

Design And Fabrication Of An Electromagnet For Abrasive Finishing Machine

Ronit Markad.¹, Sujit Pathare.², Pratik Pathare.³, Samsheer Sheikh.⁴

B. E Student, Department of Electrical Engineering, Dr. Vithalrao Vikhe Patil College of Engineering, A.nagar, India^{1,2,3}

Associate Professor, Department of Electrical Engineering, Dr.Vithalrao Vikhe Patil College of Engineering, A.nagar, India⁴

ABSTRACT

This abstract presents the design and construction of an electromagnet for an abrasive finishing machine, featuring a unique shape consisting of two conical and two hemispherical rods. The electromagnet is intended to enhance the performance and efficiency of the machine by providing a strong and focused magnetic field for attracting and holding abrasive particles during the finishing process.

The electromagnet is made using 30 mm diameter copper wire wound into 24-gauge coils. A total of 1000 winding rounds are employed to ensure a sufficient number of turns and achieve the desired magnetic strength. The use of copper wire ensures excellent electrical conductivity and low resistance, enabling the electromagnet to efficiently generate a strong magnetic field.

The conical and hemispherical rod shape of the electromagnet is carefully designed to optimize the distribution and concentration of the magnetic field. This shape allows for precise control and manipulation of the abrasive particles, resulting in improved finishing outcomes.

The construction process involves winding the copper wire around a central core, carefully shaping the wire into the desired conical and hemispherical rod forms, and securing the coils in place. The finished electromagnet is then integrated into the abrasive finishing machine, ready to provide enhanced magnetic attraction and holding capabilities.

Overall, this electromagnet design offers a novel approach to optimizing the performance of abrasive finishing machines, enabling improved control and efficiency in the finishing process.

Keywords: electromagnet, abrasive finishing machine, magnetic field, conical rods, hemispherical rods.

I. INTRODUCTION

Electromagnets are widely used in various industrial applications, including abrasive finishing machines, where they play a critical role in attracting and holding ferrous materials in place. This paper focuses on the design and fabrication of an electromagnet tailored for such machines. The electromagnet's design parameters, including size, shape, and winding configuration, are discussed in detail to optimize its performance

II. LITERATURE REVIEW

Magnetic abrasive finishing used for complicated product finishing & Roughness and tolerance band achieved that is difficult using conventional machine process. The product dimensional requirement easily possible with taking trial with MAF parameters. The magnetic abrasive finishing process combining the grinding, DE-burring and polishing process. The roughness and tolerance band of component achieved using control parameter Magnetic Abrasive Machining(MAM) for polishing of cylinder work piece was developed using available abrasives. The experimentation with these process parameters reduced the surface roughness value on a cylindrical component from an initial Ra value. Study shows that on various parameters improvement in surface finish is

maximum in case of brass as compared to other materials..[1]

This paper presents recent developments in the field of magnetic abrasive finishing and describes the results obtained by various research scholars based on their experimentation in the field of magnetic abrasive finishing. Magnetic abrasive finishing with direct current has been used successfully for surface finishing as well as surface modification of external and internal surface and has given very good results.[2]

In this review paper, the working principles, processing parameters, and current limitations for the MAF process are examined via reviewing important work in the literature. Additionally, future developments of the MAF process are discussed. The MAF process has been shown to successfully improve the surface accuracy and dimensional accuracy of various workpiece shapes, including cylindrical work-pieces, tube workpieces, plate workpieces, capillary tubes, and concave surface workpieces. The MAF process can be successfully used for the finishing of various materials, such as Mg alloys, Al alloys, STS 304, zirconia ceramics, SS 305, SS 316, and brass. The critical parameters, such as magnetic abrasive type and particles, magnetic flux density, workpiece material, finishing gap, grinding oil, rotational speed, and axial vibration, are found to be effective for the MAF process..[3]

This paper provides a comprehensive review on the recent advancement of MAM process carried out by different researcher till date. The effect of different input parameters such as rotational speed of electromagnet, voltage, magnetic flux density, abrasive particles size and working gap on the performances of Material Removal Rate (MRR) and surface roughness (Ra) have been discussed. It is found that during studying of two abrasive particles Sic and Al₂O₃ on MAM process, Sic gives better surface finish than Al₂O₃. Surface finish increases with the increments in abrasive particle size, voltage, rotational speed of electromagnet and magnetic flux density but due to the decrease in working gap, surface finish increases.[4]

