VACUUM-BASED NOVEL CHALKBOARD DUSTER

Submitted in partial fulfilment of the requirements for the completion of

INTERDISCIPLINARY PROJECT

By

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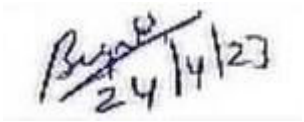
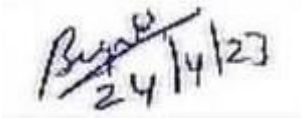
BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **KAVVAMPALLY RAHUL** (Reg. No. 40860002) AND **B. KESHAVA KALYAN** (Reg. No. 40150713) who carried out the Interdisciplinary Project entitled **"VACUUM BASED NOVEL CHALKBOARD DUSTER"** under our supervision from February 2023 to April 2023.



Internal Guide
Dr. V. K. Bupesh Raja, M.E., Ph.D.



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DECLARATION

I KAVVAMPALLY RAHUL (Reg. No. 40860002) hereby declare that the Project Report entitled **"VACUUM BASED NOVEL CHALKBOARD DUSTER"** done by me under the guidance of **Dr. V. K. Bupesh Raja, M.E., Ph.D.** is submitted in partial fulfilment of the requirements for the completion of Interdisciplinary Project.

DATE: 28.04.2023 **SIGNATURE OF THE CANDIDATE**

PLACE: CHENNAI

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TABLE OF CONTENTS

ABSTRACT

This project reveals the design fundamentals and the cleaning procedure of the chalkboard duster. The goal of the project is to clean the fibre of the blackboard duster efficiently and without releasing the chalk powder in the air. The chalk is composed of various chemicals like mineral calcite, which is a form of calcium carbonate and contains small amounts of other minerals and impurities, such as clay and silt. Inhaling chalk powder can potentially irritate the respiratory system, particularly if the person inhales a large amount of it over a prolonged period. The integral part used for scrapping out the dust is the vacuum pump which receives the power from a rechargeable battery. This product is operated by a push button and a static brush is mounted to disturb the particles on the duster. The Chalkboard duster is manually moved over the vacuum surface where the suction of dust takes place and stored in a separate compartment for the recycling process.

LIST OF FIGURES

LIST OF TABLES

LIST OF SYMBOLS AND KEYWORDS

AC	Alternating Current
DC	Direct current
RPM	Revolutions per minute
V_B	Battery Voltage
A	Amperes
Pa	Pascal

Keywords

1. Blackboard duster
2. Chalk powder
3. Vacuum
4. DC motor
5. Filters
6. Purification
7. Environment

Chapter 1
INTRODUCTION

When using chalkboards, it's common to see teachers and students "clean" the chalk duster by beating it against a wall or floor. This method is often used as a quick and easy way to remove excess chalk dust and debris from the duster. However, this practice is ineffective and can cause more problems than it solves. Firstly, beating the chalk duster against a wall or floor can cause dust and debris to scatter, creating a mess and potentially leading to respiratory issues for those in the vicinity. Additionally, this method does not effectively remove all the chalk dust from the duster. It can cause the chalk dust to become more embedded in the duster's fibers, making it less effective at cleaning the chalkboard surface. Moreover, repeatedly beating the chalk duster against a hard surface can damage the duster's fibers, causing it to wear out more quickly and decreasing its overall effectiveness. In conclusion, while beating the chalk duster against a wall or floor may seem like a quick solution for cleaning it, it is an ineffective and potentially harmful method that can create more problems than it solves.

Chalkboard dusters are commonly used in schools and other educational settings to clean chalkboards after us.

