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MAGNETO-RHEOLOGICAL ABRASIVE FLOW FINISHING OF STAINLESS STEEL BY USING FLUENT ANSYS 18.1

Yeshwant Kumar Dewangan*[1] & Dr. Mukesh Dubey[2]
[*1&2]Department of Mechanical Engineering, Bhilai Institute of Technology, Durg-491001, Chhattisgarh, India

ABSTRACT

An advanced nano completing procedure called magneto-rheological abrasive flow finishing, which is just a joined cross breed type of abrasive flow machining process and magneto-rheological finishing process, has been intended for smaller scale finishing of parts even with troublesome geometry for an expansive scope of modern purposes. In the current work, a model for the forecast of evacuation of material and surface roughness has been evaluated. An exertion has been made to consider the flow going through the stainless steel work piece by CFD modeling in ANSYS 18.1 FLUENT. By accepting the medium as Bingham plastic different parameters influencing the surface roughness has been determined. Likewise a hypothetical estimation is made for the model on the model that no attractive field is applied and, at that point similar investigation of the two models is proposed. An optimization of the procedure has likewise been completed. With the assistance of SN Ratio plot and Means plot advanced estimation of information parameters has been discovered to accomplish better surface completion.

Keywords: Magneto-rheological abrasive flow fluid, Computational fluid dynamics, Nano-sized magnetic particle-based Ferro fluid, Carbonyl iron particle, Finite volume method.

INTRODUCTION

Rheology refers to the science of the flow of matter under external volume and therefore magneto rheology means a fluid in which the viscous velocity exerts a magnetic force to the point of being viscoelastic solid. In many applications of Magneto rheological (MR) spraying technologies have been proven, such as seat dampers, shock shocks, etc. Be that as it may MR fluids can just show a yield pressure of 50-100 kPa at a magnetic flux of 150-280 kA / m. Therefore, the appropriate choice of different components of MR fluid such as carrier fluid, magnetic particles and additives to achieve a high pressure yield system.

With the source of MR fluid, the yield pressure can be increased or reduced by magnetic force.
$\tau = \tau y\ (H) + \mu p \dot{\gamma}$

There, $\tau\ (H)$ Known as yield stress due to the application of magnetic force H. μp is the plasticity of the material and $\dot{\gamma}$ is the ratio of shear stress.

Depending on the type of need used as deformation MR fluids can work in three practical ways such as ducting mode, shear mode and valve mode. In the case of declination mode, the MR fluid decreases with normal pressure where the magnetic field is taken under compression or tension. In the shear mechanism, the MR fluid is located between two moving surfaces while the magnetic field is flowing in the normal direction of the shear surface. When occurring in valve mode, between the standard plates the MR fluid is forced to flow directly.

MR Fluid component options:

Mutations in one or more genes contribute to the effects of MR. The different selection criteria for the MR fluid components are given below

Liquid carrier

Carrier liquid is a large component of MR fluid 60-80 percent by volume. At the highest magneto rheological impact the viscosity of the liquid carrier should be low and should be independent of temperature.

Silicone oil

Silicone oil has good heat transfer properties and good signs of elasticity, very low temperature, resistance to oxidation and high flash points. Silicone oil is very difficult to sign. In addition to the wide temperature range there is little change in the physical properties and usability from 40 to 204 ° C and the shell temperature slope.

Magnetic Particles

The thickness of the particles with the energy close to the order of 1µm to 10µm. The concentration of soluble particles in the fluid can increase to 50%. The available energy increases as the size of the active particle increases but with the increase in the viscosity of the MR fluid [30]. High power satellite magnetization, Low coercively, high permeability, low hysteresis loop and low recovery are some of the features of magnetic fields in the design of MR fluid.

Additives

Grease or other thixotropic additives containing exceptionally visible materials are utilized to improve stability. Magnetic particles are combined with materials such as gaur gum, polystyrene (PS) etc. to reduce the concentration of CI particles, improve the stability of the fibers and prevent CI particles from coming into contact.

