FABRICATION OF CUTTING TOOL AND SINTERED ABRASIVE FOR NANO FINISHING USING MAF

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ABSTRACT

In magnetic abrasive brush polishing the most important part is preparation of magnetic abrasive brush. The strength of brush depends on the structure of magnetic tool required to hold the sintered abrasive particles. The design have main concern about the angles and distance between magnets to hold and retain the working ability of brush formed on it with the help of iron particles in abrasives.

Keywords: Abrasive brush, Sintering, Grit number.

INTRODUCTION

Nano finishing of surface of any material is very important task to create the finished surface required in a number of engineering and bio medical field. For this purpose a number of engineers are working in this field to improve the surface finish of modern material like SUS304L. Due to versatile use of these materials, they require to finish at micro level. For the operation of surface finish at micro or Nano level the strength of brush play the important role.

While making a brush using abrasive particle, a sintering is also very important [art. We can do the mechanical or physical mixing of abrasive material with ferrous particles but due to the breakage of these physical mixed abrasive at high speed, sintered abrasives are more preferred. These brushes will fill the gap between tool and workpiece and act as a brush for material removing process at micro level [1, 2]. Stainless steel of various grades are being used in many aerospace, naval and medical fields due to its hardness, strength, corrosion free property. A high finished surface give best performance like in engine performance. [3, 4]. Shinmura et al. [5] deliberate the experiments working on various factors on surface finish taking vibration as an important part of observations. They concluded that vibration reduces the finish quality of any surface. Yamaguchi and Shinmura [6] has prepared abrasive by sintering the diamond particles with the ferrous particles. Results shows the good sintering happened as particles remain connected even after experimentation. Shinmura et al. [7] explained that why the particle size of abrasive is more important that quantity in case of finishing of stainless steel after performing a number of experiments using abrasive of various size in large variation of quantity of abrasives. Shinmura [8] worked on the speed of tool effecting the surface finish quality. Shinmura and Aizawa [9] found that circumferential speed of cutting tool is the leading factor among all other to crease the required level of surface finish. Yamaguchi et al. [10] performed all of the experiments on stainless steel of grade

304 and used a tube like structure of this material. Diameter of tube was taken as 80micrometres and high temperature and pressure is applied during the experimentation.

PRINCIPLE OF FLEXIBLE BRUSH PREPARATION

The main purpose of magnets is to attract ferrous particles and hold them like a chain or wire of a brush. Due to these attraction of ferrous particles, the abrasive sintered with these ferrous particles also get attached with the tool making a brush like structure. Which will then act as a flexible form for finishing the surface at Nano level. When the tool is allowed to rotate inside or outside the workpiece then the abrasive attached with tool will also rotated and strike against the surface of tube and surface quality is improved at Nano level.

DIMENSIONAL DECISION AND ACTUAL FABRICATION OF MAF TOOL

In order to conduct experiment gently and with minimum scope of mistakes, a specified set up was created. Used platforms of Solid Works software, AutoCad and ZW-Cad for getting the designing section done. Manufacturing of tool is completed by taking mild steel, that is, a non-ferrous but with better mechanical strength metal as work is obtained using the permanent magnets of surface finish of stainless steel. Consider Figure 1, for 3D design view of tool. Lathe machine operation like cutting, turning and facing is utilized to convert the probable size of mild steel rod to required size of Spindle Shaft (40 mm length, 52.5mm diameter), Rotor Shaft, and Rotors.

