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Atmospheric Dust Collector Using Renewable Energy through Air Purifier

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A B S T R A C T

This research aims to address air pollution, particularly the presence of polyurethane (PU) dust in industrial environments, which poses health risks to workers. We have developed a dust collection machine specifically designed to capture PU dust generated during the grinding process of polyurethane applicator rollers. The machine utilizes a cyclonic air filtration method to efficiently collect dust particles near the lathe machine. Our objective is to enhance the working environment for machinists by reducing air pollution and maintaining a clean workspace. The design of the dust collection system employs the lapple method to ensure aesthetic integration with the machine. Theoretical calculations suggest an efficiency of 70%, while practical testing has demonstrated an efficiency of 90%. This research emphasizes the importance of mitigating air pollution in industrial settings for the health and well-being of workers and underscores the effectiveness of specialized dust collection systems in achieving this goal.

Keywords: air pollution, polyurethane dust, dust collection machine, cyclonic filtration, machinist environment, efficiency validation

1. INTRODUCTION

The escalating levels of air pollution, driven primarily by industrial activities, have become a pressing concern globally. Among the myriad pollutants, polyurethane (PU) dust poses a significant health hazard in industrial environments, particularly in settings where grinding operations are common. PU dust particles generated during the grinding process of polyurethane applicator rollers not only compromise the quality of air but also endanger the health of workers. In response to this challenge, the development of efficient dust collection systems tailored to specific industrial processes is imperative.

This research endeavors to tackle the issue of PU dust pollution by introducing a specialized dust collection machine designed to capture dust particles emitted during grinding operations. The machine employs a cyclonic air filtration process to effectively trap PU dust near the source, thereby minimizing its dispersion into the surrounding environment. By focusing on the development of a practical solution, this research aims to enhance the working environment for machinists and mitigate health risks associated with prolonged exposure to PU dust.

Moreover, the design of the dust collection system incorporates the lapple method, ensuring seamless integration with existing machinery while maintaining aesthetic appeal. Through theoretical analysis and practical validation, the efficiency of the dust collection machine is assessed, providing insights into its effectiveness in reducing PU dust pollution. This introduction sets the stage for understanding the significance of addressing air pollution in industrial settings and highlights the potential of specialized dust collection systems in achieving this objective.

2. OBJECTIVES

- Develop a specialized dust collection machine to capture polyurethane (PU) dust generated during grinding operations.
- Implement a cyclonic air filtration process to efficiently trap PU dust near the source, minimizing dispersion into the environment.
- Enhance the working environment for machinists by reducing air pollution and health risks associated with PU dust exposure.
- Utilize the lapple method to design the dust collection system for seamless integration with existing machinery while maintaining aesthetic appeal.
- Assess the efficiency of the dust collection machine through theoretical analysis and practical validation.
- Provide insights into the effectiveness of specialized dust collection systems in mitigating PU dust pollution in industrial settings.

3. METHODOLOGY

- Develop the dust collection machine tailored to capture polyurethane (PU) dust.
- Implement cyclonic air filtration to trap PU dust efficiently.
- Integrate the dust collection system with existing machinery using the lapple method.
- Conduct theoretical analysis to evaluate the efficiency of the dust collection machine.
- Perform practical validation to assess the effectiveness of PU dust capture.
- Analyze data to provide insights into the performance and effectiveness of the system.