These days, there is no effective cleaning of the chalkboard duster in use today because consumers are simply tapping the duster against the walls to clean it. As a result, the wall paint and the duster become ruined, there is no effective cleaning of the duster, and the chalk powder is released into the environment, which can have a hazardous impact on students, educators, and the classroom environment. Clean the duster by tapping it on the floor or wall. Somebody is required to do that job when somebody is cleaning the duster, the respiratory system and body are completely exposed to the tiny Chalk particles they are tiny enough to get accumulated and form a thin layer within the respiratory system which may lead to respiratory problems and skin allergies. Many times, doctors get patients with issues of throat pain, skin allergies, or problems with the respiratory system these all are the results of exposure to chalk dust. The teacher's two remaining options are to switch to a different teaching strategy or to utilize low-powder chalks (dustless chalks). Additionally, utilizing dustless or low-powder chalks may trigger asthma episodes or allergies in pupils who are casein sensitive since casein, a milk protein, is used in the creation of dustless chalk. When these casein particles are inhaled, they may trigger severe asthma attacks, coughing, sneezing, or congestion. The whole scenario results in an increase in student absences from classes and educational institutions, which ultimately affects their academic performance.

Cleaning a chalkboard is an important task to maintain the quality of the board and to ensure that it is ready for the next use. Chalkboards are commonly used in educational and business settings for lectures, presentations, and meetings, and are also used in arts

and crafts projects and home settings for decorative purposes. Traditionally, cleaning a chalkboard involved using a chalkboard duster to remove the chalk markings from the surface of the board. However, this method can release dust and particles into the air and leave behind residue. To address this issue, vacuum-based chalk duster systems have been developed, which effectively remove dust and debris from the chalkboard and duster, resulting in a more thorough clean. In addition to using a chalk duster or vacuum-based system, there are other methods for cleaning a chalkboard, such as using a damp cloth or sponge to wipe the board or using a chalkboard cleaner solution to remove any stubborn stains or residue. It is important to follow proper cleaning techniques to avoid damaging the board, such as using a soft cloth or sponge and avoiding harsh chemicals that can strip the board of its finish or erode the surface. Overall, cleaning a chalkboard is an essential task to ensure the quality and longevity of the board, and there are various methods and tools available to effectively clean and maintain the board.

Table 1. Representing the skin-related problems caused due to the usage of chalk.

Skin problems	Rashes	Itching	Peeling of skin	Flaky skin	None
Percentage of the study population	10.5	21.5	8.32	24.9	53.3

We employed a vacuum-based chalk duster system to achieve efficient cleaning of the chalk duster.

Adopting an effective cleaning method for chalk dusters based on vacuuming is important for several reasons. Vacuuming is a highly effective way to remove dust and debris from surfaces, and this applies to chalk dusters as well. By using a vacuum cleaner to clean a chalk duster, the dust and debris are effectively trapped and collected, preventing it from scattering into the air or onto other surfaces. Vacuuming a chalk duster is a simple process. First, select a vacuum cleaner with a hose and a brush attachment. Turn on the vacuum and use the brush attachment to gently run over the surface of the duster, picking up any dust and debris. It is important to use a gentle touch when vacuuming the duster to avoid damaging the fibres or causing the dust to scatter. Adopting a vacuum-based cleaning method for chalk dusters can help to prevent respiratory problems caused by exposure to chalk dust, particularly for individuals with allergies or asthma. It can also help to keep the classroom environment cleaner by reducing the amount of dust that settles on surfaces. Regular cleaning and maintenance of the chalk duster are also important to ensure its effectiveness and longevity. In addition to vacuuming, it may be necessary to wash the duster in water or use a brush to remove any remaining dust and debris after each use. Overall, adapting an effective cleaning method for chalk dusters based on vacuuming can help to ensure a clean and healthy learning environment, while also prolonging the life and effectiveness of the duster itself.

Cleaning a chalk duster using a vacuum cleaner is an effective way to remove dust and debris, ensuring that the duster is clean and ready for use. Chalk dusters are essential tools in classrooms and other educational settings, and their effectiveness can be greatly improved by regular cleaning and maintenance.