The MAF is a novel technique for the finishing of cylindrical specimens such as rollers for use in ceramic hybrid bearings. The material removal rate is generally high (~1µm/min) and the finish quality is also excellent (Ra~5nm). magnetic abrasives. In present study we tried to made a complete setup of MAF process on lathe machine by fixing some of the parameters related to process. The process is highly efficient and the removal rate and finishing rate depends on the work piece circumferential speed, magnetic flux density, working clearance, work piece materials, and size, type and volume fraction of abrasives. The exciting current of the magnetic coil precisely controls the machining force transferred through magnetic abrasives on the work piece. The maximum percentage improvement in surface roughness for simply mixed magnetic abrasives and Silicon Carbide was approximately 18%. [5]

The magnetic abrasive flexible brush carries out the fine surface finishing operation by controlling working gap. Surface roughness was studied on 18mm Al alloy rod with Al₂O₃ and Fe₂O₃ particles. Surface roughness was improved by 29.9% to 71.21%. Also A value decreased and has range from (0.849-2.018 µm) based on the 9 experiments which have been carried out. The improvement of surface finish is almost 29.9%-71.21%. The analysis of the Taguchi method established that, in general mixture ratio significantly affect the finishing process while spindle speed has minimal influence. It is concluded from the results that time and mixture ratio (FeO:Al₂O₃) of work piece are the parameters which significantly influence the material removal, change in surface roughness value (ΔRa), and percent improvement in surface finish and circumferential speed or spindle speed (0.91%) is least significant.[6]

III. METHODOLOGY

1. Electromagnet Design:

1.1. Size Determination:

The electromagnet is designed to have a diameter of 30 mm. This size ensures sufficient magnetic field coverage while maintaining compactness for integration within the abrasive finishing machine.

1.2. Shape Selection:

To enhance the electromagnet's magnetic field distribution, two conical and two hemispherical rods are employed. The conical shape concentrates the magnetic flux towards the pointed end, while the hemispherical shape helps create a more uniform magnetic field in the region of interest.

2. Winding Configuration:

To achieve the desired magnetic field strength, the electromagnet is wound with 24-gauge copper wire in a total of 1000 winding rounds. The winding configuration involves evenly distributing the wire around the conical and hemispherical sections, ensuring consistent coverage and avoiding overlapping or gaps.

3. Fabrication Process:

The fabrication process involves several steps, including rod shaping, wire winding, insulation, and mounting. The conical and hemispherical rods are carefully shaped and smoothed to ensure uniformity. The copper wire is

then meticulously wound around the rods, following the predetermined winding configuration. Insulation material is applied to prevent short circuits and ensure electrical safety. Finally, the fabricated electromagnet is mounted securely within the abrasive finishing machine

IV. HARDWARE DESCRIPTION

Electromagnet:

An electromagnet is a type of magnet that is created by passing an electric current through a coil of wire. When the electric current flows through the wire, it generates a magnetic field around the coil. The strength of the magnetic field can be increased or decreased by adjusting the amount of current flowing through the wire. Electromagnets are widely used in various applications, such as electric motors, generators, speakers, MRI machines, and magnetic levitation systems. They offer the advantage of being able to control the strength of the magnetic field, unlike permanent magnets. Electromagnets play a crucial role in modern technology and have revolutionized many industries.

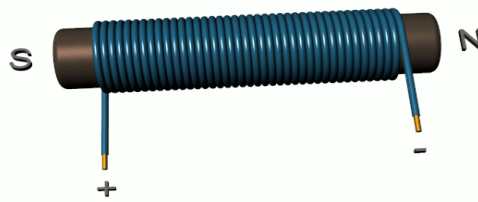


Fig. Electromagnet

Copper Coil:

A copper coil is a tightly wound spiral of copper wire used in various applications due to copper's excellent electrical conductivity. The coil is typically formed by winding the wire around a cylindrical or other suitable core. Copper coils are commonly used in electrical transformers, motors, generators, and inductors. The number of turns in the coil determines its inductance, which influences its magnetic field strength and impedance. The size and gauge of the copper wire used in the coil depend on the specific application requirements, with larger wire sizes offering lower resistance and higher current-carrying capacity. The quality of the copper wire and the precision of the winding process are crucial for achieving optimal electrical performance.



