Development of Magnetic Abrasive Finishing Process to Finish Brass Rods

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Abstract - Surface finish plays an important role in manufacturing industry. There are many traditional processes used to reduce the surface roughness, Magnetic abrasive is one of them. In present study a setup was prepared for machining of brass rods. The setup was designed to study the effect of various parameters such as working gap, machining time and grit size. Abrasive particles (Emery) and magnetic particles (Iron) were used. Taguchi approach was used to reduce the number of experiments. L9 orthogonal array was used. "Talysurf" surface roughness tester was used for measurement of roughness. Results showed that most optimum working gap is 8mm, grit size 180 grit and 12 minutes machining time. MINITAB software was used for further analysis.

Keywords: Magnetic abrasive machining, surface finish, abrasive particles, taguchi approach.

I. INTRODUCTION

In conventional methods it is difficult to machine different type of material with high surface finish so there was need to developed process to get high surface finish. Non-conventional methods use energy in form of direct or indirect, these methods are called "non-traditional methods" [1]. Magnetic abrasive finishing (MAF) is one of them which were developed to improve the surface finish. MAF is one of non-conventional machining process which came to the surface in 1938 in a patent by Harry P.Coats [2]. It provides a high level of surface finish and close geometrical and dimensional tolerances [3]. Later this process was purposed by different countries, India was one of them. Nowadays, the study of the magnetic field assisted finishing processes is being conducted at industrial levels around the world. The MAF process consists of two pairs of magnetic poles (S and N) and the work piece. The gap between the poles and work piece is filled with the mixture of iron (ferromagnetic particles) and abrasive particles known as magnetic abrasive particles (MAPs) [4]. Ferromagnetic particles role in MAF is that it retains the abrasive particles flying out the machining area and the abrasive particles serve as the cutters [5]. Under the magnetic field, the abrasives will gather to form a flexible magnetic brush which does not require dressing [6]. The brush behaves like a multipoint cutting tool for the finishing process. The relative motion between the polishing medium and the work piece surface provides the required finishing action [7].
The MAF process offers many advantages, such as self-sharpening, self-adaptability, controllability and the finishing tools require neither compensation nor dressing [8]. Magnetic abrasive finishing used finishing of external surfaces as well as internal surfaces, ferrous metals as well as non-ferrous metals [9].

II. LITERATURE REVIEW

Jain et al., 2001, designed a setup for finishing cylindrical work pieces and it was mounted on lathe machine. They investigate the effects of working gap and circumferential speed on material removal, change in surface finish and percent improvement in surface finish. Based upon the results, in general, material removal decreases by increasing working gap or decreasing circumferential speed of the work piece [10].
Singh et al., 2005, investigated effect of current, mesh number, machining gap, and number of cycles on MAF performance and concluded that magnetic flux density depends on current to the electromagnet and machining gap. Magnetic flux density and machining gap are found as the most influencing parameters followed by grain size and number of cycles in their work [11].
Kaushal et al., 2006, studied the effect of various parameters on surface roughness. These parameters were Magnetic flux density, machining time, grit size of abrasives, circumferential speed. Magnetic Flux Density (MFD) was significant in effecting the surface finish of the component, with increase in MFD, percent improvement in surface finish was increased. Initially the Surface finish increases rapidly with a little increase in Machining time but thereafter little improvement in surface finish was observed with further increase in Machining time [12].
Yang et al., 2009, they used finite element method to analyze magnetic field characteristics for three different magnetic poles such as solid cylindrical pole, hollow cylindrical pole, and hollow cylindrical pole with grooves design. The results showed that the hollow cylindrical with grooves can generate the better surface roughness in MAF [13].

III. EXPERIMENTAL SETUP

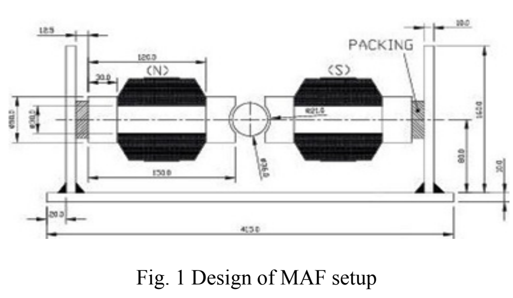

Fig. 1 Design of MAF setup

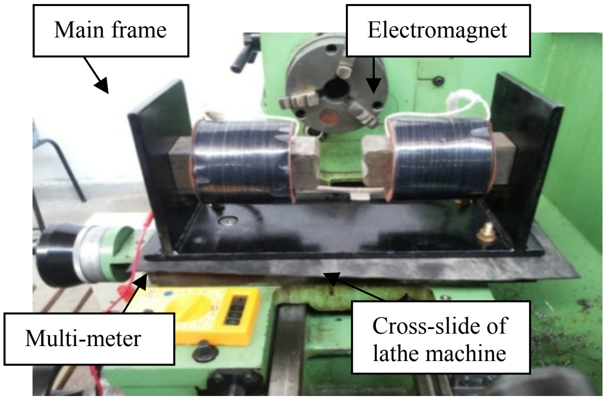

Fig. 2 Installed setup on lathe machine

The dimmer was used to vary the current. The washers were used to vary the working gap. DC current/voltage readings were taken by multi-meter. The figure 2 shows the various parts of prepared setup. The MAF setup was prepared in college and used as attachment on cross slide of lathe machine. The setup consists of main frame and electromagnets.