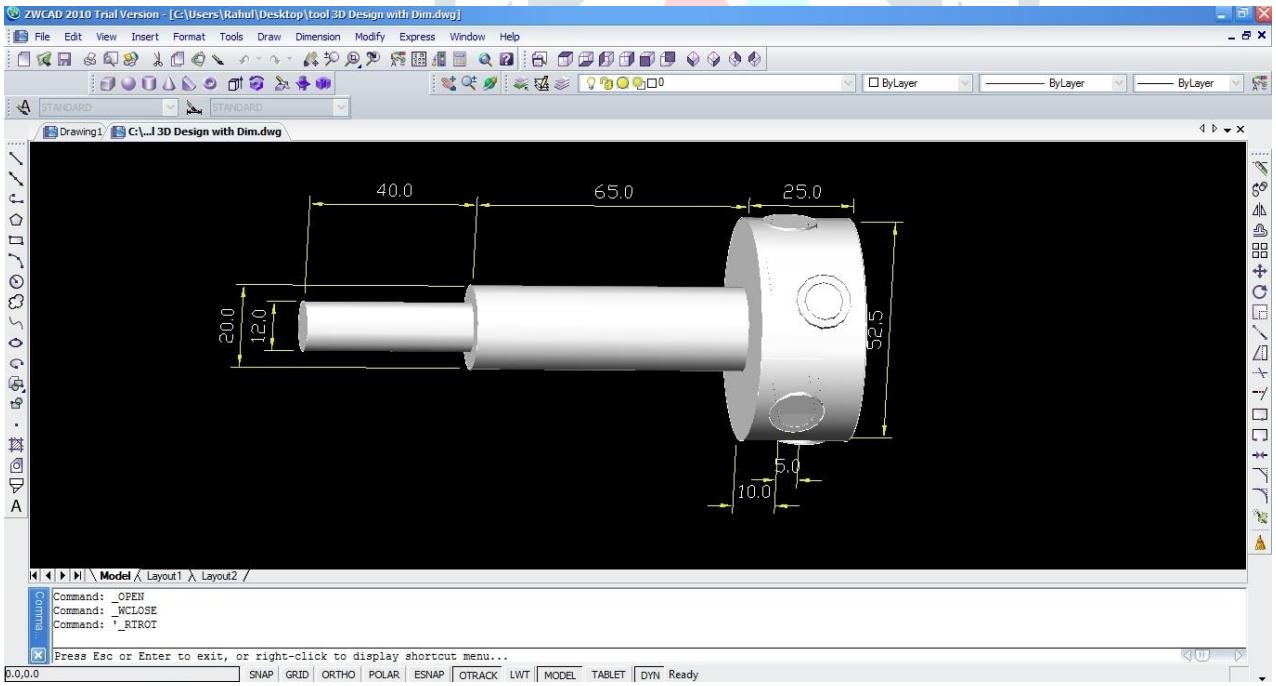

Fig 1: Tool Design with dimensions in AutoCAD.

After that Rare Earth magnets are infused and get fixate it by using epoxy resin. Now assembled tool has been prepared as per the obligatory parameters. Figure 2 gives the actual representation of manufactured MAF Tool.

Fig2: Tool prepared after actual fabrication

PREPARATION OF SUS 304L WORKPIECES

By dividing the thickness to internal diameter, the value obtained as ratio of work piece must be not more than 0.077. So, to get this required dimensions, boring and cutting operations are performed on lathe machine by taking standard available size of SUS-304L. Therefore 16 various internal diameter work pieces was made. Each of them go through experimentation process at different specifications as per Taguchi Method. 3-Dimensional design view can be seen in Fig 3.

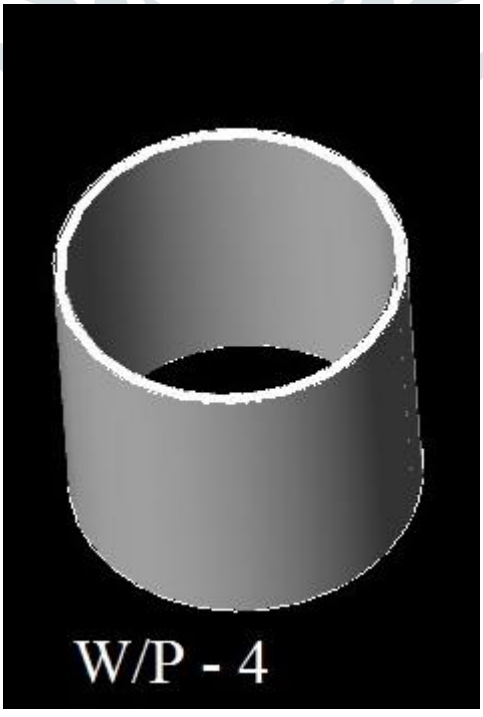

Fig. 3: Workpiece design in autoCAD.

