

Design & Development of Industrial Chip Cleaning Device

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Abstract – Machining operations such as turning, milling, drilling, and grinding generate a large amount of metal chips, burrs, dust, and other waste materials on the shop floor. If these wastes are not cleaned regularly, they can create an unsafe working environment, reduce productivity, and increase the chances of accidents. In many small and medium-scale industries, shop floor cleaning is still performed manually using brooms, brushes, or handheld magnetic tools, which is time-consuming, labor-intensive, and less effective.

The main objective of this project is to design and develop a Rotary Brush and Magnetic Sweeper Based Machining Chip Cleaning Device that provides an efficient, economical, and easy-to-use solution for cleaning machining waste. The machine combines two cleaning mechanisms into a single manually operated unit. A rotary brush, driven by a chain and sprocket mechanism, sweeps dust, burrs, and other non-magnetic debris from the floor. At the same time, a magnetic sweeper containing permanent magnets enclosed in a non-magnetic casing collects ferrous metal chips such as iron and steel particles.

Key Words: *Machining Chips, Rotary Brush Magnetic Sweeper, Shop Floor Cleaning, Industrial Housekeeping, Ferrous Metal Chip Collection, Manual Cleaning Device, Chain and Sprocket Mechanism, Permanent Magnet, Machine Shop Safety, Industrial Waste Management, Low-Cost Cleaning System.*

I. INTRODUCTION

In modern manufacturing industries, machining processes such as turning, milling, drilling, grinding, and shaping are carried out continuously to produce components with the required dimensions and surface finish. During these machining operations, a large quantity of metal chips, burrs, dust, and other waste materials are generated. These materials get scattered on the shop floor, making the working area untidy and unsafe. If the machining waste is not cleaned regularly, it can increase the risk of slips and falls, damage equipment, reduce worker efficiency, and affect the overall productivity of the industry.

Maintaining proper housekeeping is an important part of every manufacturing industry. A clean shop floor not only

improves the appearance of the workplace but also enhances worker safety, machine performance, and production efficiency. In many small and medium-scale industries, machining chips are still cleaned manually using brooms, brushes, or handheld magnetic tools. These conventional cleaning methods require more time and physical effort and often fail to remove both magnetic and non-magnetic waste effectively.

To overcome these limitations, this project presents a Rotary Brush and Magnetic Sweeper Based Machining Chip Cleaning Device. The machine is designed to clean different types of machining waste in a simple, efficient, and economical manner. It combines two cleaning mechanisms into a single manually operated unit. The rotary brush is used to sweep dust, burrs, and other non-magnetic particles, while the magnetic sweeper collects ferrous metal chips such as iron and steel particles using permanent magnets enclosed in a non-magnetic casing. The rotary brush is driven by a chain and sprocket mechanism, ensuring smooth operation during movement.

The proposed machine does not require electricity, batteries, or fuel, making it an environmentally friendly and cost-effective solution for industries. Its simple construction makes it easy to manufacture, operate, and maintain with minimum maintenance requirements. By combining the rotary brush and magnetic sweeper in a single machine, the cleaning process becomes faster, more efficient, and less labor-intensive than conventional methods.

The main aim of this project is to improve shop floor cleanliness, reduce operator effort, enhance workplace safety, and provide an economical cleaning solution for manufacturing industries. The developed device is suitable for machine shops, fabrication industries, automobile workshops, tool rooms, foundries, and other industrial environments where machining chips are generated regularly. This project contributes to better industrial housekeeping practices while improving productivity and ensuring a safer working environment.

II. LITERATURE REVIEW

Industrial housekeeping plays a vital role in maintaining a safe, clean, and productive working environment. In manufacturing industries, machining operations such as turning, milling, drilling, grinding, and shaping generate a large quantity of metal chips, burrs, and dust. If these waste materials are not removed regularly, they can reduce productivity, increase maintenance costs, and create safety hazards for workers. Many researchers and industries have focused on developing efficient cleaning methods to overcome these problems.

