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A Review on Magnetic Assisted Abrasive Flow Machining (MAAFM)

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***Abstract*: For machining difficult surfaces and edges Abrasive flow machining (AFM) process was developed. Recasting layer is produced by wire electrical discharge machining (WEDM), it is effectively removed by Abrasive flow machining (AFM). However, surface roughness produced can be easily uniform when a complex hole is polished by this method. Numerical method like Computational Fluid Dynamics (CFD) can be used to design good passageway. This aid gives the smooth roughness on the complex hole in AFM. Shear forces and the flow properties of the medium in the AFM play the roles in controlling the roughness on the entire surface. Velocities, strain rates and shear forces of the medium acting on the surface can controlled by CFD software. For complex whole mould core could be deigned and put into mould. If no mould core is inserted shear forces and strain rates change sharply on the surface to be machine. So to produce uniform roughness on the surface mould core must be inserted into hole. Theoretical model of forces acting on a single grain can be develop to study the finishing mechanism of AFM. An experimental research can carried out by measuring the axial force, radial force, and active grain density during the AFM process. Results of theoretical model for grain–work piece interaction can be compared with experimental data obtained during AFM process. Scratching experiments can be carried out to study the mechanism of material removal during the AFM process. Rubbing and ploughing modes of material deformation could be obtained by the analysis of scratching experiment and AFM process. Material removal rate is very slow in AFM process. So the researchers have to develop the hybrid abrasive flow machining process integrated with other non-traditional machining processes. Hybrid abrasive flow machining process increases material removal rate. Several hybrid abrasive flow machining processes are abbreviated as UFP, MAAFM, HLX-AFM, DBG-AFF, MRAFF and ECA2FM.**

***Keywords*: Abrasive flow machining; Axial force; Radial force; Active grain density; Rubbing; Ploughing**

1. Introduction

Extrude Hone Corporation (USA) developed Abrasive flow machining in 1960. Various types of Magnetic assisted abrasive flow machining (MAAFM) process reported in this literature are study simulation of magnetic field assisted finishing (MFAF) process utilizing smart MR polishing tool [1], experimental investigations into internal magnetic abrasive finishing of pipes [2], development of magnetic abrasive finishing combined with electrolytic process for finishing SUS304 stainless steel plane [3] Nano finishing is achieved in Magnetic field assisted finishing (MFAF) process. MFAF process uses external magnetic field for better control of the finishing forces. This process can easily produce mirror like finished surface. Different types of MFAF processes are available e.g. Magnetic abrasive finishing (MAF) [4], Magneto rheological finishing (MRF) [5], Magneto rheological jet finishing (MRJF) [6], Magneto rheological abrasive flow finishing (MRAFF) [7], Rotational magneto rheological abrasive flow finishing (R-MRAFF) [8], and Ball end magneto rheological finishing (Ball end MRF) [9] etc.

A. Principle of AFM

Semi-solid medium is used in AFM process. Media comprises of a carrier in the form of a polymer base containing abrasive powders in the desired proportion. Semi-solid media is extruded under given pressure across the surface, which is to be machined. Whenever media is subjected to some restrictions due to the uneven surface; it acts as a flexible tool. Generally, a fixture is required to offer restriction and focus the media to desired locations the work piece.

B. Classification of AFM

1) One-way AFM

One way AFM [10] [11] process apparatus is provided with a hydraulically assisted reciprocating piston. An extrusion media cavity receives and extrude medium uni-directionally across the internal surfaces of a work piece. Work piece having internal passageways. The medium flows from the extrusion medium chamber into the internal passages of the work piece directed by the fixture. When it is extruded out from the internal channels a medium collector collects the medium. An access port is provided intermittently receive medium from the collector into extrusion medium chamber. A hydraulically actuated piston occasionally withdraws from its extruding position to open the extrusion medium chamber access port to collect the medium in the extrusion medium chamber. When the extrusion medium chamber is completely filled with the working medium, the operation is resumed.

