Fine Finishing of Al 6061 with Mechanical Vibration Assisted Magnetic Abrasive Finishing Process

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ABSTRACT
Magnetic Abrasive Finishing (MAF) is one of the advance fine finishing processes. Many researchers have worked on MAF of various materials. But little work has been reported on the study of combined effect of parameters like rotational speed, machining time, abrasive mesh number with varying values of vibration.In the present research work, MAF process has been combined with mechanical vibrations to study the effect of vibrations on the surface finishing capabilities of the process. It is also known as Vibration Assisted Magnetic Abrasive Finishing (VAMAF). The varying value of acceleration combined with other effective parameters (rotational speed, time and abrasive size) was used to investigate the effect. Design of Experiment approach “Response Surface Methodology” was used to conduct and analyze the experiments for finishing aluminum flat plate with silicon abrasives. Empirical relation between input and output parameter also suggested. Percentage improvement in surface roughness (PISF) 56.85% for aluminum flat plate at rotational speed 500 rpm, acceleration 11.84 m/s^2, time 40 minutes, mesh number 200 and percentage conventional machining processes.

Keywords
PISF, Acceleration, rotational speed, time, Mesh number, Aluminum flat plate.

Nomenclature

MAF	Magnetic Abrasive Finishing
VAMAF	Vibration Assisted Magnetic Abrasive Finishing
PISF	Percentage Improvement In Surface Roughnes
RSM	Response Surface Methodology
Ra	Average of Roughness Profile

1. INTRODUCTION
MAF is a process which used to remove material in the form of power by magnetic abrasive particles. MAF is used to finish flat, curved, or uneven surface as well as nonconductive and nonmagnetic materials. While MAF is useful in application, it suffers drawback of deep scratches. In present study, vibrations are adding to MAF process to improve surface finish. Vibrations are produced in the work material with help of a DC motor. Vibrations can be induced either by changing the motor speed with constant unbalance mass or by varying value of unbalanced mass attached to the shaft of motor. In the present research work, the second method has been used to generate the vibrations. Vibrations help to increase finishing efficiency and reduce the time of finishing by changing the orientation of the abrasive grains so that fresh sharp edges strike and act against the work piece surface and finish the material.

2. BACKROUND AND REVIEW
Magnetic abrasive finishing process give batter result as compare to other methods. Singh et al. (2004) optimized the parameters of a MAF process. They concluded that magnetic flux density was most effective parameter followed by working gap. Effect of grain size and rotational speed was less. Naifet et al (2012) presented the MAF was use to remove micro deburring. They concluded that continues supply of coolant and abrasive particles improve the surface roughness. Remaining particles were removed by ultra-sonic cleaning process.

3. OBJECTIVE OF RESEARCH
The following objectives have been finalised to carry out the research work:

3.1 Effect of vibration as well as other selected parameters on surface finishing by vibration assisted magnetic abrasive finishing.
3.2 To develop the empirical relation between input and output parameters.