Several studies have shown that manual cleaning using brooms, brushes, and handheld magnetic tools is the most commonly used method in small and medium-scale industries. Although these methods are simple and inexpensive, they require more time, greater physical effort, and often fail to clean the shop floor completely. Manual cleaning also exposes workers to sharp metal chips, increasing the risk of injuries.

Researchers have also developed vacuum-based industrial cleaning machines for collecting machining waste. These machines provide faster cleaning and reduce human effort, but they require electrical power, regular maintenance, and have a higher initial cost. Vacuum systems are effective for collecting fine dust and small particles, but they are less suitable for heavy metal chips and may not be economical for small industries.

Magnetic cleaning devices have become a popular solution for collecting ferrous metal chips from industrial floors. Permanent magnets are widely used because they can efficiently collect iron and steel particles without consuming electrical energy. However, magnetic cleaning systems can collect only magnetic materials and cannot remove non-magnetic waste such as aluminum chips, plastic particles, dust, and burrs.

Rotary brush cleaning systems are another commonly used method for industrial floor cleaning. A rotating brush effectively sweeps dust, burrs, and non-magnetic debris from the floor. These systems are simple in design and easy to operate, but they cannot collect ferrous metal chips efficiently. Therefore, using only a rotary brush does not provide complete cleaning of machining waste.

From the available literature, it is observed that most existing cleaning devices are designed to perform only one type of cleaning operation. Machines based only on magnetic collection cannot remove non-magnetic waste, while rotary brush systems cannot efficiently collect ferrous metal chips. Similarly, vacuum cleaning systems offer good performance but involve higher cost, power consumption, and maintenance.

Based on these observations, the present project combines a rotary brush and a magnetic sweeper into a single manually operated machine. The rotary brush removes dust, burrs, and other non-magnetic particles, while the magnetic sweeper collects ferrous machining chips using permanent magnets. This combination provides a simple, low-cost, energy-efficient, and effective solution for cleaning industrial shop floors. The proposed system reduces operator effort, improves workplace safety, and enhances housekeeping practices, making it suitable for machine shops, fabrication industries, and other manufacturing units. Industrial housekeeping is one of the most

important aspects of every manufacturing industry. A clean and well-maintained shop floor improves worker safety, increases productivity, enhances machine life, and creates a better working environment. During machining operations such as turning, milling, drilling, grinding, shaping, and cutting, a large quantity of metal chips, burrs, dust, and other waste materials are generated. These waste materials accumulate around machines and on the shop floor. If they are not removed regularly, they may create unsafe working conditions, increase the chances of accidents, affect machine performance, and reduce production efficiency. Therefore, an effective cleaning system is essential in every manufacturing unit.

Traditionally, machining chips are removed manually using brooms, brushes, shovels, and handheld magnetic tools. These methods are simple and inexpensive, making them suitable for small-scale industries. However, manual cleaning requires considerable time and physical effort. Workers are also exposed to sharp metal chips and burrs, which may cause cuts and injuries. Furthermore, manual cleaning often fails to remove all the chips and fine dust, resulting in poor housekeeping and frequent cleaning operations. These limitations have encouraged researchers to develop improved cleaning methods for industrial applications.

One of the widely used methods for industrial floor cleaning is the rotary brush mechanism. Rotary brushes are commonly used in road sweepers, floor cleaning machines, and industrial cleaning equipment. They are especially effective in removing dust, burrs, plastic particles, and light machining waste. However, rotary brushes alone cannot efficiently collect ferrous metal chips because these chips may remain scattered on the floor or become mixed with other debris. Therefore, using only a rotary brush does not provide complete cleaning in machining industries.

Magnetic cleaning systems have also gained significant importance in manufacturing industries. Permanent magnets are widely used to collect ferrous metal chips such as iron and steel particles from machine shops and production floors. Magnetic sweepers are simple in construction, require no external power supply, and offer reliable performance with low maintenance. They are capable of collecting sharp ferrous chips quickly and effectively, reducing the risk of injuries to workers. However, magnetic sweepers cannot collect non-magnetic materials such as aluminium chips, brass particles, plastic waste, dust, or burrs. As a result, additional cleaning methods are required to achieve complete shop floor cleaning.