2) Two-way AFM

Two way AFM [12] machine has two hydraulic cylinders and two media cylinders. The media is extruded, hydraulically or mechanically, from the filled chamber to the empty chamber via the controlled passage through or past the work piece surface to be abraded (Fig. 1). For the desired fixed number of cycles the medium is extruded to and fro between the chambers. Recessed areas, counter bores, and even blind cavities can be finished by using restrictors or mandrels to direct the medium flow along the surfaces to be finished.

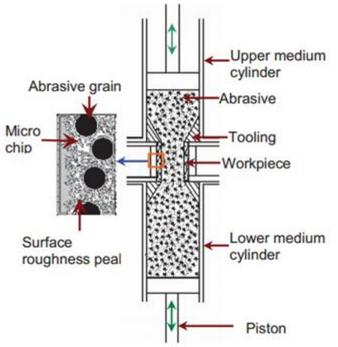

Fig. 1. Principle of material removal mechanism in two way AFM

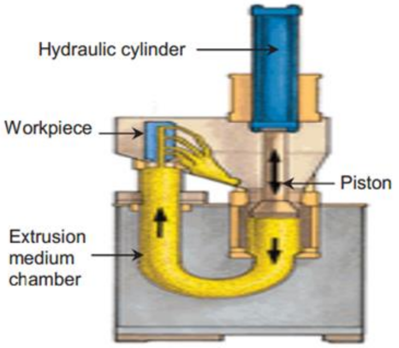

Fig. 2. Unidirectional AFM Process

3) Orbital AFM Process

In orbital AFM, the work piece is precisely oscillated in two or three dimensions within a slow floating ‘pad’ of compliant elastic/plastic AFM medium. In orbital AFM, surface and edge finishing are achieved by rapid, low-amplitude, oscillations of the work piece relative to a self-forming elastic plastic abrasive polishing tool. The tool is a layer of abrasive-laden elastic plastic medium (similar to that used in two-way abrasive flow finishing) or pad, but typically higher in viscosity and more in elastic. Translational motion is given to the work piece in Orbital AFM concept. When work piece with complex geometry translates, it displaces by compressive and tangentially slides across the compressed elastic plastic self-formed pad. A pad is a layer of viscoelastic abrasive medium which is positioned on the surface of a displacer. Displacer is roughly a mirror image of the work piece. Displacer accommodates plus or minus a gap of layer of medium and a clearance. A small orbital (0.5 to 5mm) circular eccentric planar oscillation is applied to the work piece so that, at any point in its oscillations, a portion of its surface bumps into the medium pad, elastically compressed (5 to 20%) and slides across the medium as the work piece moves along its orbital oscillation path. Different portions of the work piece slide across the medium, when the circular eccentric oscillation continues. Finally, the full circular oscillation is provided to each portion of the surface. Uniformity is assured by the highly elastic abrasive medium must be somewhat plastic in order to be self-forming and to be continually presenting fresh medium to the polishing gap. For finishing applications, AFM medium allows the use of simple arrangement for feeding and evacuating the abrasive medium pad to achieve uniform results. Due to deformation heating, regions of the medium in the gap that are worked excessively become warmer, and finally become less elastic and more plastic and are squeezed out of the work gap. Orbital AFM’s small (0.5 to 5 mm) oscillation amplitude allows finishing highly complex geometries, since all areas except internal features that are even smaller than the oscillation amplitude are equally worked in the process. The controlled and cushioned, but still repeated, pumping of the work piece against the self-shaped tool imparts beneficial residual compressive stresses to the work piece surfaces. Cushioned abrasive particles provides remarkable improvements in surface roughness due to tangential translation of the work piece across the elastic compression. Different work pieces are machined by Orbital AFM by many different industries from precision ground aerospace components to cast aluminum wheels. Coining dies used to make proof coins can be polished from a 0.5 µm before surface to an amazing 0.01 µm after finish after only seven minutes of Orbital AFM processing. Orbital AFM is used to produce extremely fine finishes on the complex geometry of prosthetic devices while maintaining critical dimensional tolerances. Orbital AFM process is used in finishing of beverage container blow moulds and reduce polishing costs while, at the same time, increasing production rates, improving consistency, and reducing the need for skilled labor.