4. METHODOLOGY

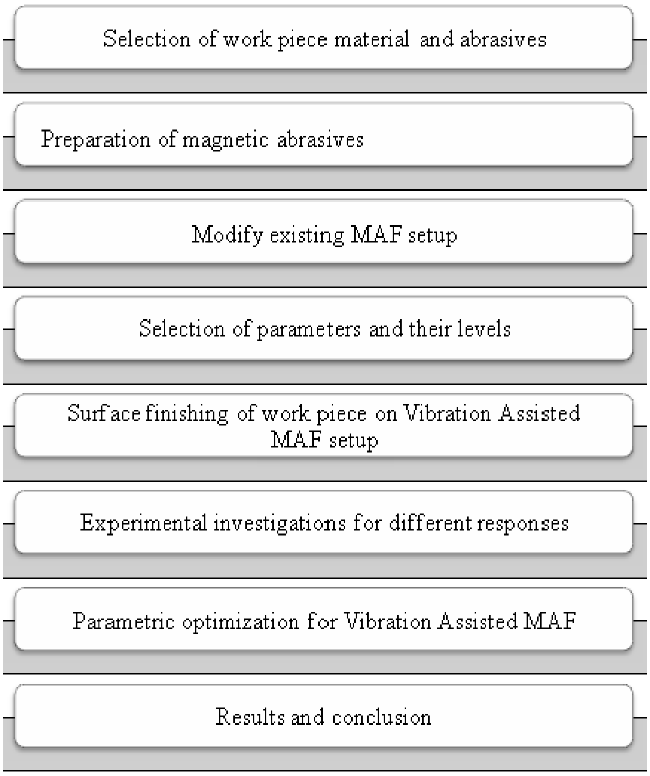

Fig.1 Show the steps involve for methodology of work

4.1 Experimentation

During experimentation the work piece is mounted on the table of vibration assisted magnetic abrasive finishing setup. The work piece is parallel to the permanent magnet, gap between work piece and magnet are fixed. Working gap between magnet and work piece is maintain by adjusting the position of magnet and work piece platform base. The base of work piece attached with 12V DC motor with offset mass attached to shaft to create vibrations. Power is supplied to both DC motor which rotates permanent magnets and second one which produced vibrations. Permanent magnets energized magnetic abrasive particles and flexible magnetic abrasive brush formed which used to finish the work piece. Permanent magnet has been used to develop circumferential magnetic lines of forces, and used to develop experimental setup for MAF and VAMAF. A special work piece fixture is needed so that work piece can be excited using mechanical vibrations. The forces during VAMAF were measured by Vibscanner Equipment (VIB 5.480) which used to find the acceleration and velocity of vibration. This section deals with the details electromagnet and work piece fixture, selection of process parameters rotational speed in rpm (500,650,800), acceleration in m/s^2 (11.84, 16.84, 21.85), machining time in min. (30, 40, 50) and mesh size (140,200,270). Design of Experiment approach "Response Surface Methodology" was used to conduct and analyze the experiments for finishing aluminum flat plate with silicon abrasives

Table 1 Experimental details

Work piece	Aluminum (Al6061), dimensions (29×24×1mm)
Magnetic abrasive	Silicon Carbide (Sic), ratio 15-85
Work piece gap	Constant
Permanent magnet power	5,000 gauss each

4.2 Result and Discussion

4.2.1 Combined effect of Rotational speed and Acceleration on PISF:-

It concluded that low value of rotational speed, percentage improvement in surface roughness increase then decrease with increase in acceleration. At high value of rotational speed, percentage improvement in surface roughness increase with increase the value of acceleration. At low value of acceleration, percentage improvement in surface roughness decrease with increase in rotational speed. At high value of acceleration, percentage improvement in surface roughness increase with increase in rotational speed.

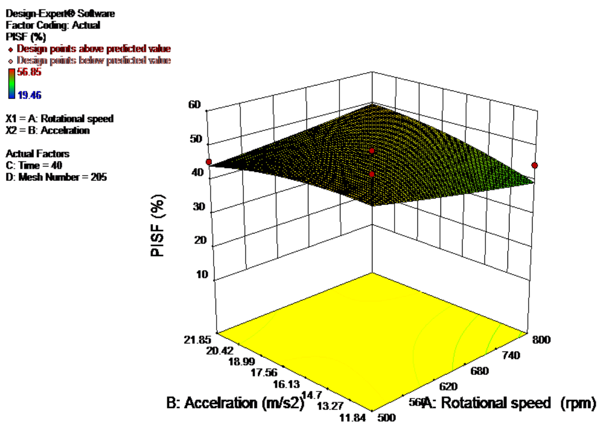

Fig.2 Effect of Rotational speed and Acceleration on PISF

4.2.2 Combined effect of Rotational speed and Time on PISF:-

It concluded that low value of rotational speed, percentage improvement in surface roughness increase then decrease with increase in time. At high value of rotational speed, percentage improvement in surface roughness decrease with increase the value of time. At low value of time, percentage improvement in surface roughness increase with increase in rotational speed. At high value of time, percentage improvement in surface roughness decrease with increase in rotational speed.

