered magnetic abrasives provide better result in improvement as compared to gel based abrasives , the value increases from 10 % -15 % concentration after that it decreases for 15 % - 25% . The best result is observed for 15 % concentration for both the abrasives.

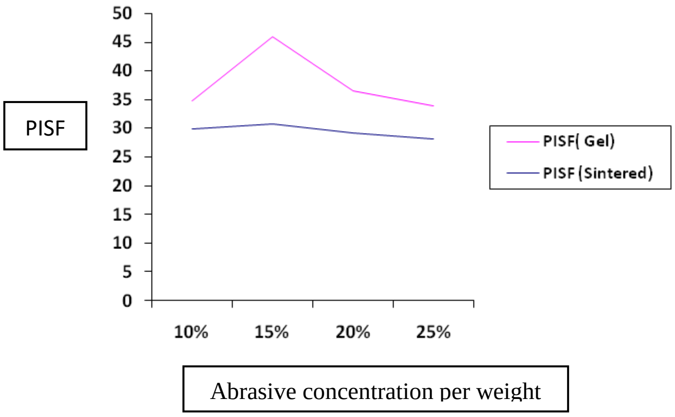

Figure 3.1 (a) PISF V/S Abrasive concentrations per weight

Figure 3.1 (b) shows the variation in Material removal rate with respect to the abrasive concentration by weight for both gel based and sintered magnetic abrasives. It has been observed the material removal rate increases from 10 % -15 % and after that there is decrease in the value of removal rate and for 20 % -25 % it remains almost constant and there is not much change in removal rate.

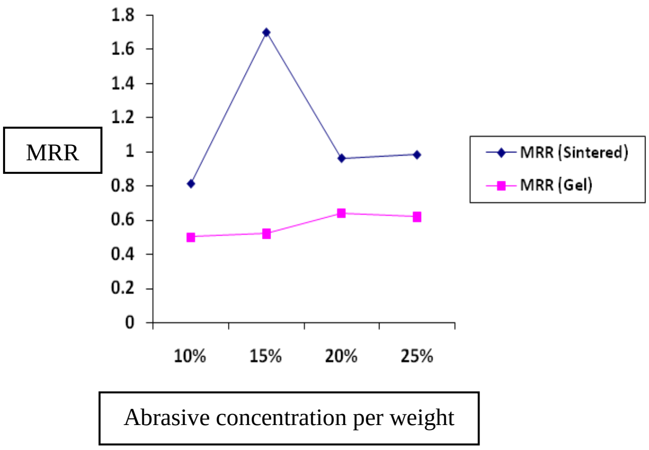

Figure 3.1 (b) MRR V/S Abrasive concentrations per weight

3.2 Effect of current supplied on PISF & MRR

In second set of experiment the current supplied was varied from 2 Amp – 5 Amp in order to study its effect. With increase in current the magnetic flux density increases. The other variables were kept constant i.e rotational speed 600 rpm ,10gm quantity of 15 % concentration powder ,machining time 45 minutes.

Figure 3.2 (a) shows the effect of current supplied on percentage improvement in surface roughness .The results show that the PISF increases as the current is increases from 2 Amp-5 Amp .the maximum value is observed for sintered abrasives i.e 25.71 as compared to gel based abrasives i.e 11.04.

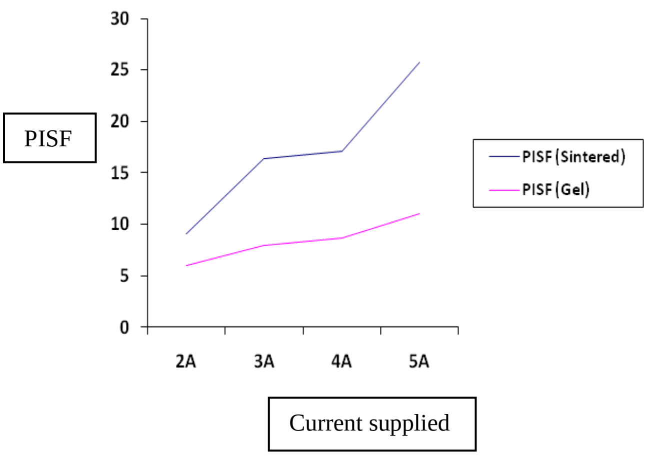

Figure -3.2 (a) PISF V/S Current supplied

Figure 3.2 (b) shows the effect of current supplied with respect to material removal rate. It has been that the material removal rate increase from 2 A – 4 A where it achieves the maximum value and there after decreases from 4 A – 5 A.