2. Literature review

Major areas of experimental research in magnetic assisted abrasive flow machining (MAAFM)

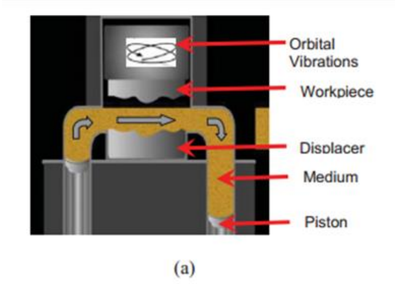

Fig. 3. Orbital AFM (a) before start of finishing,

Singh and Shan [13] developed Magneto Abrasive Flow Machining (MAFM) process to improve the material removal rate and reduces surface roughness by applying a magnetic field around the work piece. ANOVA technique is used to identify the most significant parameters like- volume flow rate, magnetic flux density, number of cycles, medium flow volume, abrasive concentration abrasive grit size, and reduction ratios. Improved surface finish and MRR is observed in AFM over MAFM. The schematic diagram of MAFM is shown in Fig. 4.

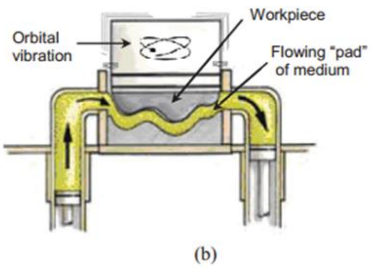

Fig. 3. Orbital AFM (b) while finishing [14]

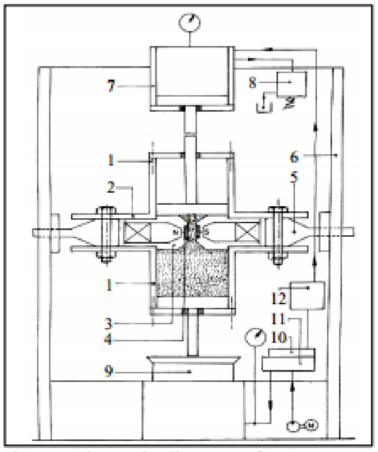

Fig. 4. Schematic diagram of MAFM Main parts
:
(1) cylinder containing medium; (2) flange; (3) nylon fixture;(4) work piece; (5) eye bolt; (6) hydraulic press; (7) auxiliary cylinder; (8) modular relief valve; (9) piston of hydraulic press; (10) directional control valve; (11) & (12) manifold blocks; (13) electromagnet

Table 1
Experimental conditions of MAF process [15]

Conditions of MAF process	
Work piece	SUS304 plane (100 × 100 × 1 mm)
Original roughness	0.39 μm Ra
Compound magnetic abrasives	Electrolytic iron powder (149, 75, and 30 μm in mean diameter) WA particles: #800, #4000, #8000, #10000 Oily grinding fluid
Working gap	1 mm
Stage feeding speed	5 mm/s
Tool rotational speed	450 rpm
MAF test time	90 min

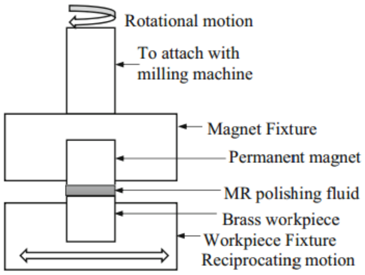

Fig. 5. Magnetic field assisted finishing process (MFAF)

With the application of magnetic field, the carbonyl particles make chains and enhance the viscosity of the media, which results in the increase in dynamic force on the abrasive and thus more cutting. It was also found that the magnetic field is more effective at lower extrusion pressure. The application of providing magnetic field to AFM results in the increase in material removal rate (MRR) and better surface finish in terms of quality (Fig. 5).

Patil V, Ashtekar J [16] enforced magnetic force in the development of flexible magnetic brush, which provided comparatively more cutting forces on the metal, surface, thus more polish on the surface (Fig. 6) (Fig. 7).