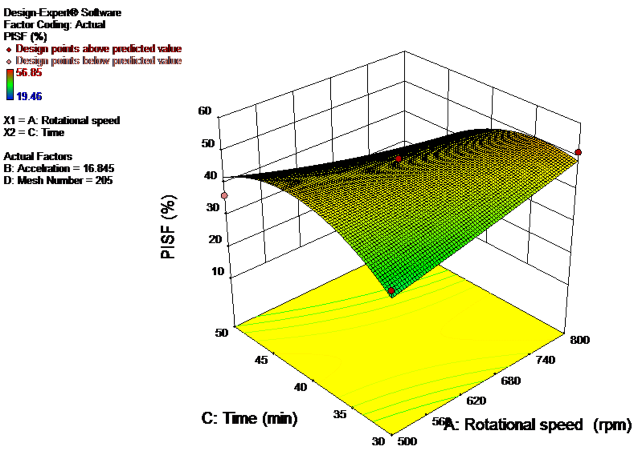

Fig.3 Effect of Rotational speed and Time on PISF

4.2.3 Combined effect of Rotational speed and Mesh Number on PISF:-

It concluded that low value of rotational speed, percentage improvement in surface roughness increase then decrease with increase in mesh number. At high value of rotational speed, percentage improvement in surface roughness increase then decrease with increase the value of mesh number. At low value of mesh number, percentage improvement in surface roughness decrease with increase in rotational speed. At high value of mesh number, percentage improvement in surface roughness increase with increase in rotational speed.

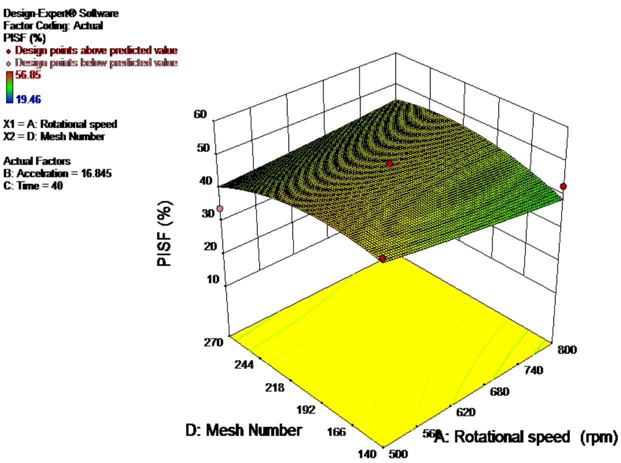

Fig.4 Effect of Rotational speed and Mesh Number on PISF

4.2.4 Combined effect of Acceleration and time on PISF:-

It concluded that low value of acceleration, percentage improvement in surface roughness increase then decrease with increase in time. At high value of acceleration, percentage improvement in surface roughness increase then decrease with increase the value of time. At low value of time, percentage improvement in surface roughness decrease with increase in acceleration. At high value of time, percentage improvement in surface roughness increase with increase in acceleration.