Vacuum-based cleaning methods for chalk dusters are gaining popularity because they are simple, effective, and efficient. By using a vacuum cleaner, the dust and debris are effectively trapped and collected, preventing them from scattering into the air or onto other surfaces.

Vacuum-based cleaning methods for chalk dusters are an effective way to prevent respiratory problems caused by

The broadest definition of vacuum is simply "an absence or near absence of matter". In practical terms, a vacuum can be created in a closed vessel by removing all or part of the air within the vessel. Vacuums are employed in many manufacturing technologies, ranging from incandescent light bulbs to thermal drink containers to food preservation. In technology, vacuum conditions are important for producing the thin film coatings that are used in applications ranging from the trivial (i.e., reflective balloon coatings) to the critical (i.e., hardened tool coatings, integrated circuit components, anti-corrosion coatings, etc.). Much of modern scientific research would not be possible without effective vacuum containment. Researchers in chemistry, physics, and high technology routinely employ vacuum to create an environment in which the physicochemical conditions are precisely known. Under vacuum conditions, they can perform experiments with highly controlled levels of molecular and surface interactions and with minimal influence due to unknown contaminants. As well, the prediction of gas behaviour is simplified under vacuum conditions since gases come closer to obeying the Ideal Gas Law as pressure is reduced. The degree of vacuum within a vessel is determined by the gas pressure, defined as a measure of the cumulative force of individual gas molecules colliding with each other and with the walls of their container. The force (pressure) the gas exerts on the walls of a container is defined as Force/Area or F/A. This force is a function of the number of molecules in the container and the rate at which momentum, mass × velocity, mv, is transferred from the moving molecules to the container surface. The force per unit time exerted on the wall of a container by a single molecule can be expressed as: Force per unit time exerted on the wall of a container by a single molecule (equation)

The principle of a vacuum is based on the concept of negative pressure, which is created by the removal of air molecules from a particular area or container. In a vacuum cleaner, negative pressure is created by a motor that generates suction, which pulls air, dust, and debris into the collection chamber or bag. As the air is drawn into the vacuum cleaner, it passes through a filter, which traps dirt and debris, allowing clean air to be exhausted back into the room. The suction nozzle, or head, of the vacuum cleaner contains a rotating brush that agitates the surface being cleaned, dislodging dirt and debris and allowing it to

be easily suctioned into the collection chamber. The amount of suction generated by a vacuum cleaner depends on several factors, including the strength of the motor, the quality of the filter, and the design of the suction nozzle. The power of a vacuum cleaner is typically measured in terms of its suction strength, which is often expressed in terms of air watts or cubic feet per minute (CFM). In summary, the principle of a vacuum cleaner is based on the creation of negative pressure, which generates suction that pulls air, dirt, and debris into the collection chamber or bag, while clean air is exhausted back into the room. By using this principle, a vacuum cleaner can effectively remove dirt and debris from floors and other surfaces, providing a cleaner and healthier environment.

Vacuum-based cleaning methods for chalk dusters can fill the gap in existing cleaning techniques by providing a more effective and efficient way to clean the dusters. Traditional methods of cleaning chalk dusters, such as beating them against a wall or wiping them with a cloth, can be ineffective and may even create more dust in the air.

Here are some ways in which vacuum-based cleaning methods can fill the gap:

More thorough cleaning: Vacuum cleaners are more effective than traditional cleaning methods at removing dust and debris from surfaces. By using a vacuum cleaner, you can ensure that the chalk dust is effectively trapped and collected, preventing it from scattering into the air or settling on other surfaces.

Faster cleaning: Vacuum-based cleaning methods are faster than traditional cleaning methods, allowing you to clean the chalk duster more quickly and efficiently.

Safer cleaning: Vacuum-based cleaning methods are safer than traditional cleaning methods because they prevent the spread of dust and debris in the air, reducing the risk of respiratory problems and allergies.

