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Electro Magnetic Abrasive Finishing Machine

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ABSTRACT:

Advanced finishing processes have expanded as a result of the need for a high finish with accuracy and the difficulties of finishing components using traditional techniques. The magnetic abrasive finishing method is a sophisticated finishing technique that may be used to polish, deburr, and precisely chamfer components. On flat and cylindrical workpieces, both internally and externally, magnetic abrasive finishing method can affordably achieve nanometer surface finish. To achieve a surface polish of nanometers, very small finishing forces are given to the magnetic abrasive particles during the operation. As a result, polishing brittle materials without creating microcracks or other flaws is a particularly valuable use. Numerous researchers altered the procedure and created hybrid variations of it. Their main goals are to increase the process's efficiency and furthermore

KEYWORDS: Magnetic abrasive finishing Surface roughness Modeling Abrasive particle

INTRODUCTION:

For items in a variety of applications, including aerospace equipment, medical devices, semiconductors, vehicles, tools, and dies, among others, a high-quality surface with a low value of surface roughness and high dimensional accuracy is needed. The production of components with complicated shapes for various applications requires the use of sophisticated materials, such as alloys of hard materials, glass, ceramics, and composite materials. These materials are challenging to finish because of their extreme hardness and toughness, as well as the goods' intricate shapes. The finishing process is the last step in the manufacture of components, and it accounts for around 15% of the overall production expense. Abrasive finishing is a method for precision surface finishing that shows promise. In order to complete the intricate shapes shows promise.

OBJECTIVES:

This study aims to propose a novel magnetic abrasive finishing design using stationary equipment whereby the machining process is carried out by regulation of magnetic fields without using any mechanical moving parts. A rotating magnetic field, which is obtained by energizing the electromagnets sequentially via control of the duty cycle, and on-time interval, for each electromagnet, was used. Thus, regulating the magnetic field allows control of the magnetic force which, in this case, represents the cutting force. This enables automating of the performance of the finishing process. Further, it enhances the accuracy and controllability of the process, and it also improves the quality of the final product. From another perspective, it also minimizes the mechanical power consumption by elimination of any mechanical motion. The designing process included a number of processes, such as creating a simulation and mathematical model for the metal removal mechanism and calculating the magnetic and cutting forces used in the MAF process. Additionally to the creation of the experimental setup and the design and optimisation of the electromagnetic actuator. Additionally, characterising the completed surface with regard to the roughness profile and surface textures is done, as well as researching the effects of the process parameters (such as applied current, frequency of the rotating magnetic field, and magnetic abrasive particles).

LITERATURE REVIEW:

Magnetic Abrasive Finishing (MAF) was originally mentioned in a patent in the United States in 1938 by Henry P. Coats [1]. Shinmura T.'s[2] initial explanation of the fundamentals of the MAF process included experimental verification in a model test that the Magnetic Abrasive Particles (MAPs) deliver sufficient pressure to finish the work surface in accordance with the strength of the applied magnetic field. They discussed how a stainless steel tube is inside finished by MAF. Additionally, they investigated how many process variables might impact the final surface roughness and discovered that the permanent magnet, workpiece material, shape, and size all affect the magnetic force's ability to control strength. The outcomes of the experiment demonstrated that the surface roughness he is the first to use an electromagnet with alternating current (AC) in the MAF process, and his enhanced up to 0.1 m Rmax. They used a rotating magnetic field that was created by applying a three-phase AC current to three coils that were aligned in a circle at 120-

degree intervals. For an internal finishing of cylindrical work components, experiments were carried out. It was determined that applying a rotating magnetic field increased stock removal when compared to applying a static magnetic field, but surface finish was decreased. He also suggested a new finishing method that involved applying a rotating magnetic field with six coils mounted on a circular yoke. A novel alternating magnetic field-based ultra-precision magnetic abrasive finishing procedure was described.from Yanhua Zou[4]. On the rate of metal removal and the finished surface finishing, they looked at the effects of finishing factors such the rotational speed of the magnetic pole and the frequency of the alternating current. They also looked at the impact of cutting fluid and demonstrated that plain cutting oil is more suited for this processing than silicone fluid and cutting fluid that is water soluble.