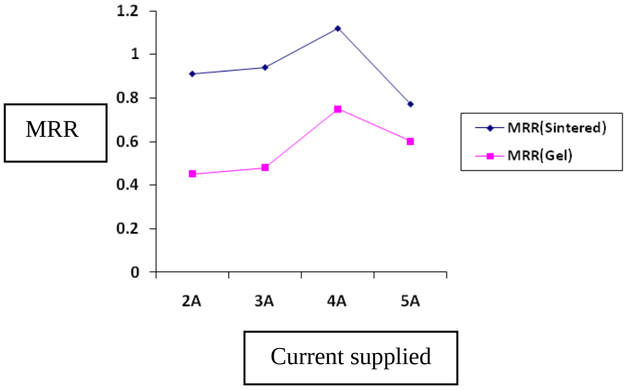

Figure 3.2 (b). MRR V/S Current supplied

3.3 Effect of machining time on PISF & MRR

In third set of experiment the machining time of work piece was varied from 15 min – 60 min in order to study its effect. The other variables were kept constant i.e rotational speed 600 rpm ,10gm quantity of 15 % concentration powder ,current 4 A.

Figure.3.3. (a) shows the effect of Machining time with respect to percentage improvement in surface finishfor sintered and gel based abrasives. It has been observed with increase in machining time the PISF increases. The results showed the maximum surface finish as 38.63 for sintered as compared to 15.32 for gel based magnetic abrasive for 60 minutes of machining time

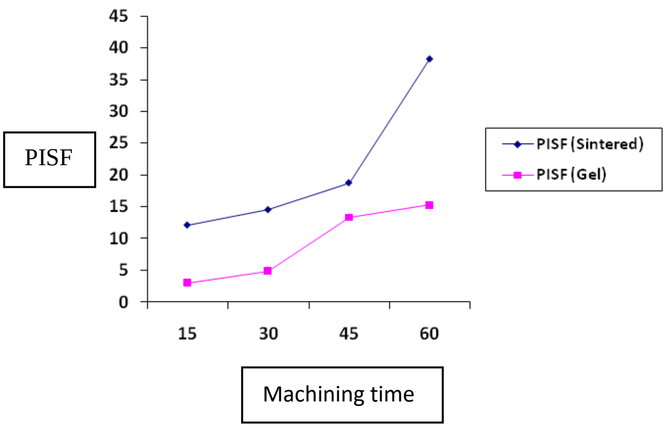

Figure 3.3 (a) PISF V/S Machining Time

In figure 3.3 (b) the effect of machining time with respect to material removal rate which increases as increase in the machining time from 15 minutes to 60 minutes. The maximum value of MRR is 0.98 for sintered abrasives as compared to 0.68 for gel abrasive for 60 minutes of machining of brass tube

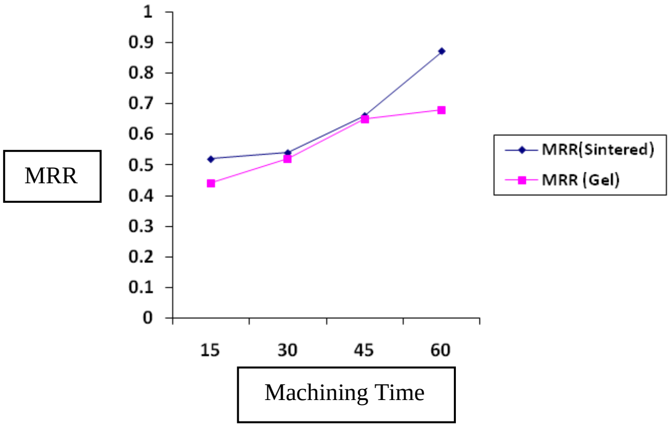

Figure 3.3 (b) MRR V/S Machining Time

3.4 Effect of Quantity of abrasive on PISF & MRR

In fourth set of experiment the quantity of abrasive was varied from 5gm -20gm in order to study its effect. The other variables were kept constant i.e rotational speed 600 rpm ,abrasive powder of 15 % concentration ,current 4 A, machining time -45 minutes.

Figure 3.4 (a) shows the effect of Quantity of abrasives on percentage improvement of surface finish from 5-20gm of abrasive powder. The surface finish increases from 5-15gm and then decreases from 15 gm -25 gm. The better results were generated for 15 gm of powder for sintered as 30.40 as compared to gel based magnetic abrasive i.e. 14.10.