Longer lifespan of the duster: Regular vacuum-based cleaning of chalk dusters can help to prolong their lifespan by preventing the build-up of dust and debris, which can cause the fibers to deteriorate over time. By using vacuum-based cleaning methods for chalk dusters, you can fill the gap in existing cleaning techniques and ensure a cleaner and healthier learning environment.

Healthier environment: When chalk dust is released into the air, it can lead to respiratory issues, allergies, and other health problems. Vacuum-based cleaning helps to minimize the amount of dust and particles released into the air, resulting in a healthier environment.

Timesaving: Vacuum-based cleaning is typically faster than traditional methods, as it does not require the user to manually clean the chalkboard or chalk duster. This can save time and increase efficiency in educational and business settings.

Reduced waste: Vacuum-based cleaning typically results in less waste than traditional methods, as it does not require the use of disposable cleaning materials, such as paper towels or cloths.

Overall, vacuum-based chalk duster cleaning fills the gap of existing cleaning techniques by providing a more effective, efficient, and environmentally friendly way of cleaning chalkboards and chalk dusters, resulting in a cleaner and healthier environment.

Vacuum-

The word "vacuum" comes from the Latin "vacua", which means "empty". However, there does not exist a totally empty space in nature, there is no "ideal vacuum". Vacuum is only a partially empty space, where some of the air and other gases have been removed from a gas containing volume ("gas" comes from the Greek word "chaos" = infinite, empty space). In other words, vacuum means any volume containing less gas particles, atoms and molecules (a lower particle density and gas pressure), than there are in the surrounding outside atmosphere. Accordingly, vacuum is the gaseous environment at pressures below atmosphere.

A vacuum, in the context of cleaning, refers to a machine or device that creates suction to remove dirt, dust, and debris from surfaces. Vacuums are commonly used in both residential and commercial settings to clean floors, carpets, upholstery, and other surfaces. Vacuums work by creating negative pressure that pulls air and particles into a collection chamber or bag. As the air passes through the vacuum, it is filtered to trap dust and debris, while clean air is released back into the room. Modern vacuums come in a variety of types and styles, including upright vacuums, canister vacuums, handheld vacuums, stick vacuums, and robotic vacuums. Each type of vacuum has its own unique features and advantages, depending on the specific cleaning needs of the user. Overall, vacuums are an essential tool in maintaining a clean and healthy environment, by effectively removing dirt, dust, and debris from surfaces, and improving the air quality in a room.

Since the times of the famous Greek philosophers, Demokritos (460-370 B.C.) and his teacher Leukippos (5 th century B.C.), one is discussing the concept of vacuum and is speculating whether there might exist an empty space, in contrast to the matter of countless numbers of indivisible atoms forming the universe. It was Aristotle (384-322 B.C.), who claimed that nature is afraid of total emptiness and that there is an insurmountable "horror vacui". Therefore, he doubted and even rejected an absolute vacuum. He assumed, for example, that the idea of empty space would invite the concept of motion without resistance, i.e. a motion at infinite velocity. This opinion became a paradigma for almost 2000 years. It was believed by famous writers, like Roger Bacon (1214-1299) and René Descartes (1596-1650) and was strongly supported also by the church. Only in the 17th century were vacuum physics and technology born. Galileo (1564-1642) was among the first to conduct experiments attempting to measure forces

required to produce vacuum with a piston in a cylinder. Torricelli (1608-1647), an associate of Galileo´s, succeeded in 1644 to produce vacuum experimentally by submerging a glass tube, which was filled with mercury and closed at one end, with its open end in a pool of mercury. By using mercury instead of water, he was able to reduce the size of the apparatus to convenient dimensions. He demonstrated that the mercury column was always 760 mm above the level in the pool, regardless of size, length, shape or degree of tilt of the tube (see Fig. 1) and, in this way, he measured for the first time the pressure of atmospheric air. Also, by other experiments, performed by the French scientist and philosopher Blaise Pascal (1623 - 1662), the idea of the "horror vacui" was proved to be wrong (see Fig. 2). Pascal also measured, for example, the altitude with the Hg barometer (invented by Torricelli), contributed significantly to our understanding of vacuum physics and made many other important discoveries in physics. The unit of measure of the degree of vacuum of the International Standards Organization, i.e. the SI-unit of pressure, was called in honor of Pascal: 1 Pa = 1 N/m 2 = 7.501 x 10-3 Torr =10 -2 mbar