Kurobe, T., made a preliminary proposal for investigation into the MAF method' use of an electromagnet and DC. The finishing operation was carried out by inducing polishing pressure with the help of a magnetic field while DC power was supplied. Jain V. K. et al. conducted a second study to examine the impact of working gap and circumferential speed on MAF process performance. For complicated internal geometriesJha S. and Jain V.K.[5] used a magnetorheological polishing fluid (MR) containing silicon carbide abrasives and carbonyl iron powder with mineral oil to apply a new precision finishing procedure.

A rotating magnetic pole with a new method of magnetic field assisted finishing and application for interior capillary tubes were proposed by Yamaguchi H.[3]. This work provided an explanation of the connection between the magnetic field, the force acting on the abrasive, and the abrasive behaviour. Mori T[8] developed the mechanism of a planar magnetic abrasive polishing technique for stainless steel, a nonmagnetic material. They looked at how a magnetic flexible brush (MAFB) forms and how normal force causes the abrasives on the brush end to indent into the material surface ofthe work product. Wang and Hu suggested the MAF technique to create high-quality completed inner surfaces for tubes. This study came to the conclusion that when the magnetic pole's rotational speed rose, the Material Removal Rate (MRR) also increased. Lin C.T.[9] performed free-form surface abrasion of stainless steel using a permanent magnetic finishing machine set up in a CNC machining centre. To investigate the influencing parameters, including the working gap, feed rate, and MAPs, the operations were carried out utilising the Taguchi experimental design. According to the study, the working gap has the biggest influence on the calibre of the finishing. Kwak J.S.[6] suggested a method to increase the magnetic flux density in magnetic materials as evidence that MAF can be utilised for non-ferrous materials.polishing with abrasives of a magnesium specimen. Kurobe, T.[7] proposed early study on the use of the electromagnet with DC in the MAF process. A magnetic field was created and induced polishing pressure to carry out the finishing process when DC power was supplied. Jain V. K. conducted additional research to examine the impact of working gap and circumferential speed on MAF process performance. Jha S. and Jain V.K. used a new precision finishing method for intricate internal geometries utilising a magnetorheological polishing fluid (MR) that contained silicon carbide abrasives and carbonyl iron powder along with mineral oil.

ABOUT SYSTEM:

Using a specialised machining technique called electro magnetic abrasive finishing (EMAF), metallic workpieces can have high-quality surface finishes. EMAF removes material from the workpiece surface using abrasive particles and an electromagnetic field, producing a smoother and more uniform finish..

PROPOSED SYSTEM:

The suggested configuration is a stationary system that relies on the rotation of a magnetic field to move MAPs on the surface of the workpiece and regulate the finishing procedure. This configuration is tested to see if it can finish a component with a complex form in addition to a flat surface, such as the femoral components of knee prosthesis, the grooves of ring seals, and the surface and first edges of cutting tools. The finishing process can be carried out by this technology without the need of any mechanical moving parts. It relies on the application of a rotating magnetic field, which is produced by successively energising the electromagnets by regulating their duty cycle and on-time interval. Most earlier studies in the literature stimulate the electromagnets using apower source for direct current (DC). However, employing a DC power supply has two major drawbacks: coil heating, which could harm the electromagnet, and wear and tear on the cutting edges of the abrasive particles from repeated use of the same particles. Therefore, these issues can be resolved and the disadvantages can be avoided by employing the suggested technique for energising the electromagnets. The key characteristics of the suggested system are its size, mobility, cost-savings, control of the cutting force, and wide range of surface roughness.

SYSTEM DESIGN:

A workpiece holder, an abrasive suspension tank, and an electromagnetic field generator make up the EMAF machine. The holder, which is then immersed in the abrasive suspension, is filled with the workpiece. The workpiece's surface is traversed by the abrasive particles in a controlled manner as a result of the generator's powerful magnetic field, which removes material and provides the appropriate surface finish. Depending on the particular application, the abrasive particles employed in EMAF can either be free or bound to a carrier material. The intensity of the abrasion can be changed by varying the magnetic field, giving the surface finish gained precise control.

When producing high-quality surface finishes for products in the aerospace, automotive, and medical device industries, EMAF is used.are essential to the functionality and lifetime of a product. When finishing complicated or irregularly shaped objects, such turbine blades or medical implants, where conventional machining processes may be constrained, it is especially effective. The experimental configuration of the system is shown in the figure below.

a b

Fig 3: Four-coil configuration, (a) Coils hang under the workpiece and MAPs, (b) Coils are located above the workpiece

Fig 4: SMPS

HARDWARE DESIGN:

Stepper motors, a switched motor power supply, and a 3D printer are included.

