International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 03 Issue: 06 | June -2019 ISSN: 2590-1892

A Case Study of Abrasive Flow Machining and its Material Removal Rate(MRR)

Ashish Yadav[1], Sanjay Kumar[2]

Department of Mechanical Engineering, M.R.K.I.E.T., Rewari[Hr.], India

Abstract

The abrasive flow machining and its types like magneto, electrochemical and ultrasonic abrasive flow machining are used where high accuracy and surface finish is required. Abrasive flow machining demand special machining devices which limits its application and dissemination. In this machining process high pressure air stream consisting of abrasive particles strikes on the work surface forced by a hydraulic ram, effectively performing erosion. Abrasive flow machining is not used for typically large removal operations although it can be used but not because of its low metal removal rate. The present paper consists of preliminary results of an ongoing research project with an aim to explore the techniques for improving the metal removing rate of abrasive flow machining. One of the techniques studied uses formation of magnetic field around the workpiece. Magnetic abrasive finish uses magnetic fields for its finishing processes in the past. The combination of magnetic Abrasive Finish and Abrasive Flow machining is given a common name Magneto Abrasive Flow Machining. The paper discusses the possible improvements in the material removal rate by the use of magnetic field around the workpiece in abrasive flow machining.A set up has been made for Magneto Abrasive Flow Machining and the effect of key parameters on the performance of the machining process has been studied. Other various parameters on which metal removal rate depends are velocity abrasive particle, abrasive particle size, stand off distance, flow volume etc.

Keywords- Abrasive flow machining(AFM), Material Removal Rate(MRR), Magneto abrasive flow machining(MAFM), Stand Off Distance(SOD), Abrasive flow rate.

Introduction

Abrasive flow machining is a non traditional machine which operates without any physical contact between the tool and workpiece, thermal stress and shocks are not developed as there is no contact between the tool and workpiece. In abrasive flow machining the abrasive particles are made to flow on the workpiece with a velocity resulting in erosion. The abrasive particles implinges the raised features on the surface of the workpiece and removes them. The abrasive fluid used is viscous in nature and is forced with the help of hydraulic ram. Abrasive flow machining is also known as abrasive flow deburring or extrude honing.

Due to low material removal rate of the abrasive flow machining magnetic fields are being used to get better material removal rate and use of magnetic fields in abrasive flow machining is known as magneto abrasive flow machining. MAFM is a new technique in machining which is said to be an improvement in Abrasive flow machining. This machining process have wide applications in Automobiles, Die and mould, Metal fabrications , Aerospace engine etc.

Advantages of Abrasive flow machining :-

- Internal deburring is possible.
- Polishes internal and external features of components.
- Controllability, repeatability and cost effectiveness.
- Removes recast layers of components.

Limitations of abrasive flow machining:-

- Low material removal rate.
- Low surface finish.
- Not used for ductile materials as particles can embed in workpiece.
- Require close environment
- Due to low MRR it is not used for mass removal.

Background

Abrasive flow machining process was developed in 1966 by extrude hone corporation, USA. After that a number of research and studies were performed regarding process mechanism, surface generation, process monitoring of AFM which was conducted by Williams and Rajurkars in late 1980. Their work was related to online monitoring of acoustic emissions and modelling of this process. Kozal et al and Loveless et al investigated upon the effects on the surface of workpiece after machining. Flow behaviour of the abrasive medium was also observed in the study by them. Effect of temperature on the material removal rate in AGM was done by Fletcher. Different researchers worked upon stimulation of material removal and surface generation by neural networks and finite element method.
Modification to Abrasive flow machining was first given by Jones and Hulls by the use of ultrasonic waves in the medium for removing blind cavities. Gilmore gave orbital flow machining process which is said to be new advancement in AFM. These advancement in non conventional machining process are known as Hybrid Machining process(HMP).

Experimental set up

An experimental setup is shown in fig. 1.