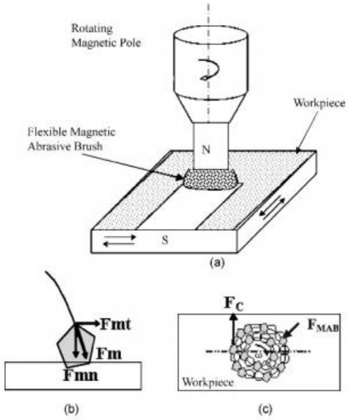

Fig. 6. (a) Plane magnetic abrasive finishing of magnetic work material (b) Schematic diagram showing the normal (Fmn) and tangential components (Fmt) of magnetic force (Fm) acting on a magnetic abrasive particle. (c) Flexible magnetic abrasive brush and the cutting force (Fc) acting on an abrasive particle.

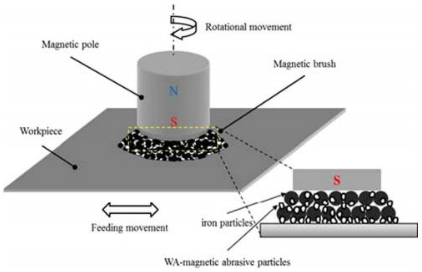

Fig. 7. Schematic of MAF process

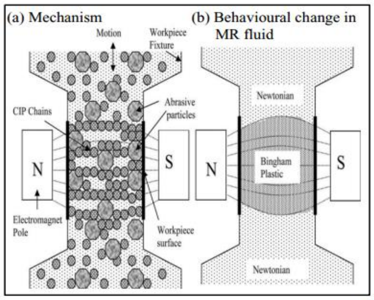

Fig. 8. Schematic diagram of Magneto rheological Abrasive Flow Finishing
(a) Mechanism of magneto rheological abrasive flow finishing process (b) Change in rheological behavior of MR-polishing fluid

*Jha and Jai*n [17] explored Magneto rheological Abrasive Flow Finishing (MRAFF) process for finishing complex internal geometries as shown in Fig. 8. In this process magneto rheological polishing fluid consists of carbonyl iron powder and silicon carbide abrasives are mixed with visco elastic base grease and mineral oil used to finish stainless steel work pieces. No improvement was observed in surface finish at zero magnetic field; and at high magnetic field strength 30 % improvement in surface finish was observed.

Das et al. [18] proposed Rotational Magneto rheological Abrasive Flow Finishing (RMRAFF) process to enhance the finishing performance of MRAFF process. In this process, a rotation and reciprocating motion is provided to the abrasive medium by a rotating magnetic field and hydraulic unit as shown in Fig. 9. Smooth and mirror-like surfaces are observed in both stainless steel and brass work pieces.

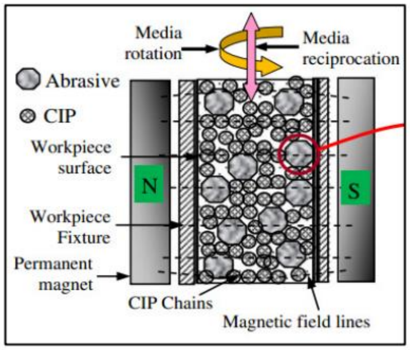

Fig. 9. Schematic diagram of R-MRAFF

Anwesa Barman, Manas Das [19], simulate the MFAF process carried out in a static condition. The magnetic field distribution during finishing was simulated in the finishing zone. The variation of magnetic flux density around the finishing zone was plotted. The normal indentation force on the work piece surface by abrasive particles through surrounding CIPs was calculated considering magnetic flux density and its gradient in the Z direction. The deformation of work piece due to one abrasive particle was simulated and the results were plotted. The flow of MR fluid between permanent magnet and brass work piece was analyzed. Two different flow behavior of MR fluid i.e. Newtonian (without magnetic field) and non-Newtonian (with magnetic field) were investigated. The velocity profiles of MR fluid distinctly show that the solid core and sheared zone which resembles the non-Newtonian flow behavior of MR fluid with the application of magnetic field. The surface roughness profiles plotted and its magnitudes for MFAF process were calculated. Also, the final surface roughness profiles for both experimental and simulated results show good agreement between them. Hence, finite element method can be successfully used to model MFAF process.