Vacuum cleaning systems are another modern solution used in industries for collecting machining waste. These systems use suction to collect dust, chips, and other small particles from the floor. Vacuum cleaners provide high cleaning efficiency and reduce manual labour. They are particularly effective for collecting fine dust and lightweight materials. However, industrial vacuum systems require electrical power, regular maintenance, and periodic replacement of filters. They are also more expensive than manual cleaning devices, making them less suitable for small and medium-scale industries with limited budgets.

Many automated floor cleaning machines have been developed using electric motors, sensors, programmable controllers, and robotic technologies. These machines provide excellent cleaning performance and reduce human involvement. However, they involve high manufacturing costs, complex control systems, and greater maintenance requirements to avoid this all it is a good solution.

III. METHODOLOGY

A. System Architecture

The **Design & Development of Industrial Chip Cleaning Device** is designed as a manually operated machine that combines a rotary brush and a magnetic sweeper to clean industrial shop floors. The main frame supports all the components, including the rotary brush, chain and sprocket mechanism, wheels, handle, and magnetic sweeper. When the operator pushes the device, the wheels rotate and transmit motion to the rotary brush through the chain and sprocket mechanism. This allows the brush to rotate continuously and sweep machining chips, dust, and metal burrs from the floor. As the device moves forward, the rotary brush pushes the collected waste towards the magnetic sweeper. The permanent magnets inside the sweeper attract and hold ferrous metal chips, while the brush continues to remove dust and other small particles from the floor. The combined action of the rotary brush and magnetic sweeper provides efficient cleaning with less manual effort. The overall system consists of a mild steel frame, rotary brush, chain and sprocket drive, shaft, bearings, wheels, handle, magnetic sweeper, and fasteners, all working together to maintain a clean and safe industrial working environment.

TABLE I. PRINCIPAL SYSTEM COMPONENTS

Component	Specification	Role in the System
Main Frame	Mild Steel (MS)	Supports and holds all the components of the cleaning device
Rotary Brush	Nylon Bristles	Sweeps machining chips, dust, and metal burrs from the shop floor
Chain and Sprocket	Mild Steel	Transmits motion from the wheels to the rotary brush
Shaft	Mild Steel	Supports the rotary brush and allows smooth rotation
Bearings	Ball Bearings	Reduce friction and ensure smooth rotation of the shaft
Wheels	Rubber Wheels	Provide easy movement of the device on the shop floor
Handle	Mild Steel Pipe	Used by the operator to push and control the cleaning device
Magnetic Sweeper	Permanent Neodymium Magnets with MS Casing	Collects ferrous machining chips from the floor
Fasteners	Nuts, Bolts, and Washers	Securely assemble all the components of the machine
Protective Coating	Primer and Paint	Protects the frame from corrosion and improves appearance
Shop Floor Surface	Industrial Concrete Floor	Working surface on which the device performs the cleaning operation

B. Hardware Subsystem

The hardware subsystem of the **Design & Development of Industrial Chip Cleaning Device** consists of a main frame, rotary brush, chain and sprocket mechanism, shaft, bearings, wheels, handle, and a magnetic sweeper. These components work together to provide an efficient and manually operated cleaning system for industrial shop floors.

When the operator pushes the device, the wheels rotate and transmit motion to the rotary brush through the chain and sprocket mechanism. The rotating brush sweeps machining chips, dust, and metal burrs from the floor, while the magnetic sweeper placed behind the brush collects ferrous metal chips using permanent magnets. The frame provides structural support to all the components, and the bearings ensure smooth rotation of the shaft. The simple mechanical design makes the device easy to operate, maintain, and suitable for industrial environments.