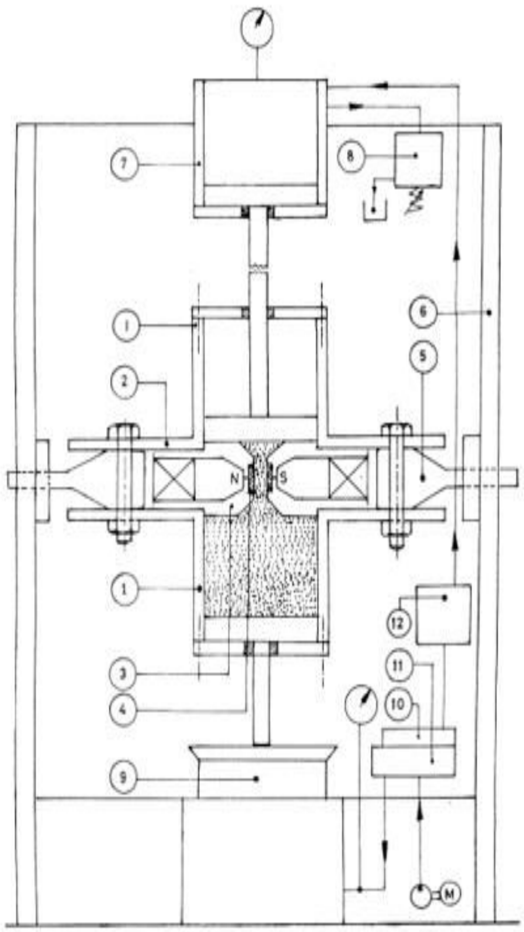

Figure 1

Arrangemnt consists of :-

1. Two cylinders which contains medium along the oval flanges.
2. Flanges provide clamping of the fixture made up of nylon, a non magnetic material.
3. Fixture which consists the workpiece.
4. Workpiece and index which is capable to provide rotation upto 180°.
5. Two eye bolts.
6. Hydraulic press.
7. Auxialiary hydraulic cylinders capable of providing variable pressure to the abrasive medium.
8. Relief valve that provide desired value to resistance offered by cylinder.
9. Piston of Hydraulic press.
10. Directional control valve.
11. Manifold Blocks.
12. Electromagnet which consists of two poles in order to provide maximum magnetic fields around the workpiece

Principle

A volume of abrasive particles are made to carry with helf of abrasive fluid over the workpiece resulting in erosion. Abrasive particles strikes on the workpiece with a specified pressure generated with the help of hydraulic cylisnder and piston arrangement. High velocity is obtained by converting pressure energy into kinetic energy of the fluid.

By introduction of electromagnets to the process the abrasive particles diverge less from the path and impinges on the workpiece by small angle. Therefore by the application of magnetic field more abrasive particles strikes the workpiece.

Following are the process parameters affecting metal removal rate of abrasive flow machining other than magnetic fields

- Volume flow rate of medium

- Number of cycles.
- Stand off distance.
- Viscosity of medium.
- Magnetic flux density.
- Material of workpiece.
- Grain size of abrasive particles.
- Concentration of abrasive particles.
- Volume of the mediu.
- Presurre generated with the help of piston.
- Extrusion pressure.

Conclusion

An increase in the material removal rate of the abrasive flow machining process is seen by introducing a magnetic field around the workpiece. By the observations of the response surface following results are obtained regarding the response parameters with the independent parameters within specific range.

1. Magnetic fields changes the metal removal rate in a significant manner. Also the metal removal rate increases more as compared to surface roughness. So by increasing the magnetic field intensity higher values of metal removal rate can be expected.
2. The combination of medium flow rate and magnetic field intensity can provide high metal removal rate as they tend to interact with each other.
3. A visible improvement in Metal removal rate and surface roughness is seen for a specific number of cycles. If magnetic field is applied less number of cycles are required for removing the same material without magnetic fields.
4. Medium flow rate of abrasive particle does not affect material removal rate in the presence of magnetic field.
5. Material removal rate stops increasing after a certain number of cycles.

Magneto abrasive flow machining is an advanced abrasive flow machining variety of surface finish requirements can be obtained for the application such as medical, aerospace, mould, dies, automobiles etc. Better surface finish can be obtained for complex shapes by the use of magneto abrasive flow machining. A number of improvements are required in this machining process and one of them is its low finishing rate.

References

1. Singh S, H.S, "Development of magneto abrasive flow machining process", International Journal of

machine tools and manufacture, Issue number 42 (2002), 953-959.

2. V.K Jain, R.K Jain,"Modelling of material removing and surface roughness in magneto abrasive flow machining process", International journal of machine tools and manufacture, Issue number 114(1992), 74-81.

3. Jha S, V.K Jain,"Design and development of magneto rheological abrasive flow finishing process", International journal of machine tool and manufacture, Issue number 44(2004), 1019-1029.

4. Wang TT(2013) Fundamental research on abrasive flow finishing machining based on hydrodynamic effects. Dissertation, Nanjing University of Aeronautics and Astronautics.

5. Gorana V.K, Lal G.K,"Forces prediction during material deformation in magneto abrasive flow machining", Journal of manufacturing systems. Issue number 260(2006),128-139.

6. L.J Rhoades, Kobut T.A Nokovich N.P Unidirectional abrasive flow machining, US patent number 5,367,833, Nov 29,1994.