Power supply

A switching regulator is included into a switched-mode power supply (SMPS), also known as a switched power supply, switch-mode power supply, switched power supply, or switcher, which is an electronic power supply.

An SMPS, like other power supplies, converts voltage and current characteristics while transferring power from a DC or AC source (often mains power; see AC adapter) to DC loads, like a personal computer. In contrast to a linear power supply, a switching-mode supply's pass transistor alternates between full-on and full-off states with low dissipation and spends comparatively less time in transitions with high dissipation, minimising lost energy. In an ideal switched-mode power supply, there is no power loss. Varying the ratio of on-to-off time, sometimes referred to as duty cycles, regulates voltage. InIn contrast, a linear power supply continuously dissipates power in the pass transistor to control the output voltage. An key benefit is the greater electrical efficiency of the switched-mode power supply.

Stepper motor

Fig 5: stepper motor

A brushless DC electric motor that divides a whole rotation into a number of equal steps is called a stepper motor. As long as the motor is appropriately scaled for the application in terms of torque and speed, the position of the motor can be instructed to move and hold at one of these steps without any position sensor for feedback (an open-loop controller). Large stepping motors with fewer poles, known as switched reluctance motors, are often closed-loop commutated.

When DC voltage is provided to the terminals of brushed DC motors, the motors continue to spin. The stepper motor is well known for its ability to transform an input pulse train (usually composed of square waves) into an accurately measured increment in the rotational position of the shaft. The shaft revolves with each pulse.via a predetermined angle. Stepper motors really consist of several "toothed" electromagnets arranged as a stator revolving around a central iron rotor.

3D Printer

Using computer-aided design (CAD) software, a 3D printer is a sort of additive manufacturing technology that builds three-dimensional items by layering material. After reading a digital 3D model, the printer produces the object by extruding or depositing material in layers until the desired shape is achieved.

Fused Deposition Modelling (FDM), Stereolithography (SLA), and Selective Laser Sintering (SLS) are just a few of the numerous varieties of 3D printers. Each kind of printer produces objects with various degrees of intricacy, detail, and sturdiness using various materials and techniques. There are many uses for 3D printing in a variety of fields, including product creation, architecture, engineering, medicine, and education. It permits quicker prototyping, personalization, and the development of intricategeometries and structures that are either impossible or extremely difficult to manufacture using conventional manufacturing techniques.

Even while 3D printing technology has advanced significantly in recent years, there are still several drawbacks, like the length of time it takes to print huge objects, the calibre of the final result, and the price of materials. However, it is anticipated that future advancements in the industry

Fig 6: 3D Printer

SOFTWARE DESIGN:

This entails developing the hardware necessary to hold the coils, the workpiece, and the motor. Tinkercad is utilised for that designing process, and an app is used to control the machine using g code..

Tinker CAD

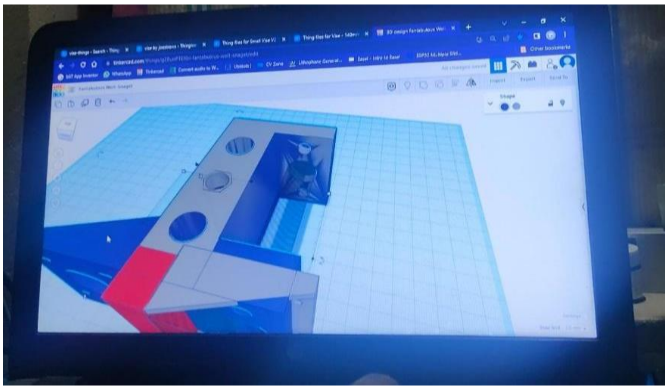

Fig 7: Designing the 3D model of hardware in tinkercad

Professionals and amateurs alike utilise the well-known web-based 3D design and modelling programme Tinkercad for a variety of tasks. Utilisations for Tinkercad include:

Tinkercad is frequently used in classrooms and other learning environments to instruct students in 3D modelling and design. It offers a straightforward interface for producing 3D models and is free to use.