Chalk duster

A chalkboard duster, also known as an eraser, is a tool used to clean chalkboards. It typically consists of a rectangular or circular pad made of felt, foam, or other materials, which is attached to a handle. The pad is used to erase or remove chalk markings from the surface of the chalkboard. Chalkboard dusters are an essential tool in educational and business settings, where chalkboards are commonly used for lectures, presentations, and meetings. They are also used in arts and crafts projects and in home settings for decorative purposes. Chalkboard dusters come in a variety of sizes, shapes, and materials. Some are designed to be used with a specific type of chalk or chalkboard surface, while others are more versatile and can be used with a variety of materials. While traditional methods of cleaning chalkboards involve beating the duster against a surface, this can release dust and particles into the air and leave behind residue. To address this issue, vacuum-based chalk duster systems have been developed, which effectively remove dust and debris from the chalkboard and duster, resulting in a more thorough clean.

Vacuum filters

A vacuum filter is a component of a vacuum cleaner that is used to separate dirt, dust, and debris from the air as it is drawn into the vacuum. The filter is designed to trap particles and prevent them from being released back into the air, resulting in a cleaner and healthier living or working environment. There are several types of vacuum filters, including paper bags, cloth bags, foam filters, and HEPA filters. Paper bags are the most

common type of filter and are designed to trap large particles and debris. Cloth bags are more durable and can be reused but may not be as effective at filtering small particles. Foam filters are designed to capture finer particles, such as dust and pet dander, and are often used in conjunction with a paper or cloth bag. HEPA filters, which stand for High-Efficiency Particulate Air, are the most effective type of vacuum filter, capturing particles as small as 0.3 microns and removing up to 99.97% of all particles from the air. Vacuum filters are an essential component of any vacuum cleaner and should be regularly cleaned or replaced to ensure maximum performance and filtration. A dirty or clogged filter can reduce the suction power of a vacuum and release particles back into the air, potentially causing respiratory problems or allergies.

Vacuum DC Motor

A DC motor, or direct current motor, is an electrical device that converts electrical energy into mechanical energy. It is a type of electric motor that is commonly used in a wide range of applications, including electric vehicles, robotics, industrial machinery, and household appliances such as fans and vacuum cleaners. The basic principle of a DC motor is that it relies on the interaction between a magnetic field and an electric current to produce rotational motion. The motor consists of two main parts: the stator, which is the stationary part of the motor that contains the field windings, and the rotor, which is the rotating part that contains the armature. When an electric current is applied to the motor, it flows through the field windings in the stator, creating a magnetic field. The armature in the rotor then interacts with this magnetic field, causing the rotor to rotate. The direction and speed of the rotation can be controlled by changing the direction and amount of the current applied to the motor. DC motors are known for their efficiency, reliability, and versatility. They are also relatively easy to control, making them a popular choice for a wide range of applications. However, they do require regular maintenance and may need to be periodically replaced if they wear out or become damaged.

A vacuum DC motor is a type of electric motor used in vacuum cleaners and other applications where high power and compact size are required. The motor is designed to provide high torque at low speeds, which is necessary for effective suction in a vacuum cleaner. The basic principle of a DC motor is that it converts electrical energy into mechanical energy by using magnetic fields. The vacuum DC motor operates on the same principle but is specifically designed to be more efficient and powerful in a vacuum cleaner application. The motor consists of a stator, which is the stationary part of the motor, and a rotor, which is the rotating part. The stator contains field windings, which create a magnetic field when an electric current is applied. The rotor contains the armature, which is a set of coils that rotate within the magnetic field, producing torque. Vacuum DC motors are typically designed to be brushless, meaning they do not use brushes to transfer power to the rotor. Instead, they use electronic commutation to control the flow of current to the armature, resulting in improved efficiency and longer lifespan compared to brushed motors. Overall, vacuum DC motors play a critical role in the performance and efficiency

of modern vacuum cleaners, providing the power and torque necessary to effectively clean floors and other surfaces.

