REVIEW ON ADVANCED FINISHING PROCESSES (AFPs)

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ABSTRACT

The technology is really spice of life. Advanced finishing processes are all about latest technology which are useful for finishing material with very high precision. The traditional finishing processes i.e. grinding, lapping, honing have various limitations like complex shape, iniature sizes,3-D parts cannot be processed & finished economically and rapidly. This led to development of advanced finishing processes to overcome the limitations of traditional finishing process in terms of higher tool hardness requirement and precise control of finishing forces during operations and also use to finish complicated geometries by enhancing reach of abrasive particles to a complex region of the workpiece surface. AFPs includesAbrasive Flow Machining (AFM), Magnetic Abrasive Finishing (MAF), Magnetic Float Polishing (MFP), Magneto-rheological Abrasive Finishing (MRF), Ion Beam Machining (IBM), Elastic emission machining (EEM),Chemo mechanical polishing (CMP). The review of working principles and applications of some of these processes are discussed in this paper.

Keywords: abrasive particles, higher precision, fine finishing

I. INTRODUCTION

There are many advances taking place in the finishing of materials with fine abrasives, including the processes, the abrasives and their bonding, making them capable of obtaining nanometer order surface finish.To make different products in various shapes and sizes, many times, the traditional manufacturing techniques do not work. One needs to use non-traditional or advanced manufacturing techniques. With abrasives, it has become possible to achieve nanometer surface finish and dimensional tolerances.There is a process IBM which can give ultra precision finish of the order of the size of an atom or molecule of the substance. Elastic Emission Machining (EEM) and Ion beam Machining (IBM) work directly by removing atoms and molecules from the surface. Other processes based on abrasive particles wear remove them in clusters. AFPs can be broadly categorized into mechanical, thermoelectric, electrochemical and chemical processes.This paper deals with some of the advanced fine finishing processes like Abrasive Flow Machining (AFM), Magnetic Abrasive Flow Machining (MFP), Magnetic Abrasive Finishing (MAF), Magnetic Float polishing (MFP), Magneto Rhelogical Abrasive Finishing (MRF).

II. ABRASIVE FLOW MACHINING (AFM)

Abrasive flow machining is also known as Abrasive flow deburring or extruder honing. .This process was developed basically to deburr, polish and radius difficult to reach surfaces and edges by flowing abrasive laden polymer over the work piece surface. It uses two vertically opposed cylinders, hydraulic ram fixture, clamping system and the medium. The medium (mixture of viscoelastic material and abrasive particles) enters inside the work piece through the tooling. Abrasive fluid flows through workpiece by hydraulic ram.The key components of AFM are the machine, the tooling, types of abrasives, medium composition.

In abrasive flow machining, the abrasive fluid flows through the workpiece, effectively performing erosion. Abrasive particles in the fluid contact raised features on the surface of the work piece and remove them. Due to tangential force, the material is removed in the form of chips. The highest amount of material removal occurs in areas where the flow of the fluid is restricted, the flow speed and pressure of the fluid increase in these areas, so there is higher material removal rate.

There are three major elements of the AFM system- Tooling, Machine, and Medium.

Tooling-which confines and directs the abrasive medium flow to the work piece surface areas where surface finishing desired.

Machine- to controls the process variables like extrusion pressure, medium flow volume and medium flow rate.

Medium-The abrasive laden polymer is medium whose rheological properties determine the pattern and aggressiveness of the abrasive action.

Types of AFM are one- way flow process and two-way flow process.In the two-way flow process, a reservoir of medium exists at either end of the work piece, and the medium flows back and forth through the work piece from reservoir to reservoir. AFM- may be manually operated or automated using CNC. Automated AFM is capable of handling 1000s of parts per day.

Due to low material removal rate, not typically used for large stock removal operations.Its ability to process multiple parts simultaneously, and finishing inaccessible areas and complex internal passages economically and effectively led to its application in wide range of industries.

Applications of AFM- Aerospace, aircraft, medical components, electronics, automotive parts, precision dies and moulds manufacturing industries, food processing, semiconductor equipment, pharmaceutical manufacturers, ultra clean or high purity devices.

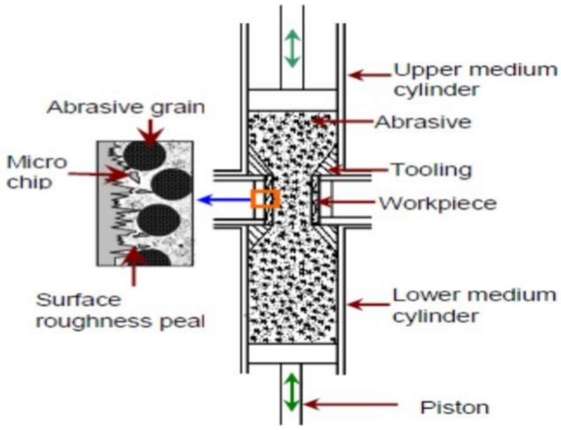

Fig.1 Abrasive flow machining

III. MAGNETIC ABRASIVE FINISHING (MAF)

Some affords are being made to enhance the material removal rate during AFM by the application of the magnetic field while using magnetic abrasive particles in the place of simple abrasive particles. MAF is also known as magnetic field-assisted machining. This process is developed to produce efficiently and economically good quality finish on the internal and external surfaces of tubes as well as flat surfaces made of magnetic ornon-magnetic materials. It is essentially the manipulation of a homogeneous mixture of magnetic particles and abrasive particles with a magnetic field to impart a machining force on a workpiece.

