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Development of a Low-Cost Material Polishing Setup with Integrated Speed Control and Water Circulation System

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Abstract: This project presents the design and development of a cost-effective metal polishing setup built specifically for research applications and lab testing. The goal was to create a compact, user-friendly system that offers controlled polishing with added features like speed regulation and water-based cooling, both of which are often missing in traditional polishing machines. The setup uses a 350-watt, low-RPM motor capable of running up to 300 RPM, which drives a stainless-steel bevel gear pair with a 1:1 gear ratio. Power is transmitted through a 15 mm diameter, 1.25-foot-long mild steel shaft, which connects to a polishing wheel. To keep the system cool and prevent heat-related damage or discomfort during prolonged operation, a simple water circulation system has been integrated using a small submersible pump. This continuously delivers water to the polishing area and recycles it through a filtration unit. A speed controller is also incorporated, allowing users to adjust the motor RPM based on material type or finishing needs. The setup is mounted on a rigid mild steel frame, designed with vibration control in mind to ensure smooth operation.

Keywords: *Stainless Steel Grade 216 Circular Disc; Speed Control System; Emery Paper; Manufacturing; Cost Effective.*

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I. INTRODUCTION

Polishing is a process involved in material finishing widely used in industries like manufacturing, automotive, and metal fabrication for producing surfaces that are smooth and improves the quality of the product. Conventional polishing setups are often costly and may not possess the operational control flexibility which can make it less feasible for small-scale industries and workshops. This paper proposes to build a low-cost material polishing setup with integrated speed control and water circulation system.

The objective of this project is to design a low-cost high-performance polishing system where polishing speed can be user-defined according to the material used. The variable speed motor allows adjusting the speed according to the material being polished, and the water circulation system provides moisture for cooling and lubrication, preventing overheating and improving the service life of the polishing tools. This system represents an economical alternative to high-end commercial polishing machines by utilizing hardware that can be employed for a lower cost and is more applicable for local sourcing.

The proposed system aims to achieve consistent surface treatment, minimize material wastage, and enhance operator safety. Most advantageous for small workshops, research laboratories, and industries needing bespoke polishing solutions. This project validates through experiments that a cost-effective, energy-efficient, and machine agnostic polishing setup is able to achieve industrial standards and therefore, is able to open up access to a wider user base.

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II. WORKING PRINCIPLE

It works with abrasive polishing with a controlled speed process and continuous cooling. The rotating polishing disk is powered by a variable rate motor which allows the polishing rate of the disk to be finely tuned according to the surface finish required and the material being processed.

By the abrasive surface of the rotating disc, the workpiece is taking pressure on the surface, every roughness on the surface burns due to friction between the abrasive surface and the workpiece and achieve smooth surface. This speed control mechanism allows users to adjust the motor's RPM based on the material being polished, ensuring optimal results with minimal heat generated.

They had linked together a simple integrated water system through which a continuous stream of water was supplied to the polishing area which enhanced efficiency. This serves two key purposes:

- Cooling - Reduces the heat produced while polishing, which prevents damage to the material being polished and increases the life of the tool.
- Lubrication & Cleaning – Lowers friction, cleans away mess, and provides uniform polishing action.

By adjusting the movement speed and the circulation of the water jet, a uniform and high-quality surface finish can be achieved, with less material waste and a reduction in operator risk. The system above aims to be low cost by using materials found locally everywhere, b it proves to be a great alternative to traditional polishing systems for a relatively low cost.

III. KEY COMPONENT

➢ *Frame:*

The frame is the structural backbone, giving structure and support to everything that sits on top. The frame is specified as follows:

- **Material:** MS for strength, corrosion resistance, and lightweight construction.
- **Dimensions:** It will be about 508 mm × 450 mm × 350 mm (L × W × H)

➢ *DC Motor:*

A DC motor is delivering the required rotary motion to the polishing disc. DC motor specifications:

- **Power (W):** 350W
- **Velocity Range:** 100-500 RPM (Directly adjustable from built-in speed switch).

➢ *Bevel Gear:*

We use a set of Bevel gear, which is used for transmitting the power between intersecting motor and shaft at an angle of 90 degree. Its specification is:

- **Material:** Alloy Steel
- **Gear type:** Straight Bevel Gear
- **Teeth count:** 19 teeth
- **Pressure angle:** 20 Degree

➢ *Bearing:*

The UCP-205 bearing is an integral part of a Polishing machine. It offers all-round support for spinning shafts, enables smooth rotation, handles loads, simplifies mounting, reduces vibrations, and contributes to the machine's overall durability and longevity.

