Review On Surface Finishing Methods by Using MRF Fluid

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Abstract: This paper represents surface finishing operation by using MR fluid. The surface finishing operation of various material like steel, brass etc. by using different composition of MR fluid as well as different technique as like MRAFF,R-MRFF, sintered iron-CNT compound abrasive are applied for complex internal geometry and surface finishing achieved up to Nano level.

Keywords: Magnetic Field, MR fluid

1. INTRODUCTION

Magneto-rheological (MR) fluid based finishing process was based on a MR fluid consisting of non-magnetic polishing abrasive and magnetic carbonyl iron particles (CIPs) in water or other carrier. With the appropriate composition of MR fluid, this process has successfully polished a variety of materials ranging from optical glasses to hard crystals to sub-nanometer surface-roughness level. In the absence of a magnetic field, the MR fluid behaves as a Newtonian fluid (viscosity 0.1-1 pa s). The magnetic field stiffens the MR fluid ribbon (viscosity 10-20 pa s) depending upon the magnetic field strength and behaves like a viscoplastic fluid.

Science and technology have made amazing developments in the design of electronics and machinery using standard materials, which do not have particularly special properties (i.e. steel, aluminum, gold). Imagine the range of possibilities, which exist for special materials that have properties scientists can manipulate. Some such materials have the ability to change shape or size simply by adding a little bit of heat, or to change from a liquid to a solid almost instantly when near a magnet; these materials are called smart materials. Smart materials have one or more properties that can be dramatically altered.

Most everyday materials have physical properties, which cannot be significantly altered; for example if oil is heated it will become a little thinner, whereas a smart material with variable may turn from a liquid state which flows easily to a solid. Each individual type of smart material has a different property which can be significantly altered, such as viscosity, volume or conductivity. The property that can be altered determines what type of applications the smart material can be used for.

Varieties of smart materials already exist, and are being researched extensively. These include piezoelectric materials, magnetorheostatic materials, electrorheostatic materials, and shape memory alloys. Some everyday items are already incorporating smart materials (coffeepots, cars, glasses) and the number of applications for them is growing steadily. Magneto-rheological materials (fluids) (MR) are a class of smart materials whose rheological properties (e.g. viscosity) may be rapidly varied by applying a magnetic field. Under influence of magnetic field the suspended magnetic particles interact to form a structure that resists shear deformation or flow. This change in the material appears as a rapid increase in apparent viscosity or in the development of a semisolid state. Advances in the application of MR materials are parallel to the development of new, more sophisticated MR materials with better properties and stability. Many smart systems and structures would benefit from the change in viscosity or other material properties of MR. Nowadays, these applications include brakes, dampers, clutches and shock absorbers systems.

2. Present theories and work

Vijay Kumar presented the work which is used to investigate the finishing efficiency of magneto-rheological fluid on steel specimen surfaces under magnetic field [1].

Song, choi, lee et.al. evolved in order to improve the surface quality of machining work piece a micro-precision surface finishing method by applying magneto-rheological fluid to the machined surface. Magneto-rheological fluid is colloidal suspension and stiffens into semi-solid when subjected to a magnetic field. Thus, the surface roughness of the finished surface could be controlled by magneto-rheological fluid under the different magnetic fields. Several sets of tests were performed with various normal loads, finishing speeds and magnetic fields. Their test results showed different surface characteristics of the test material under different magneticfields and proved the feasibility of this micro-precision surface finishing method to reduce the surface roughness of machining work piece efficiently [2].

Singh, jain, raghuram, et.al. .has proposed , Taguchi design of experiments is applied to find out important parameters influencing the surface quality are voltage (DC) applied to the electromagnet, working gap, rotational speed of the magnet, abrasive size (mesh number). Experimental results indicate that for a change in surface roughness (ΔR_a), voltage and working gap are found to be the most significant parameters followed by grain mesh number and then rotational speed. To analyses the finishing process, a force transducer has been designed and fabricated to measure forces acting during MAF [3].