Girish Chandra Verma, Prateek Kala & Pulak Mohan Pandey [20] used two similar magnetic poles (north–north) and diamagnetic property of copper has successfully created a high magnetic flux density at the periphery of the ferromagnetic disc. A variable magnetic flux density tool is successfully fabricated to finish internal surface of holes of specified dimension, which has given effective results on stainless steel (SS304) pipes. The developed model showed that magnetic flux density is the most effective parameter in the given range of variables. Working at “magnetic flux density = 0.8 T, RPM = 500, abrasive weight percentage = 20, and abrasive mesh number = 1200” results in 89.6 % change in surface roughness and 56 nm of surface finish.

Xu Sun & Yanhua Zou, [03] developed magnetic abrasive finishing combined with electrolytic process. In electrolytic magnetic abrasive finishing (EMAF) tool of compound magnetic poles and electrodes are able to achieve two different processes. The SUS304 stainless steel plane was used as work piece. In order to select electrolytic finishing time for EMAF process, the investigation of electrolytic process has been carried out efore EMAF process. The experimental results show that EMAF process can a little obtain higher quality surface, and machining efficiency is improved by about 50%, which compared with that of traditional plane MAF process. Also surface roughness can be reduced to 30.94 nm Ra from original roughness of 393.08 nm Ra in 40 min by the EMAF process.

A. *Basic processing principle of EMAF*

Since the electrolytic process is an important part of EMAF process, principle of electrolytic process will preferentially be introduced in the following. Figure 10 shows the machining principle of electrolytic process. The $NaNO_3$ solution is neutral which produces less pollution for environment. Thus, the $NaNO_3$ solution is adopted as the electrolyte in this study from the view of environmental protection. When turning on DC constant voltage power, aqueous solution of $NaNO_3$ will take place electrolytic reactions which are shown as Eqs. (1) and (2).