IV. EXPERIMENTAL CONDITIONS

TABLE 1 FIXED AND VARIABLE PARAMETERS

Current	4 amp
speed	280 rpm
Composition	55% (Fe) – 45% (Emery)
Work material	Brass IS319 rod of Φ26mm
Working gap	8mm, 10mm and 12mm
Grit size	150 grit, 180 grit and 250 girt
Machining time	4min, 8min and 12 min

V. RESULTS

Effect of working gap

As the working gap increases from 8mm to 12mm surface finish decreases. It may due to reduced strength of magnetic brush when the working gap increased.

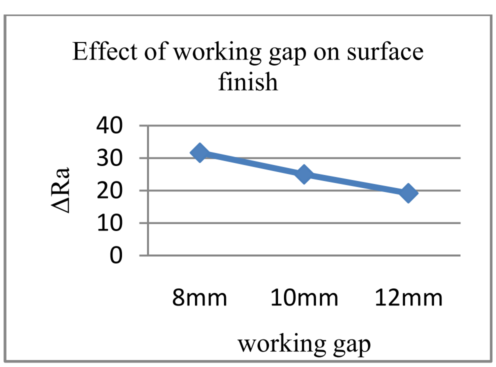

Fig. 3 Effect of working gap on surface finish

Effect of grit size

The percent improvement in surface finish improves considerably when grit size varies from 150 grit size to 180 grit size. It reaches a maximum value at 180 grit size and then it again decreased at 250 grit size.

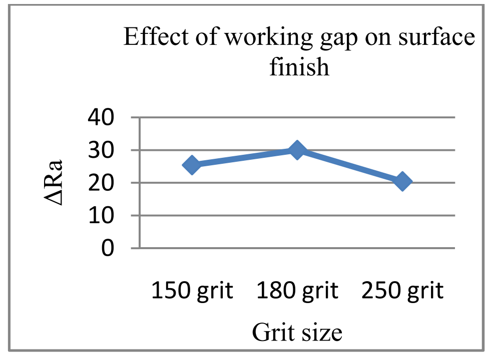

Fig. 4: Effect of grit size on surface finish

Effect of machining time

Surface finish improved considerably when machining time was increased from 4 minute to 8 minute, however appreciable improvement was not seen by further increase in machining time.

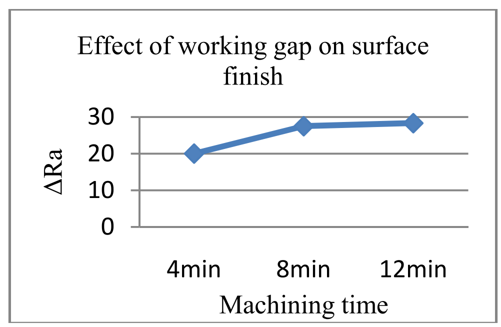

Fig. 5 Effect of machining time on surface finish

VI. TAGUCHI ANALYSIS

Taguchi design method used as an experimental design process. Taguchi L9 orthogonal array was used to investigate the effects of different parameters. Results were critically analyzed using MINITAB 17 software. S/N ratio and mean were also calculated by using larger is better in MINITAB 17 software. As shown in fig. the optimum working gap was 8mm, 180 grit size and 12 minutes time.

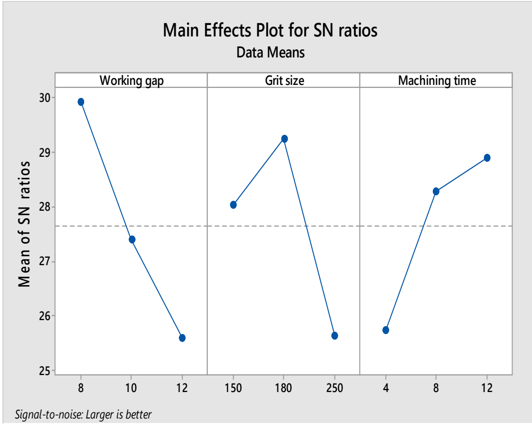

Fig. 6 Main effects plot for SN ratios

VII. CONCLUSION

All variable parameters (working gap, grit size and machining time) have significant effect on brass IS319 rod, however the most optimal parameter as per MINITAB software analysis under the given set of conditions was working gap.

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