4. CONSTRUCTION AND WORKING PRINCIPLE

4.1 WORKING PRINCIPLE

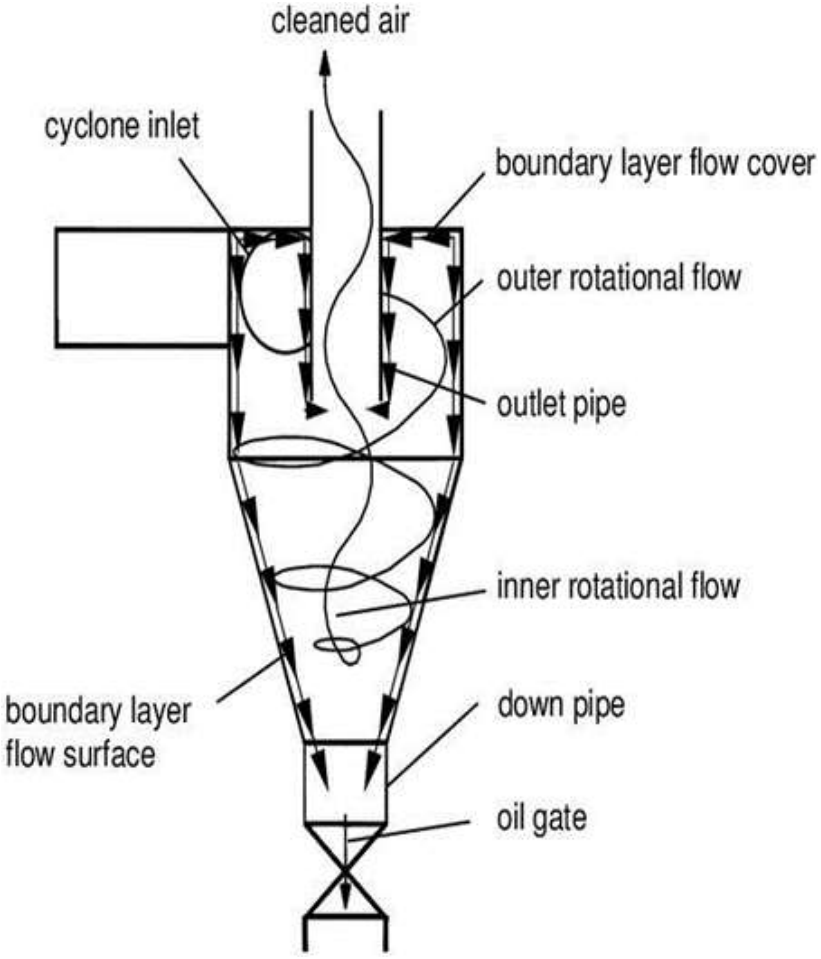

Fig 1 :cyclone separator

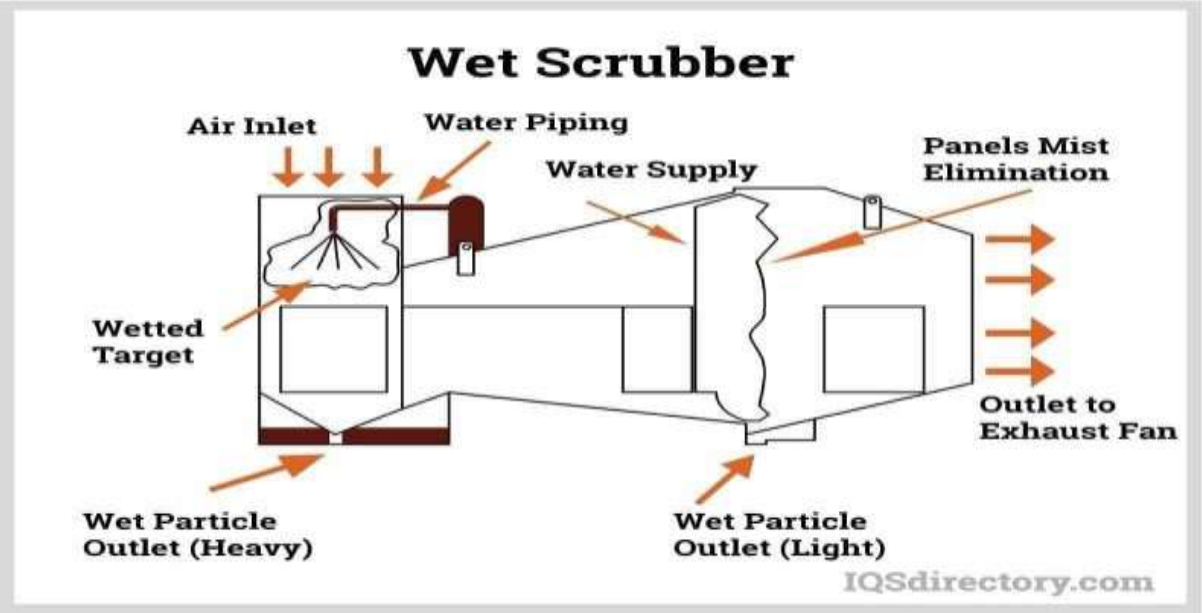

Fig 2: wet scrubber

To comply with environmental and worker safety regulations, factories, plants, warehouses, and other industrial or commercial settings utilize industrial dust collectors as a sort of air pollution control equipment. During production and manufacturing, efficient dust collection systems regulate, diminish, and eliminate potentially hazardous particulate matter and fumes from gases from a manufacturing process or the air and the surrounding environment. In order to preserve and enhance air quality, the apparatus is especially made to filter and purify dangerous dust and fine particulate matter that is emitted into the atmosphere or work area.

5. DESIGN PARAMETERS

Hose Pipe Inlet Diameter (Di) = 100mm

Outlet Diameter (Do) = 75, mm

Cylindrical Shell Length (Lb) = 300 mm

Diameter (D) = 500, mm

Frustum of a Cone Small Diameter (ds) = 150 mm

Larger Diameter (dl) = 500 mm

Length (Lc) = 400 mm

Vortex Length (S) = 300 mm

Diameter (Ds) = 250 mm

Guide Ways Turns (n) = 1

Peripheral Length = 3150 mm

Motor Power = 0.5 HP

Speed (N) = 2880RPM

6. PARTS DESCRIPTION

6.1 DUCTS

Ducts are conduits or channels used in heating, ventilation, and air conditioning (HVAC) systems to distribute air throughout buildings. They play a crucial role in maintaining indoor air quality and thermal comfort by transporting conditioned air to various spaces. Ducts come in various shapes and sizes, including round, rectangular, and oval, and can be made from materials such as sheet metal, fiberglass, or flexible plastic. Proper design, installation,

and maintenance of ductwork are essential for efficient HVAC system operation, ensuring optimal airflow, temperature control, and energy efficiency within residential, commercial, and industrial buildings.