Sample workpiece shown in Fig. 4. Excess material removed by process of internal grooving to make a thin cylinder on the actual measurements of workpieces. These are the cylindrical workpieces of 4 different size sets. All 16 workpieces are prepared in the same type of size and other dimensions.

Fig. 4: Work piece manufacturing as per desired parameters

SINTERING OF ABRASIVES WITH IRON PARTICLES

Muffle furnace is used to make the sintered abrasives as shown in figure 5. Then electrolytic iron powder, 70% by weight, which was of grit size 100 and green silicon carbide powder (30% by volume) which was 200 grit size has taken. By combining both and forming a mixture was kept in an alumina crucible prepared specially, and then was placed for 2 minutes at 1100 degree Celsius temperature in the muffle furnace. Powder of the various grit numbers was obtained by crushing the solid mortar and pestle and then by passing through sieve shaker.

Fig. 5: Sintering process in a muffle furnace.

In Figure 6 the operation is explained to divide the prepared sintered abrasive into desired size using baffles of different grit size. In this the size obtained is of four different categories.

Fig. 6: Separation of abrasive according to the grit number.

CONCLUSION

Tool fabricated and also designed for the purpose of internal Nano finishing of SUS-304L. So for this, sintered ferromagnetic abrasives and thin cylinders are taken to prepare workpieces by considering all the requirement. Workpieces are mounted on the drill machine and tool setup is done in order to check dimensional result for workpieces and tool. Magnetic separation test performed so as to examine the properties as per required of sintered abrasives.

REFERENCES

[1] G.-W. Chang, B.-H. Yan, and R.-T. Hsu, "Study on cylindrical magnetic abrasive finishing using unbonded magnetic abrasives," International Journal of Machine Tools and Manufacture, vol. 42, pp. 575-583, 2002.

[2] J.-D. Kim, "Polishing of ultra-clean inner surfaces using magnetic force," The International Journal of Advanced Manufacturing Technology, vol. 21, pp. 91-97, 2003.

[3] C.-T. Lin, L.-D. Yang, and H.-M. Chow, "Study of magnetic abrasive finishing in free-form surface operations using the Taguchi method," The International Journal of Advanced Manufacturing Technology, vol. 34, pp. 122-130, 2007.

[4] T. Kanish, S. Narayanan, P. Kuppan, and S. D. Ashok, "Investigations on wear behavior of Magnetic Field Assisted Abrasive Finished SS316L material," Materials Today: Proceedings, vol. 5, pp. 12734-12743, 2018.

[5] T. Shinmura, K. Takazawa, E. Hatano, and T. Aizawa, "Study on magnetic-abrasive process: process principle and finishing possibility," Bulletin of the Japan Society of Precision Engineering, vol. 19, pp. 54-55, 1985.

[6] H. Yamaguchi and T. Shinmura, "Internal finishing process for alumina ceramic components by a magnetic field assisted finishing process," Precision Engineering, vol. 28, pp. 135-142, 2004.

[7] T. Shinmura, K. Takazawa, and E. Hatano, "Study on magnetic abrasive finishing: effects of various types of magnetic abrasives on finishing characteristics," Bulletin of the Japan Society of Precision Engineering, vol. 21, pp. 139-141, 1987.

[8] T. Shinmura, H. W. FENG, and T. Aizawa, "Study on a new finishing process of fine ceramics by magnetic abrasive machining: on the improving effects of finishing efficiency obtained by mixing diamond magnetic abrasives with ferromagnetic particles," International journal of the Japan Society for Precision Engineering, vol. 28, pp. 99-104, 1994.

[9] T. Shinmura, "Study on internal finishing of a non-ferromagnetic tubing by magnetic abrasive machining process," J. of JSPE, vol. 54, pp. 767, 1988.

[10] H. Yamaguchi, T. Shinmura, and M. Sekine, "Uniform internal finishing of SUS304 stainless steel bent tube using a magnetic abrasive finishing process," Journal of manufacturing Science and Engineering, vol. 127, pp. 605-611, 2005.

[11] T. Mori, K. Hirota, and Y. Kawashima, "Clarification of magnetic abrasive finishing mechanism," Journal of Materials Processing Technology, vol. 143, pp. 682-686, 2003.