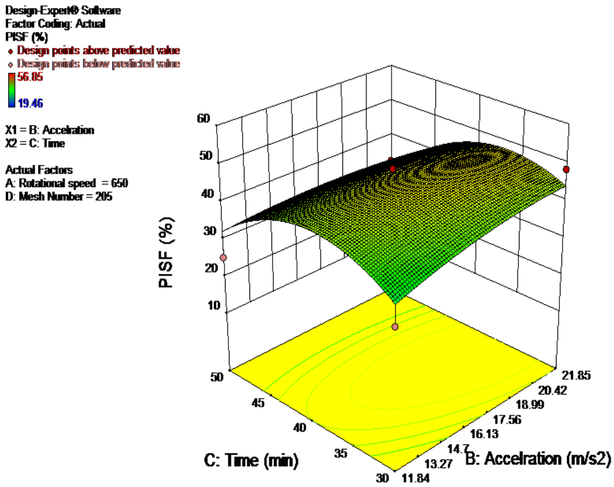

Fig.5 Effect of Acceleration and time on PISF

4.2.5 Combined Effect Mesh number and Acceleration on PISF:-

It concluded that low value of acceleration, percentage improvement in surface roughness increase then small decrease with increase in mesh number. At high value of acceleration, percentage improvement in surface roughness small increase then decrease with increase the value of mesh number. At low value of mesh number, percentage improvement in surface roughness increase with increase in acceleration. At high value of mesh number, percentage improvement in surface roughness decrease with increase in acceleration.

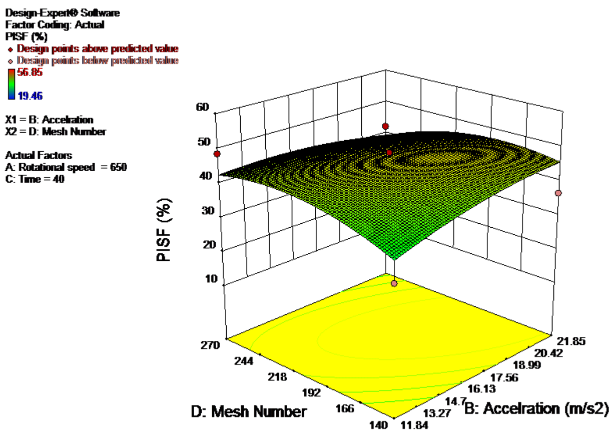

Fig.6 Effect Mesh number and Acceleration on PISF

4.2.6 Combined Effect of Mesh Number and Time on PISF:-

It is concluded that the low value of time, percentage improvement in surface roughness decrease with increase in mesh number. At high value of time, percentage improvement in surface roughness increase with increase the value of mesh number. At low value of mesh number, percentage improvement in surface roughness increase then decrease with increase in time. At high value of mesh number, percentage improvement in surface roughness increase then decrease with increase in time.

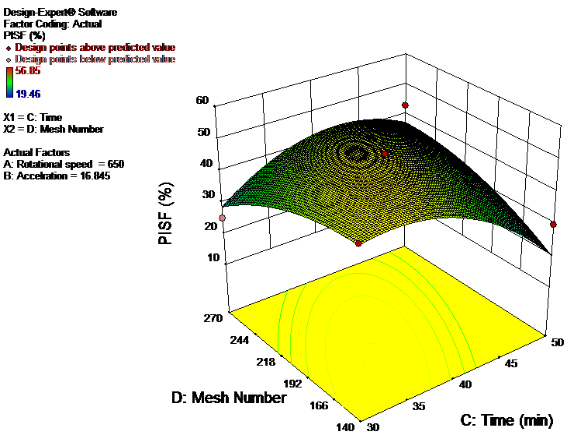

Fig.7 Effect of Mesh Number and Time on PISF

5. CONCLUSION

From the present research work, the following conclusions are dressed which can affect the output parameter (percentage improvement in surface roughness).

a) It is concluded that with vibrations percentage improvement in surface roughness improved by 10 % as compared to magnetic abrasive finishing.

b) Empirical relation PISF=+47.24-0.97* A+1.43* B-4.39* C-0.042* D+3.77* AB-7.77* AC+3.19* AD-2.64* BC-3.15* BD+8.63* CD+0.28* A^2-1.93* B^2-9.74* C^2-4.30* D^2.

c) Optimized parameters are rotational speed (500 rpm), acceleration (11.84 m/s^2), time (40 min), mesh number (200) and improvement in percentage surface roughness 56.85%.

[A-Rotational speed, B-Acceleration, C- Machining time, D-Mesh size]

5.1 Scope for future work

Future research may be extended in the field of vibration assisted magnetic abrasive finishing with different work piece and abrasive material

Heating effect due to vibration can be studied

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