$$NaNO_3 \rightarrow Na^+ + NO^{3-} \quad (1)$$

$$H_2O \rightarrow H^+OH^- \quad (2)$$

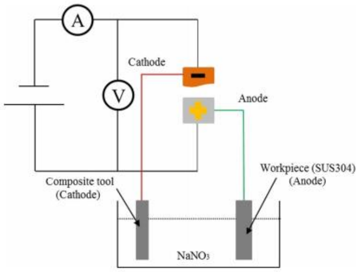

Fig. 10. Schematic of electrolysis process

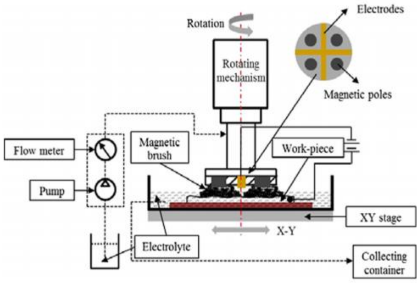

Fig. 11. Schematic of stainless planar process

Table 2
Literature review

S.No.	Author	Process	Benefits/Conclusion	Outputs
1	Sehijpal Singh, H.S. Shan	Development of magneto abrasive flow machining process	**1.** Magnetic field significantly affects both MR and *R*a. The slope of the curve indicates that MR increases with magnetic field more than does *R*a. Therefore, more improvement in MR is expected at still higher values of magnetic field. **2.** For a given number of cycles, there is a discernible improvement in MR and surface roughness. We require less cycles for removing the same amount of material from the component, if processed in the magnetic field. **3.** Medium flow rate and magnetic field interact with each other. The combination of low flow rates and high magnetic flux density yields more MR and smaller *R*a. **4.** Medium flow rate does not have a significant effect on MR and *R*a in the presence of a magnetic field. **5.** MR and *R*a both level off after a certain number of cycles.	AFM possesses excellent capabilities for finish-machining of inaccessible regions of a component. Abrasive flow machining (AFM) is one of the latest process which is non-conventional.
2	Vishwanath Patil, Prof. Jaydeep Ashtekar	Magnetic abrasive finishing	Grinding, deburing and abrasive finishing processes are combined in MAFM. Magnetic Abrasive Machining (MAM) was used for finding roughness and tolerance band of component. Polishing of cylinder work piece was done by using available abrasives. With this experimentation and process parameters; the surface roughness value on a cylindrical component was found from an initial R_a value. Study showed that on various parameters improvements surface finish was maximum in case of brass as compared to other materials. These studies also indicated that we need to consider the work piece initial roughness, apart from its hardness for achieving an improved finish on the work surface.	Magnetic abrasive finishing used for complicated product finishing. Roughness and tolerance value whichthat is difficult using conventional machine process; is achieved in MAF. The product dimensional accuracy is easily achieved with taking trial with MAF parameters.
3	Sunil Jha, V.K. Jain	Design and development of the magnetorheol ogical abrasive flow finishing (MRAFF) process	1. The role of magnetic field strength in MRAFF process is clearly distinguished, as at zero magnetic field conditions no improvement in surface finish is observed, and the improvement is significant at high magnetic field strength. This is because, in the absence of magnetic field the CIPs and abrasive particles flow over the workpiece surface without any finishing action due to the absence of bonding strength of CIPs. As the magnetic field strength is increased by increasing magnetizing current, CIPs chains keep on holding abrasives more firmly and thereby result in increased finishing action. Even magnetic flux density of 0.1521 T is capable of removing to some extent, loosely held ploughed material left after grinding process and expose the actual grinding marks made by abrasives. 2. Depths of initial grinding marks were reduced progressively as the experiments were performed at higher magnetic flux density, by reducing asperities. At higher magnetic flux density, abrasive marks in the direction of motion were also observed due to deep penetration of some abrasive particles during MRAFF in the workpiece surface.	Carbonyl iron powder and silicon carbide are main constituents of magnetorheological (MR) polishing fluid. When abrasives dispersed in the viscoplastic base of grease and mineral oil; it exhibits change in rheological behaviour in presence of external magnetic field. Magnetorheological abrasive flow finishing (MRAFF) process provides better control over rheological properties of abrasives.

Na^+ and H^+ move toward the cathode; NO^{3-} and OH^- move toward the anode. Since ionization tendency of “Na” is stronger than ionization tendency of “H,” the reaction shown as Eq. (3) occurs at the cathode. The discharge of OH^- is easier than the discharge of NO^{3-} hence, the reaction shown as Eq. (4) occurs at the anode. Through Eqs. (3) And (4), it can be seen that H_2 is generated at the cathode and O_2 is generated at the anode [21].

$$H^+ + 2e^- \rightarrow H_2\uparrow \qquad (3)$$

$$2OH^- \rightarrow H_2O + 1/2O_2\uparrow + 2e^- \qquad (4)$$

It is well known that the major composition of SUS304 is Fe (70%), Cr (20%), and Ni (10%). Generated oxygen at the anode has strong oxidizing. Hence, most of anode metal is oxidized under the action of oxygen. Moreover, a lot of mental ions such as Fe3$^+$, Cr^{6+}, Fe^{2+}, Cr^{3+} Ni^{2+}, and other elements are eluted on the metal surface by the action of oxidation reaction [21]. Compared with the concave portions of work piece, the protruding portions are closer to cathode. Thus, the current density of protruding portions is larger and eluted rate is also relatively faster. These protruding portions of work piece are preferentially leveled during electrolytic process, and the surface precision polishing can be completed by elution [22], [23]. Along with the electrolytic reaction proceeds, the surface