Jha,das et.al.has developed a magneto-rheological Abrasive Flow Finishing (MRAFF) is a novel precision finishing process developed at I.I.T. Kanpur for Nano finishing of complex internal geometries using smart magneto-rheological polishing fluid. Magneto-rheological (MR) polishing fluid comprises of carbonyl iron particles (CIPs) and silicon carbide abrasives dispersed in the visco-plastic base of grease and mineral oil, exhibits change in rheological behavior in presence of external magnetic field. . In MRP-fluid, on the application of external magnetic field, the iron particles acquire dipole moments proportional to the magnetic field strength and when the dipolar interaction between the particles exceeds their thermal energy, the particles aggregate into chains of dipoles aligned in the field direction. Figures 1a and 1b shows actual photographs taken by optical microscope of CIPs interconnected chain structure. Figure 1c illustrates a model of the structure formed when no magnetic field is applied while Figure 1d shows the structure formed with abrasives trapped and embedded between iron chains, in the presence of finite magnetic field.

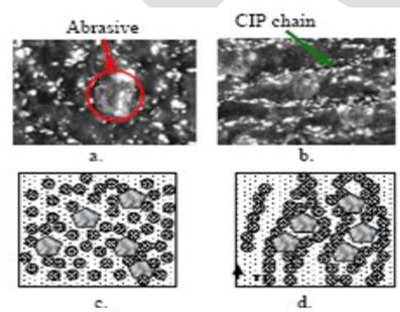

Fig 1. structure of magnetorheological polishing fluide

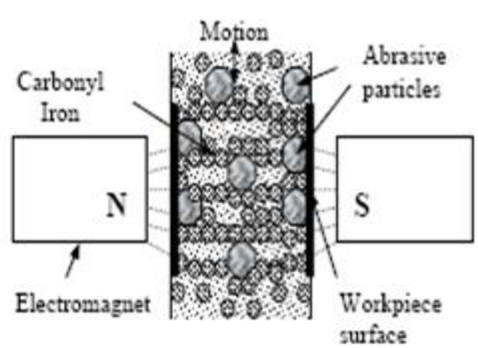

Fig 2.Mechanism of MRAFF

The mechanism of MRAFF action is illustrated in Fig. 2. The abrasive particles under the action of precisely controlled normal magnetic force due to CIP chains and tangential hydraulic extrusion force remove irregularities from the work piece surface to finish them in nanometer range. A hydraulically powered experimental setup as shown in Fig. 3 is designed to study the process characteristics and performance.

Fig 3. MRAFF Experimental setup

The results on stainless steel and silicon nitride work pieces are quite encouraging and surface roughness value, Ra up to 30 nm is already obtained using this process [4].

Das,jain, Ghoshdastidar et.al.had developed a new precision finishing process called magneto rheological abrasive flow finishing (MRAFF), is combination of flow machining (AFM) and magneto rheological finishing (MRF), has been developed for Nano-finishing of parts even with complicated geometry for a wide range of industrial applications[5].

Sunil Jha,V.K. Jain had inventeged a new precision finishing process for complex internal geometries using smart magneto-rheological polishing fluid is developed. Magneto-rheological abrasive flow finishing (MRAFF) process provides better control over rheological properties of abrasive laden magneto-rheological finishing medium. Magneto-rheological (MR) polishing fluid comprises of carbonyl iron powder and silicon carbide abrasives dispersed in the viscoplastic base of grease and mineral oil. A hydraulically powered experimental setup was designed to study the process characteristics and performance. The experiments were conducted on stainless steel work pieces at different magnetic field strength to observe its effect on final surface finish [6].

Das,manas, Ghoshdastidar et.al. had developed new finishing process named as 'rotational-magneto rheological abrasive flow finishing (R-MRAFF)' has been proposed to enhance the finishing performance of MRAFF process. In this process, a rotation cum reciprocating motion is provided to the polishing medium by a rotating magnetic field and hydraulic unit. By controlling these two rates (nanometer per cycle) is achieved for both stainless steel and brass work pieces. [7]

Jung, Byung-Kwon, Min, Lee,Seok et.al, had studied the main mechanism was a wheel-type magneto-rheological finishing process. The first uses a rectilinear alternating motion to improve processing conditions, and the second focuses on the use of more effective abrasives, namely magnetisable abrasives made of iron powders sintered with carbon nanotubes Furthermore, it was shown that these abrasives increase the lifetime of consumables (magneto-rheological fluid and abrasives) and the material removal rate [8].

3. Conclusion

From the literature search made produces data for different methodology for surface finishing by MR fluid such as MRAFF, R-MRAFF. From study it found that R-MRAFF is more convenient for to nanofinishing for different geometries.

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