CopperCoil

V. CALCULATIONS:

Hemispherical Magnet:

Diameter= 30mm

Copper wire diameter= 24 gauge= 0.5106mm

Number of turns= 1000

Voltage	Magnetic Current	Flux Density
6 V	0.2 I	2.51326×10^{-4}
12 V	0.8 I	1.0053×10^{-3}
18 V	2 I	2.5132×10^{-3}
24 V	3 I	3.7698×10^{-3}

Conical Magnet:

Diameter= 30mm

Copper wire diameter= 24 gauge= 0.5106mm

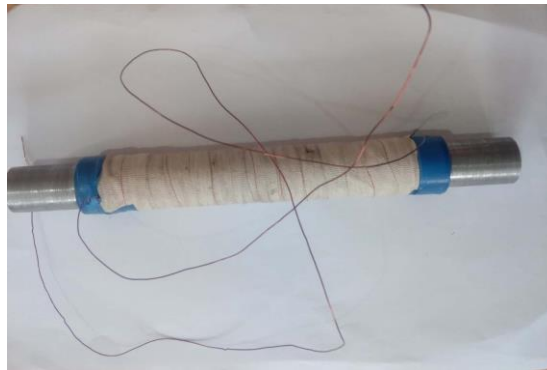
Number of turns= 1000

Voltage	Magnetic Current	Flux Density
6 V	0.4 I	5.0265×10^{-4}
12 V	0.8 I	1.25309×10^{-3}
18 V	1.6 I	2.01061×10^{-3}
24 V	2.8 I	3.5185836×10^{-3}

VI. EXPERIMENTAL SETUP:

Performance Evaluation:

The performance of the electromagnet is evaluated through experimental testing. The magnetic field strength is measured at various distances and compared with the expected theoretical values. The holding capacity of the electromagnet is also assessed by analyzing its ability to attract and securely hold ferrous materials during the abrasive finishing process.



Electromagnet

VII. ADVANTAGES

1.Enhanced magnetic field strength: The use of two conical and two hemispherical rods allows for a concentrated magnetic field within the desired area, ensuring efficient and effective abrasive finishing. This configuration helps in directing the magnetic field towards the working surface, maximizing the force applied to the abrasive particles.

2.Increased surface coverage: The shape of the electromagnet rods ensures a larger contact area with the workpiece, enabling broader coverage during the abrasive finishing process. This leads to improved efficiency and faster completion of the finishing task.

3.Targeted magnetic force: The conical and hemispherical shapes of the rods focus the magnetic force towards the workpiece, increasing the precision and accuracy of the abrasive finishing. This targeted force ensures that the abrasive particles adhere firmly to the workpiece, enhancing the finishing quality and reducing the chances of uneven surface results.

4.Durability and stability: The use of 24-gauge wire in the copper winding rounds provides a balance between strength and flexibility. This gauge allows for a robust construction of the electromagnet, ensuring durability and stability during operation. It can withstand the mechanical stress of the abrasive finishing process without deforming or breaking easily.

5. Efficient power consumption: With 1000 copper winding rounds, the electromagnet achieves a desirable level of magnetic force while minimizing power consumption. Copper is known for its excellent electrical conductivity, making it an ideal choice for the winding material.

VIII. CONCLUSION

This research paper presents a comprehensive design and fabrication process for an electromagnet optimized for an abrasive finishing machine. The use of two conical and two hemispherical rods, wound with 24-gauge copper wire in 1000 rounds, provides an effective magnetic field distribution and holding capacity. The experimental results confirm the electromagnet's ability to attract and securely hold ferrous materials, ensuring efficient and reliable abrasive finishing operations. The findings of this study contribute to the advancement of electromagnet design and its applications in various industrial processes.

The experimental results demonstrate that the designed electromagnet achieves the desired magnetic field strength and effectively attracts and holds ferrous materials. The measured magnetic field strengths closely align with the theoretical values, validating the design and fabrication process. The electromagnet's ability to securely hold materials ensures efficient and reliable operation of the abrasive finishing machine.

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