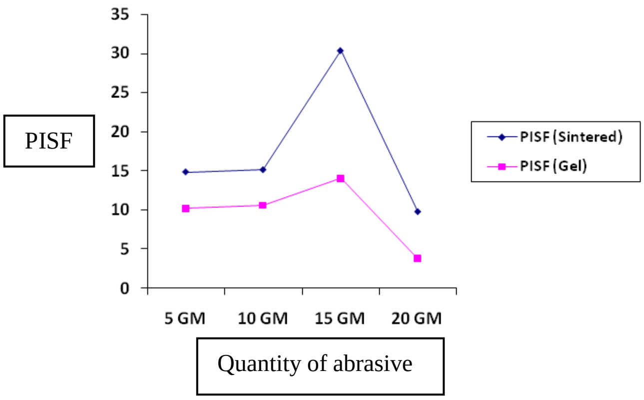

Figure 3.4 (a) PISF V/S Quantity of abrasive

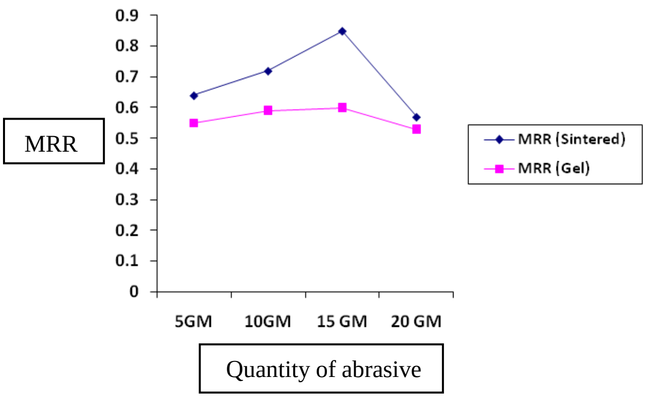

Figure 3.4 (b) MRR V/S Quantity of abrasives

3.5 Effect of Rotational speed on PISF & MRR

In fifth set of experiment the rotational speed of work piece from 300 rpm – 1200 rpm in order to study its effect. The other variables were kept constant i.e. 10gm abrasive powder of 15 % concentration, current 4 A , machining time -45 minutes.

Figure 3.5 (a) we can study the effect of percentage improvement in surface finish with respect to rotational speed of work piece which varies from 300 rpm -1200 rpm. It has been observed that there is increase in value of PISF as the rotational speed varies from 300 rpm -900 rpm and then decreases from 900 to 1200 rpm.

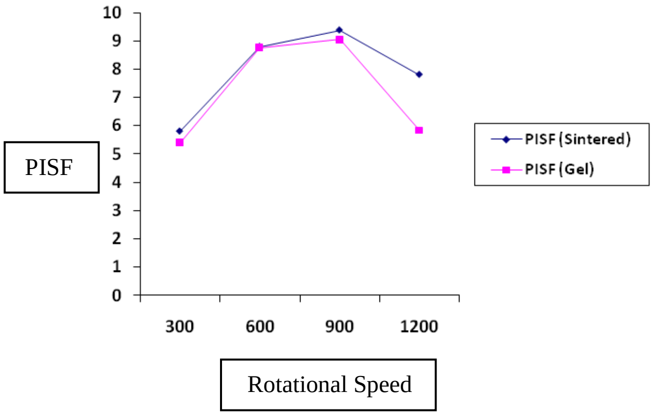

Figure 3.5 (a) PISF V/S Rotational Speed

Figure 3.5 (b) represents the effect of Rotational speed on the material removal rate for the speed varying from 300 rpm -1200 rpm. The results shows that the material removal rate increases from 300 rpm -900 rpm and the decrease in trend is were observed after 900 rpm.

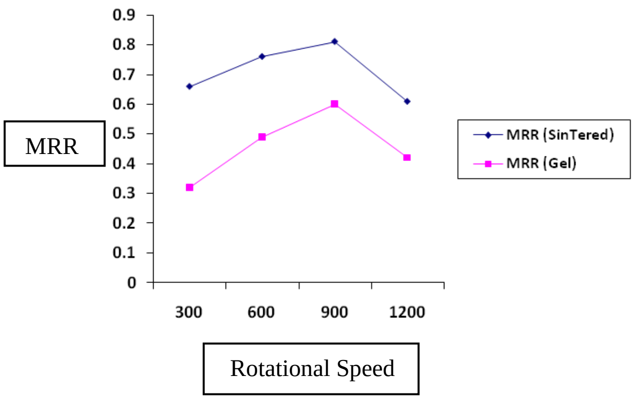

Figure 3.5 (b) MRR V/S Rotational Speed

4. CONCLUSION

This chapter deals with the conclusions which have been generated as the results of 5 set of experiments performed for internal finishing of brass tubes.