Tinkercad is frequently used for rapid prototyping of designs when quick and straightforward 3D models are required to test and validate concepts. The amount of time and money needed for prototyping is decreased thanks to its user-friendly interface, which enables users to swiftly construct 3D models and refine them.

Tinkercad is a well-liked option for 3D printing because it is compatible with a variety of 3D printing providers and software.generating 3D models that can be printed. Users are able to export their designs in a variety of file types that are compatible with various 3D printers.

Product Development: Product designers can use Tinkercad to produce 3D models of goods and parts for a variety of industries, including the manufacturing of medical devices, aircraft, and automobiles. It is a popular option for product designers since it offers a simple interface for creating intricate 3D models.

UGS Platform

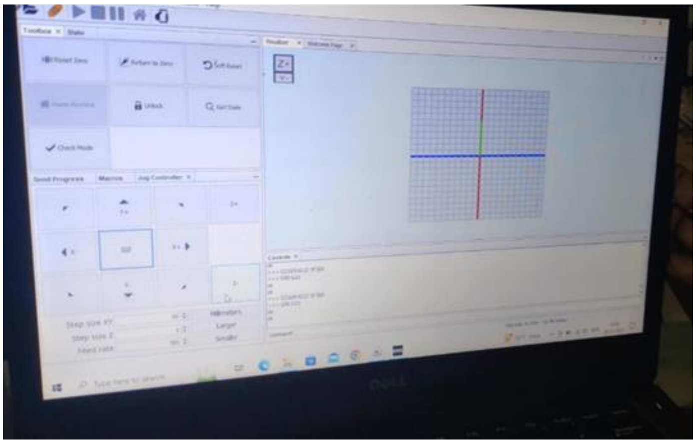

Fig 8: An app to control the Machine with g code

The newest version of Universal Gcode Sender is called UGS Platform. Because it is developed on top of the Net Beans Platform, we can take advantage of its sophisticated modular framework. This platform enables the addition of more functionality without sacrificing code quality or becoming constrained by a custom framework. As both interfaces draw on the Classic GUI as a library, essential features are advantageous to both.

Platform Advantages

New UGS features are currently aiming for this.

The UI can be organised dynamically using the out-of-the-box dynamic windowing technology.

Decoupling features are possible with the Plugin Framework.

massive array of modules to use Keybindings, code editors, and automatic updates

RESULT:

The best design parameters were used to build the electromagnets. The coil had a 1.5 cm length and a 1 cm and 0.5 cm outer and inner diameter, respectively. Figure 9 depicts the experimental setup employed for the current study. It was made for a planar finishing method that employed a rotating magnetic field. The abrasive finishing of a wood object is depicted in the figure below.

Due to its high mechanical qualities and biocompatibility, titanium and its alloys are frequently utilised in bone implants and various biomedical applications. A wood sample was used as the workpiece in this project. The Table provides an illustration of the experimental circumstances.

1.

Fig 9: Abrasive Finishing

Workpiece	Wood, Aluminium
Abrasive Particles	Al_2O_3
Iron Particles	Fe particles 0.3 [mm] in mean diameter.
Coil activation frequency	0.5 Hz
Applied voltage	30 V [current passing through the coils ≅1.5 A]
Air Gap	1 mm
Finishing time	30 min

Table 1: Experimental conditions

CONCLUSION:

The design and construction of an electromagnetic abrasive finishing machine necessitates careful consideration of a number of issues, including the choice of suitable materials, the electromagnetic coil system's design, the choice of abrasive particles, and the optimisation of operational parameters. Through thorough calibration and fine-tuning of the operating parameters, the machine's performance can be improved.

According to the EMAF machine's experimental findings, the workpiece's surface finish dramatically improved as processing time rose. The EMAF machine can produce a high-quality surface finish in a short amount of time, according to the study of the surface roughness and material removal rate. In summary, the EMAF machine is a very efficient technique for precisely finishing the surfaces of metallic and non-metallic materials.The machine offers a fast processing time, high material removal rate, and outstanding surface polish. The EMAF machine has the potential to develop into a vital tool for many sectors that demand high-quality surface finishing with additional study and development.

REFERENCES:

[1] Fundamentals of Machining Processes-Conventional and non- conventional processes-Hassan Abdel

[2] Modern Machining Process / Pandey P.C. and Shah H.S./ TMH.

[3] . New Technology/ Bhattacharya A/ the Institution of Engineers, India 1984.