Table 2 (cont.)
Literature review

4	Manas Das, V. K. Jain & P. S. Ghoshdastid-ar	Nanofinishing of flat work pieces using rotational–magnetorheological abrasive flow finishing (R-MRAFF) process	**1.** It has been found that under similar experimental conditions, R-MRAFF process is more effective in reducing surface roughness than MRAFF process. **2.** From atomic force microscope and scanning electron microscope images, it has been observed that the abrasive cutting marks in R-MRAFF process generate crosshatch pattern which increases the oil retention capability of the workpieces to reduce friction. **3.** MRAFF and R-MRAF processes are less efficient for finishing magnetic work pieces (EN-8) as compared to non-magnetic work pieces. **4.** From the ANOVA for %ΔRa, it has been observed that among the significant terms, the combination of S and its S2 has the highest contribution (37.58%) followed by combination of N and its N2 (25.8%), P and its P2 (22.17%), and R and its R2 (12.82%) for stainless steel workpiece. For brass, the combination of S and S2, P and P2, R and R2, and N and N2, have 29.72%, 24.7%, 23.5%, and 17.42% contribution, respectively.	Rotational– magneto rheological abrasive flow finishing(R-MRAFF) enhance the finishing performance of MRAFF process. A rotation and reciprocating motion is provided to the polishing medium in this process. This is achieved by a rotating magnetic field and hydraulic unit. By intelligently controlling these two motions, a uniform smooth mirror-like finished surface with improved material removal rate and finishing rate (nano meter per cycle) is achieved for both stainless steel and brass workpieces.
5	Anwesa Barman, Manas Das	Simulation of Magnetic Field Assisted Finishing (MFAF) Process Utilizing Smart MR Polishing Tool	In the present work, the simulation of MFAF process is carried out in a static condition. The magnetic field distribution during finishing is simulated in the finishing zone. Around the finishing zone the variation of magnetic flux density is plotted. The normal indentation force on the work piece surface by abrasive particles through surrounding CIPs is calculated considering magnetic flux density and its gradient in the Z direction. The deformation of work piece due to one abrasive particle is simulated and the results are plotted. The flow of MR fluid between permanent magnet and brass work piece has been analyzed. Two different flow behaviour of MR fluid i.e. Newtonian (without magnetic field) and non-Newtonian (with magnetic field) are investigated. The velocity profiles of MR fluid distinctly show that the solid core and sheared zone which resembles the non-Newtonian flow behaviour of MR fluid with the application of magnetic field. The surface roughness profiles plotted and its magnitudes for MFAF process are calculated. Also, the final surface roughness profiles for both experimental and simulated results show good agreement between them. Hence, finite element method can be successfully used to model MFAF process.	Finite element method can be successfully used to model MFAF process.
6	Girish Chandra Verma, Prateek Kala & Pulak Mohan Pandey	Experimental investigations into internal magnetic abrasive finishing of pipes	**1.** Use of two similar magnetic poles (north–north) and diamagnetic property of copper has successfully created a high magnetic flux density at the periphery of the ferromagnetic disc. **2.** A variable magnetic flux density tool is successfully fabricated to finish internal surface of holes of specified dimension, which has given effective results on stainless steel (SS304) pipes. **3.** The developed model shows that magnetic flux density is the most effective parameter in the given range of variables.	Use of two similar magnetic poles (north–north) and dia-magnetic property of copper has successfully created a high magnetic flux density at the periphery of the ferro-magnetic disc.

of SUS304 plane will accumulate a large number of passive films which can lead to the electrolytic current gradually to decrease. Thereby, the eluting amount of metal ions will decrease. The main problem of using MAF process to polish the SUS304 plane is that pressing pressure of magnetic brush is deficiency. However, if the MAF process combines with the electrolytic process, passive films are generated under the action of electrolytic process. Since the hardness of passive films is far lower than that of SUS304 material, magnetic brush can effectively remove formed passive films from the electrolytic process. Thereby, abovementioned, the main problem of using MAF process can be solved, and the machining efficiency can be improved by EMAF process. It is notable that EMAF process includes two finishing steps which are (1st) finishing step (MAF process combines with electrolytic process) and (2nd) finishing step (single MAF process). The schematic of stainless planar processing system is shown as Fig. 11. The SUS304 work piece as an anode is penetrated into electrolyte solution and connected to positive electrode of DC constant voltage power. The electrolytic