LITERATURE REVIEW

Jha and Jain (2004) proposed a structure for CIP chain and surface roughness test. The study was performed on a piece of stainless steel with different combinations of SiC and CIP particles in magneto-rheological polishing fluid to obtain certain amount. Eliminating the universal complexity of the original profile and model provided by the external hardness has been computerized throughout the CIP and SiC size combinations.
Jha and Jain (2006) describe the effect of magnetic field and cycles in the evils of robustness and the role of counterfeit behavior. The hydraulically enabled test setup is designed to understand the components of performance. All experiments were performed on stainless steel at different magnetic fields to assess their effect on surface finish.

Das et al. (2008) analyzed the plastic bingham flow through FEM. The composition of the mixture of large and Ferromagnetic particles suspended in MR polishing fluid has been estimated. The model is also proposed to determine the removal of the material hardness on the outside.
Jha et al.discussed the effect of the change in the stiffness of stainless steel on the work surface due to the change in the maximum number of finishing cycles and pressure. The research is being done on the completion of hydraulically completed power outages and proposes a new look dubbed "illegal entertainment" as a result of an increase in the number of cycles completed.

Das et al. (2010) proposed Rotational (R) – Magneto-rheological Abrasives Flow Finishing as a new rotational cooling system incorporated with magnetic applied MR polishing medium and a repetitive movement caused by a hydraulic powered unit to smooth the inner surface of a cylindrical work piece stainless steel which is a natural non-magnetic material. Nova also checked and confirmed that the speed of the Round on the sidelines provided a very high effect to improve of%, to end the world.

Saraswathamma provides a comprehensive literature review on the MRF process in the case of experimental and experimental science characters, of MR fluid. Kordonski and Jacobs have developed a model that predicts the distribution of surface deformation over an agreement that is a valid test for glass exploration.

KordonskinoGolini found that the energy required for removing items offered hydrodynamic flow of Magneto-rheological fluid when transposing the gap can be made operational area above the wall strong. It is also found that this finishing process reduces the stiffness of the optical components to ≤ 10A0.

Cheng et al. investigate parameters affecting the process of finishing the magneto-rheological for example a fraction of the power features of the magnetic field distribution of a magnetic field. Material removal work and removal rate relative to the K9 glass screen has been designed and tested is performed.

Seoka et al. contemplated how artificial check-tiny silicon-based area with the help of the checkout process MR. The most important factor is to come out as a side effect. The effect of magnetic field on the boundary of the tool cluster in finite element profiles was investigated using the line item method (eFP). Speculation profile nokugqagqana street kwekholaji using RSM service.

MATERIALS AND METHODS

Modeling of material removal

Following are the assumptions taken for the current study of removal of material by Magneto rheological abrasive flow finishing process:

- Each and every abrasive grains shapes are assumed to be spherical and of the equal size. Also the average diameter is determined from the total number of mesh size.
- Each grain is assumed to have a one active cutting edge and the pressure applied on every grain is assumed to be constant and equal to the value of average load.
- It is also assumed that each abrasive particle to achieve the equal penetration depth reliant upon the given average force and the properties of work piece material.

Material removal is assumed due to the translation and indentation of abrasive particles each time when particle and work piece interference take place. The normal force which is developing from the total magnetic force applied on an abrasive grain is the reason behind the penetration of the work piece surface. Due to shear force which is generating because of piston movement when the particle is horizontally translated, the plastically destroyed zone under the surface gets inclined. It gives rise to upward flow and because of that chip is formed, which is correspondingly sheared from the surface of the work piece. The Brinell hardness number (BHN) can be interrelated to the depth of indentation in the work piece surface as follows:
$BHN = F_N / ((\pi/2)\, D_g\, (D_g - \sqrt{Dg^2 - Di^2}))$
Where, $F_N = Fm + Fn$
and, $F_m = (m\chi mB\nabla B)/\mu o$[18]
$Fn = \sigma_{rad} \mathrm{x} A$

F_m is Indentation force on the work piece surface, m = mass of CIP, χ_m = mass susceptibility of CIP (m^3/kg), B is magnetic field density = 0.5T, $\nabla B = \delta B/\delta x$, gradient of a magnetic field, assumed here as 1, μ_0= is permeability in free space ($4\pi \times 10^{-7} Wb/Am$), σ_{rad} is the radial stress acting on the work piece surface, A is total cross-sectional area of the abrasive particle, D_i is indentation diameter and D_g is the diameter of abrasive particle (19 mm). From Viker's micro-hardness testing machine the hardness of stainless-steel work piece is found as 277 BHN. The depth of indentation 't' is obtained as
$t = (D_g/2) - 1/2 \sqrt{D_g^2 - D_i^2}$
the cross-sectional area A' of the groove generated (shaded portion of the grain) is derived from the following
$A' = D_g^2/4 \sin^{-12}(Dg - t)/Dg - t\, (Dg - t)\, (Dg/2 - t)$