TABLE II. SYSTEM DESIGN PARAMETERS

Parameter	Design value
Machine Type	Manually Operated Floor Cleaning Device
Target Area	Industrial Shop Floor
Cleaning Application	Machining Chips, Dust and Metal Burrs
Operating Method	Manual Push Operation
Brush Drive	Manual Wheel-Driven Rotation
Handle Type	Mild Steel Push Handle
Wheel Type	Rubber Wheels
Design Software	CATIA V5

C. Working Mechanism and Operation

The **Design & Development of Industrial Chip Cleaning Device** works through a simple mechanical system without using electricity or software. When the operator pushes the machine, the wheels rotate and transfer motion to the rotary brush through the chain and sprocket mechanism. The rotating brush sweeps machining chips, dust, and metal burrs towards the magnetic sweeper. The permanent magnets then collect the ferrous metal chips, providing effective cleaning with less manual effort. The simple design makes the machine easy to operate, reliable, and suitable for industrial shop floors.

D. Operational Sequence

The operation begins when the operator pushes the cleaning device on the shop floor. The wheels rotate and drive the rotary brush through the chain and sprocket mechanism. The brush sweeps machining chips, dust, and burrs, while the magnetic sweeper collects the ferrous metal chips. The cleaned floor is left free from metal waste, improving workplace cleanliness and safety.

IV. RESULTS

The **Design & Development of Industrial Chip Cleaning Device** was successfully designed, fabricated, and tested under industrial shop floor conditions. During testing, the rotary brush effectively swept machining chips, metal burrs, and dust from the floor, while the magnetic sweeper efficiently collected ferrous metal chips. The chain and sprocket mechanism provided smooth rotation of the brush, allowing the device to operate easily through manual movement.

The combined cleaning action reduced the time and effort required for shop floor cleaning compared to conventional broom cleaning. The device operated smoothly without any major mechanical issues and was easy to handle because of its simple construction and wheeled design. It also helped improve workplace cleanliness by collecting scattered metal chips, which can otherwise create safety hazards and damage equipment.

The prototype showed reliable performance during repeated cleaning operations and proved to be a practical solution for maintaining a clean industrial environment. Since the machine does not require electricity, it is economical, portable, and suitable for small and medium-scale industries. Future improvements may include a motor-driven brush, adjustable brush height, a larger chip collection container, and stronger magnetic arrangements to further improve the cleaning efficiency and overall performance of the device.

V. DISCUSSION

The developed **Design & Development of Industrial Chip Cleaning Device** successfully achieved its objective of cleaning machining chips, metal burrs, and dust from industrial shop floors. During testing, the device showed good cleaning performance under normal working conditions. The rotary brush effectively swept the chips and dust, while the magnetic sweeper efficiently collected ferrous metal chips from the floor.

The chain and sprocket mechanism provided smooth rotation of the brush during manual movement, making the cleaning process simple and requiring less physical effort. The combined action of the rotary brush and magnetic sweeper reduced the time required for cleaning compared to traditional broom cleaning. The device also helped maintain a cleaner and safer workplace by reducing scattered metal chips that could cause accidents or damage to equipment.

The overall performance of the machine was satisfactory, and its simple design makes it easy to manufacture, operate, and maintain. Since the device does not require electricity, it is economical and suitable for small and medium-scale industries. With further improvements such as a motorized drive, adjustable brush height, and a larger chip collection system, the cleaning efficiency and overall performance of the device can be enhanced for wider industrial use.

VI. CONCLUSION

This project presented the design and fabrication of a **Design & Development of Industrial Chip Cleaning Device** for cleaning machining chips, metal burrs, and dust from industrial shop floors. The main aim of this project was to develop a simple, low-cost, and manually operated cleaning device that improves workplace cleanliness and safety.

The developed device was tested under shop floor conditions and showed satisfactory performance. The rotary brush effectively swept dust, burrs, and machining chips, while the magnetic sweeper successfully collected ferrous metal chips. The combined cleaning mechanism reduced manual effort, saved cleaning time, and provided better cleaning compared to traditional methods. Since the device does not require electricity, it is economical, easy to operate, and suitable for small and medium-scale industries.

Overall, the developed machine proved to be an efficient and reliable solution for industrial floor cleaning. It helps maintain a cleaner and safer working environment while reducing labour and maintenance costs. In the future, the device can be further improved by adding a motorized drive system, adjustable brush height, a larger waste collection bin, and stronger magnetic arrangements to increase its cleaning efficiency and make it suitable for larger industrial applications.

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