6.2 BLOWER

A blower is a mechanical device used to generate airflow or increase air pressure within a system. Commonly employed in HVAC systems, industrial processes, and pneumatic conveyance systems, blowers play a crucial role in circulating air, cooling equipment, and moving materials. They typically consist of an impeller or rotor that rotates within a housing, drawing in air and expelling it at a higher velocity or pressure. Blowers come in various configurations, including centrifugal and axial designs, each suited to specific applications based on airflow requirements, pressure demands, and space constraints. Efficient operation and maintenance of blowers are essential for optimal performance and energy efficiency in diverse industries.

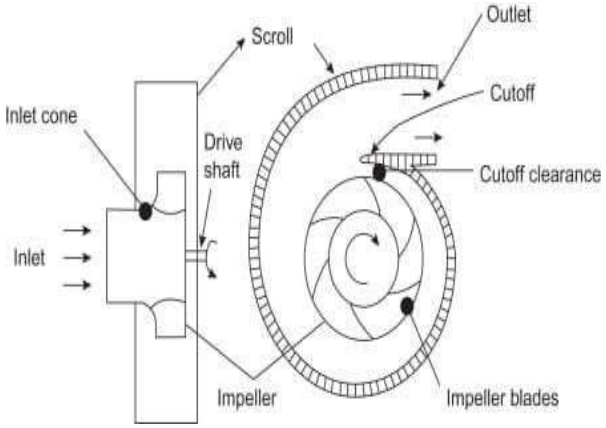

Fig 3: centrifugal fan blower

6.3 FLAT BELT

The motor and fan wheel shafts are equipped with a set of sheaves, and a belt transfers the mechanical energy from the motor to the fan.

The ratio of the motor sheave's diameter to the fan wheel sheave's diameter determines the fan wheel speed. Unless the belt(s) slide, fan wheel speeds in fans that are operated by belts are fixed. The fan wheel speed can be lowered by several hundred revolutions per minute (RPM) due to belt slippage. Additionally, belts require one more piece of maintenance.

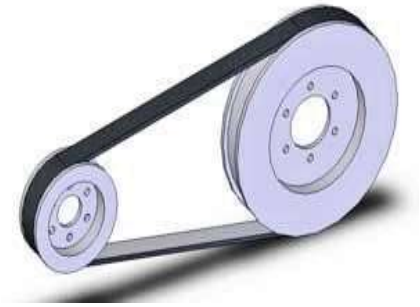

Fig 4: flat belt

6.4 BEARING

A fan's bearings are a crucial component. Ball bearings are employed in larger residential and commercial applications, while sleeve-ring bearings are used in smaller fans, such computer fans. Specialized bearings, like water-cooled sleeve bearings, may be used in industrial applications to vent hot gasses.

Either an air bearing or a magnetic bearing are used in many turbo blowers.

Low transmitted vibration, high-speed levitation, low power consumption, excellent dependability, oil-free operation, and resistance to airstream particle pollutants are all features of magnetic bearing blowers.

7. BENEFITS

- **Visibility:** Reducing dust clouds can increase operators' and employees' ability to see the work area.

- **Function:** When the machine collects harmful materials, all other devices will function more smoothly, and you prevent damage to integral parts.
- **Operator safety:** Workers' health can improve with the addition of dust collectors that minimize hazardous particles in the air.
- **Workplace optimization:** Consistent removal of dust from the air can prevent the contamination of other machines and optimize workplace functions.
- **Cleanliness:** A clean work environment will contain filtered air that is healthy and safe for all employees and machines.

8. THE SALIENT FEATURES OF THE CYCLONE ARE AS UNDER

- The shape is designed in such a way that most of the moving parts are inside the chamber.
- The dust particles are settled down at the bottom of the tank by the cyclonic process.
- The terminal velocity plays an important role in dust collection

9. APPLICATION OF CONCEPT

- ✓ Application of the cyclone is as under and
- ✓ It is used in Sawmill.
- ✓ It can be applicable to Oil refineries.
- ✓ Used in Cement industry.
- ✓ Used in Feed and grain processing.
- ✓ Mineral processing.
- ✓ Paper and textile industry are using the Cyclone type of dust collector.
- ✓ Wood working industry may be applicable for such Type of dust collector.
- ✓ Vacuum cleaners and central vacuum cleaners uses the cyclone type dust collector.

10. CONCLUSION

Dust collection system functions best within an overall air quality control strategy that may include many other components. Since dust collection systems themselves consist of multiple parts that can vary widely, they tend to be more prone to customization and upgrading than other industrial apparatuses. Therefore, when considering dust collection systems, it is important to check & consider the below point :

1) What type of dust will remove by this system ? The type of dust collector and filtration media required largely depends on the type of substance being removed. Example, synthetic cellulose filters work best for removing dry dust. "Spun-bond" filters, however, work best if moist or sticky dust is being removed.

2) How much dust can this system remove, and how fast can it remove it? An effective dust collector needs to move sizable amounts of air at reasonably fast rates. Air velocity is usually measured in feet per minute (fpm) while air volume is usually measured in cubic feet per minute

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