Table 2 (Contd.)
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7	Xu Sun1 & Yanhua Zou	Development of magnetic abrasive finishing combined with electrolytic process for finishing SUS304 stainless steel plane	**1.** The proposed plane magnetic abrasive finishing combined with the electrolytic process method has successfully achieved efficient precision machining. Additionally, a novel designed electrolytic magnetic compound machining tool has been successfully applied in EMAF process tests to simultaneously achieve two different processes (MAF process and electrolytic process). **2.** The results of experiments show that the surface roughness can reach to 41.49 from 390.98 nm Ra by 75-min traditional MAF process; the surface roughness descends from 393.08 to 30.94 nm Ra by 40-min EMAF process. **3.** The results of EDX analysis have revealed that the electrolytic process is regarded as the main effect for the change in content of surface composition and soften surface during the EMAF process. Since the electrolytic magnetic abrasive finishing can soften the surface of work piece, the material removal weight M of total EMAF process is nearly six times than that of single traditional MAF process. **4.** Through contrasting with traditional MAF process, it is confirmed that EMAF process can a little obtain higher quality surface, and machining efficiency is improved by about 50%.	**1.** It can be confirmed that the electrolytic process is a main reason for leading to change in the content of finished surface composition. **2.** The results also completely conforms that electrochemical reactions occur dur- ing the electrolytic process.

magnetic compound machining tool as a cathode is located above the work piece and connected to negative electrode of DC constant voltage power. There is a working gap between compound machining tool and work piece plane. The magnetic brush is formed by mixed magnetic abrasive particles at the bottom of the magnetic poles. Then, magnetic brush conducts rotational movement. The electrolyte is injected by a pump and the flow rate of electrolyte is controlled through a flow meter. After turning on DC constant voltage power, the protruding portions will be preferentially leveled and the passive films will form on the surface of work piece by electrolytic process. At the same time, using the magnetic abrasive particles of magnetic brush to exert friction on the surface of work piece, the passive films can be effectively removed. Thus, the efficient precision machining of work piece surface can be realized through EMAF process. In addition, in order to avoid environmental pollution, the used electrolyte is collected into a collecting container.

3. Conclusion

AFM process can be done by four categories: 1. Experimental Setups, 2. Abrasive Media, 3. Modeling and 4. Optimization Techniques. A semi-solid medium is used in Abrasive Flow Machining (AFM) process. Abrasive medium consists of visco-elastic polymer reinforced with abrasive particles are extruded under pressure through or across the surface to be finished. In the present article an attempt has been made to review the published technical papers on following conclusions are drawn from the above review. Some experimental developments setups by various scholars are detailed in the paper. These setups includes: Magneto rheological Abrasive Flow Finishing (MRAFF); Magneto Abrasive Flow Machining (MAFM); Electro-Chemical aided Abrasive Flow Machining (ECAFM);Centrifugal Force Assisted Abrasive Flow Machining (CFAAFM); Drill Bit Guided-Abrasive Flow Finishing (DBG-AFF); Ultrasonic Assisted Abrasive Flow Machining (UAAFM); Rotational-Abrasive Flow Finishing (R-AFF); and Rotational Magneto rheological Abrasive Flow Finishing (R-MRAFF) This process is successfully applied to finish the components with intricate profiles mainly used in automotive, aerospace and biomedical fields. Authors feel that there is still room for lot of improvements in the present Magneto Assisted Abrasive Flow Machining. Magnetic field significantly affects both MR and ΔRa. Improvements in MR can be expected at higher values of magnetic field. Fewer cycles are required for removing the same amount of material from component, if processed in the magnetic field. Medium flow rate does not have a significant effect on MR and ΔRa in the presence of magnetic field.

4. Future scope

MAAFM can be used in various sectors like medical, automobile and aerospace industries. Complex shapes with better surface roughness can be achieved with this process. Better performance can be achieved by monitoring the process online. Acoustic emission techniques can be applied to monitor surface finish and MRR. Various modelling techniques can also be used to correlate model process with experimental results. Researchers believe that still there is a scope of improvement in present MAAFM process

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