The initial surface profile of the work piece is assumed to be triangular.It is assumed that initial surface profile of the work piece is uniformly distributed with initial surface roughness $Ra0$ and abrasives move perpendicular to the direction of the scratches. Volume of material removed (Vg) by an abrasive grain is obtained as
$Vg = A'(1 - R_a^i / R_a^o) l_w$

where, l_w is the total length of the work piece = 35mm, $R_a^i$is surface roughness after ith cycle. As the total material removal is made up of number of similar cycles, total number of abrasive grains (n_S) indenting into the work piece surface per stroke is given by
$n_s = 2\pi r_f N_s l_s(r_c/r_f)^2$

where, l_S is stroke length of the piston = 50mm, Ns is the number of active abrasive particles per unit area of work piece = 1200, rc is radius of the medium cylinder = 28.75mm and rf is radius of the work piece fixture = 9mm. Volumetric material removal (MV) in ith stroke is given by
$Mv = ((R_a^0 - R_a^i)^2 / R_a^0) l^2_w$

Since volumetric material removal (M_v) in ith stroke = volume of material removed by an abrasive grain (V_g) × total number of abrasive grains indenting the work piece surface per stroke (n_S), and it is given as
$Mv = 2\pi f N_s l_s\, (r_c/r_f)^2 [D_g^2/4 \sin^{-1}\sqrt{t}(D_g - t)/Dg - \sqrt{t}\, (D_g - t)\, (D_g/2 - t)](1 - R_a^i/R_a^o) lw$

Comparing above equations, and after simplification we obtain
$R_a^i = R_a^0 - 2\pi r_f N_s\, (l_s / l_w)\, (r_c r_f)^2 [D_g^2/4 \sin^{-1}\sqrt{t}(D_g - t)/Dg - \sqrt{t}\, (D_g - t)\, (D_g /2 - t)]$

Surface roughness for ith cycle is calculated from Eq. Mv. Simulation results of the fluid flow through the work piece fixture is analyzed. At that point count is made to locate the various parameters like total normal force, shear force, indentation depth and material removal from the analysis data.

RESULTS AND DISCUSSION

In this part, the simulation results of fluid flow, magnetic field density, indentation depth, and final surface roughness at different CIP concentration, nano finishing process and pressures are discussed. The experimental data of the initial surface roughness obtained from the correspondence research paper are employed for the CFD analysis of the final surface roughness after finishing of the stainless steel work piece and is validated with the experimental results. The nano finishing condition during experimentation and CFD analysis are kept the same.

CONCLUSION

In view of the investigation obtained from this examination, subsequent conclusions have been created

- From the CFD analysis it is validated with the theoretical model that shearing is going on during completing, when applied shear force applied on the abrasive particle is more than the work piece material's opposing force because of the strength of the material and it is the primary driver of material expulsion.
- From the results obtained from the CFD analysis it can be concluded that the model predicts nano level finishing and model data is validated with available experimental results.
- When no magnetic effect is applied CIPs don't get that required bonding force corresponding to that the normal force is less which is required to indent the abrasive particle. So surface roughness achieved is less but material removal will occur as shear force is greater than reaction force.
- It is concluded that for optimizing the finishing process it is required that the value of axial stress and indentation depth should be low and value of radial stress should be high. The conclusions from the optimization made are following:
- The optimum process parameters for minimizing axial stress are 0.3T magnetic density, 45 bar inlet pressure and 0.01 m/sec inlet velocity.
- The optimum process parameters for maximizing radial stress are 0.3T magnetic density, 45 bar inlet pressure and 0.03 m/sec inlet velocity.
- The optimum process parameters for minimizing indentation depth are 0.3T magnetic density, 37.5 bar inlet pressure and 0.01 m/sec inlet velocity.

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