- The experimentation concluded that the ratio of abrasive concentration, current supplied in amperes, machining time, quantity of abrasive and rotational speed has a significant effect on the value PISF and MRR with change in values as per the results discussed in chapter 5.

- The experimentation concluded that the maximum PISF value was observed at 60 minutes of machining time, current supplied 4 A, 15 % of concentration by weight and quantity of abrasive 10 gm and rotational speed 600 rpm i.e 38.63 for sintered magnetic abrasives as compared to 15.32 for gel based magnetic abrasive.

- The experimentation concluded that the maximum value of material removal rate was observed at 15 % concentration by weight and the quantity of abrasive 10gm ,current supplied 4 A, rotational speed 600 rpm and 45 minutes of machining time which is 1.70 for sintered magnetic abrasives and 0.52 for gel based magnetic abrasives .

After the study we can conclude that the better results are generated for response variables PISF & MRR by sintered magnetic abrasives as compared to gel based magnetic abrasives.

5. REFRENCES

[1] Shinmura Takeo (1989) " Development of a unit system magnetic abrasive finishing apparatus using permanent magnets" Bull Japan Society of Precision Engg.,vol23,no.4,pp.313-315.

[2] Khairy Ahmed B. (2001) Aspects of surface and edge finish by Magnetoabrasive particles " Journal of Materials Processing Technology, vol. 116,pp.77-83.

[3] Wang Yan ,Hu Dejin (2005) "Study on the inner surface finishing of tubing by magnetic abrasive finishing " International Journal of Machine Tools & Manufacture,vol.45,pp.43-49.

[4] Singh Lakhvir,khangura Sehijpal Singh ,Mishra PS (2010) " Performance of abrasives used in magnetically assisted finishing : a state of the art review" International Journal of abrsive Technology, vol.3,no.3,pp. 215-227.

[5] Lin Ching-Tien ,Yangh Lieh –Dai,Chow Han-Ming(2007) "Study of magnetic abrasive finishing in free-form surface operations using Taguchi Method " International Journal of Advance Manufacturing Technology,vol.34,pp.122-130.

[6] Kim Jeong –Du (2003) "Polishing of Ultra clean Inner Surfaces using Magnetic Force."International Journal of Advanced Manufacturing Technology,vol.21,pp.91-97.

[7] Shinmura Takeo,Takazawa koya,Hatano Eiji (1987) "Study on Magnetic abrasive finishing effects of various types of magnetic abrasives on finishing characteristics " Bull Japan Society of Precision Engg.,vol21,no.2.pp.139-141

[8] Feygin S. , Kreman G.,and Igelstyn., (1998) " US patent No.5846270".

[9] Anzai Masahiro,Yoshida Takumi,Nakagawa Takeo (1996) "Magnetic abrasive automatic polishing of curved surface " RIKEN, No.12,pp15-16

[10] Handa K.,Yamaguchi H.,Zhou H (2008) " New spherical magnetic abrasives with carried diamond particles for internal finishing of capillary tubes" Diamond & related Materials,vol.17,issue7-10,pages 1434-1437.

[11] Yamaguchi Hitomi , Handa Kataro (2008)"Development of Spherical abrasive made by Plasma Spray " Journal of Manufacturing Science & Engg.,vol.130,no.3.pp. 031107-9.

[12] Jain V.K.,Kumar Prashant ,Behera P.K.,Jayswal S.C. (2001) "Effect of working gap & circumferential speed on the performance of magnetic abrasive finishing process" Wear,vol250,pp.384-390 .

[13] R.S. Mulik & P.M. Pandey (2011)"Magnetic abrasive finishing of hardened AISI52100 steel" International Journal of Advanced Manufacturing Technology,55:501-515.

[14] M.G. Patil,Kamlesh Chandra & P.S. Mishra (2012) "Study of Mechanically alloyed abrasives in Magnetic Abrasive Finishing " International Journal of Scientific and Engineering Research ,vol3,pp-1-5.

[15] Kang,P.,L.Gill,J.,(2013)"internal Finishing of SUS-304 steel bent tubes using Magnetic Abrasive finishing ",Mechanica confab,vol.2,no.3,pp.123-130.

[16] Swarn Singh and Lakhvir Singh (2014)" Effect of Magnetic Abrasive in internal finishing of brass tubes using MAF method"Journal of Academia and Industrial Research,Volume2,page689-692,