➢ *Rotating Disc:*

We take Stainless Steel Grade216 As a material of rotating disc.

➢ *AC to DC Converter:*

It is used to convert AC current into DC current

➢ *3D CAD Model:*

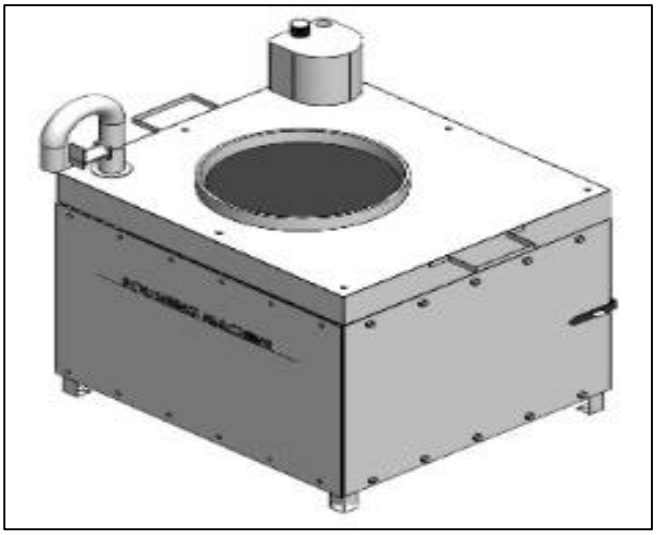

Fig 1 Top View

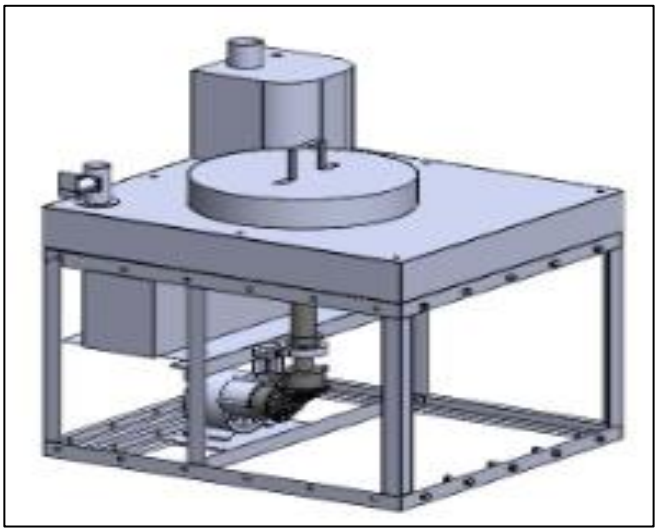

Fig 2 Inner View

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➢ *Project / Setup Photo:*

Fig 3 Front View

Fig 4 Side View

IV. RESULT

After building the polishing setup, we tested its performance using mild steel samples. The goal was to see how well it could improve surface finish, manage heat, and maintain stable operation during polishing.

Before polishing, the surface roughness of the metal was around 2.5 micrometres (Ra). After using the machine with a cloth polishing wheel and aluminium oxide compound, the roughness dropped to about 0.5 micrometres (Ra). That's a noticeable improvement, showing that the setup is effective for fine surface finishing.

The water circulation system worked just as expected. Even after running the machine for a longer time, the surface temperature stayed under 40°C, which helped prevent overheating and made the whole process more comfortable and safer.

The speed control feature was easy to use and allowed us to fine-tune the RPM according to different polishing needs. We didn't face any issues with gear slipping or wobbling—the bevel gear mechanism ran smoothly throughout, and the system stayed stable with very minimal vibrations.

In short, the polishing setup performed well. It delivered a clean surface finish, stayed cool, and ran without shaking or noise. It's simple to use, cost-effective, and ideal for students, researchers, or anyone needing a controlled polishing system for lab experiments or small-scale surface finishing work.

V. CONCLUSION

The developed low-cost material polishing setup with the presentable integrated speed controlled and water circulation system has significantly exhibited a cost-effective, efficient as well as easy-to-use approach for surface finish. This provides exact polishing speed control and generates flexibility for specific materials and surfaces. SMC developed a water circulation system accompanied by a fabric container that can finish multiple components at once.

However, this project demonstrates how a simple solution for polishing at lower costs can be created and implemented utilizing locally sourced components and general engineering principles. This setup is a cost-effective solution to to commercial polishing machines, making it available to small scale industries, workshops and technical institutions. Additional advancements which can be investigated plan on modernization and strengthening heat dissipation to refine process and broaden its use in various industrial sectors.

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