Magnetic particles along with abrasive mixture are commonly preferred as magnetic brush. The application of magnetic field attracts and densities the magnetic abrasive particles near the inner wall of the workpiece. So effective abrasive concentration increases near the wall as compared to the rest of the medium. Therefore, it enhances the material removal rate as compared to normal AFM due to increased in effective concentration of abrasive particles near the wall, increased radial force acting on abrasive particles, increase depth of cut and surface finish. MAF can be used for both external and internal surfaces. Difference between internal and external surfaces of finishing is that the location of work piece and brush, however, the application of force is essentially same so material removal mechanism is identical.

Applications- Freedom finishing-Prosthetics, Cutting Tools, Turbine Blades, Airfoils, Optics

Internal finishing- Sanitary Pipes, Food Industry, Capillary Tubes in Medical Field, Stents, Cathatershafts, Needles, Biopsy Needles, Curved Pipes, etc.

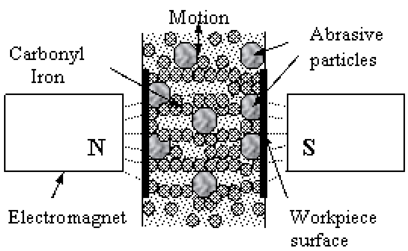

Fig.2 Magnetic Abrasive Finishing

IV. MAGNETIC FLOAT POLISHING (MFP)

Magnetic float polishing is a new technique developed for efficient finishing of very hard materials like ceramics, which develops defects during grinding leading to fatigue failure. In MFP, the process involves the use of magnetic field to support abrasive slurries in finishing ceramic balls and bearing rollers. This technique is based on the ferro-hydrodynamic behavior of a magnetic fluid that can levitate a non-magnetic float and abrasives suspended in it by magneticfield.The levitation force applied on the abrasives is proportional to the field gradient and is extremely small and highly controllable.

The setup includes magnetic fluid containing fine abrasive grains and extremely fine ferromagnetic particles in a carrier fluid (water or kerosene), work piece. The ferro fluid is attracted downward towards the area of higher magnetic field and at the same time the buoyant force is exerted on non- magnetic material to push them upward which is the area of lower magnetic field on the application of the magnetic field. The abrasive grains, the ceramics ball, and the acrylic float inside the chamber all being of non-magnetic material, are levitated by the magnetic buoyant force.The drive shaft is fed down to contact the balls and to press them down to reach the desired force level and the balls are polished by the relative motion between the balls and the abrasives.

Applications- balls for bearings

To minimize thesurface damage, 'gentle' polishing conditions are required, namely, low level of controlled force and abrasives not much harder than the work material. The magneticfloat polishing (MFP) process easily accomplishes this.

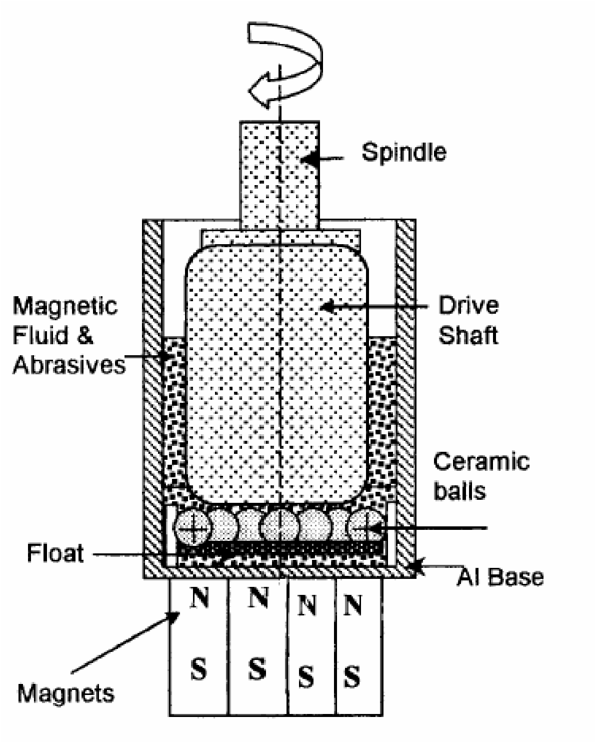

Fig.3 Magnetic Float polishing.

V. FINISHED SURFACE CHARACTERISTICS

Sr.no.	Process	Work piece	Ra(nm)
1.	Abrasive flow machining (AFM) with SiC abrasives	Hardened steel	50
2.	Magnetic Float Polishing (MFP) with • Cr2O3 abrasives • Ceo2 abrasives	Si3N4	9.1 4.0
3.	Magnetic Abrasive Finishing (MAF) With diamond abrasives	Si3N4 rollers Stainless steel rods	40 7.6

Table 1. Comparison of surface finish obtained by different advanced finishing processes

VI. CONCLUSIONS

The importance of ultrafine finishing processes using abrasive as cutting tool, and their capabilities to achieve nanometer order surface finish is discussed. It has been observed that the precise control of forces on abrasive particles using non-traditional methods are useful for fine finishing and high precision finishing. The surface finishing occur fully or partially with the use of abrasive particles in most of the advanced finishing processes. Fine finishing of brittle materials can be easily done in nanometer range.

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