Power source in vacuum

The power source in a vacuum cleaner is the component that provides the electrical energy needed to power the motor and other components of the vacuum. Most modern vacuum cleaners are powered by electricity from a wall outlet, although cordless models may use rechargeable batteries. Vacuum cleaners that are powered by electricity from a wall outlet typically use a power cord to connect to the electrical source. The power cord is usually located on the back or side of the vacuum and plugs into a wall outlet. The voltage required to power the vacuum motor varies depending on the model and manufacturer but is typically between 120-240 volts. Cordless vacuum cleaners, on the other hand, use rechargeable batteries as their power source. These batteries are usually located within the vacuum cleaner and can be charged using a charging dock or cable. The runtime of a cordless vacuum cleaner depends on the capacity of the battery and can vary between models and manufacturers. The power source is a critical component of a vacuum cleaner and directly impacts the performance and functionality of the device. Choosing the right power source for your needs, whether it be a corded or cordless model, is an important consideration when selecting a vacuum cleaner.

Dust collecting unit in a vacuum

A dust collecting unit is a critical component of a vacuum cleaner that is responsible for collecting and containing dust, dirt, and other debris that is sucked up by the vacuum. It is typically located within the body of the vacuum and consists of a filter or series of filters that trap particles as they are drawn into the vacuum. The type of dust collecting unit used in a vacuum cleaner varies depending on the model and manufacturer. Some vacuum cleaners use disposable bags that collect dust and dirt, while others use a reusable container that can be emptied and cleaned. Some models also use advanced filtration systems, such as HEPA filters, to trap even the smallest particles and allergens. A properly functioning dust collecting unit is essential for maintaining the suction power of the vacuum and ensuring that dust and other particles do not escape back into the air. If the dust collecting unit becomes clogged or dirty, it can reduce the efficiency of the vacuum and even cause it to malfunction. To maintain the performance of a vacuum cleaner, it is important to regularly clean or replace the dust collecting unit. This may involve emptying and cleaning a reusable container, replacing a disposable bag, or washing or replacing filters. Regular maintenance of the dust collecting unit will ensure that the vacuum continues to operate effectively and efficiently.

Chapter 2

LITERATURE SURVEY

1. DESIGN AND FABRICATION OF VACUUM OPERATED CHALK DUST COLLECTOR ISSN 2229-5518

The system uses a vacuum to wipe the blackboard duster with the assistance of a motor. The vacuum pump will be powered by a motor. For stopping the motor and subsequently the vacuum pump in this setup, a straightforward on/off switch will also have a modest role. The dust on the rubber will be collected and trapped using a vacuum dust collection system, saving time and energy and preventing the dust from circulating in the air and creating a hazardous environment for both the teacher and the student. The Hoover process begins when the controller button is pressed, activating the circuit. Additionally, the vacuum slot is covered by chalk rubber. When this is done the dust from the eraser is pulled out of the material due to the suction produced from the vacuum pump. Thus, avoiding the chalk dust from entering the classroom atmosphere

Drawing lines of various weights and thicknesses is simpler with chalk than it is with whiteboard markers.

• Using a technique utilising the friction of the chalk and the blackboard, dashed lines can be made very quickly.

• Whiteboard markers frequently have an offensive odour, in contrast to chalk's gentle aroma. Whiteboard markers occasionally can't compete with the contrast that chalk writing offers.

• Writing that has been left on a whiteboard for a long time may need to be removed using a solvent; however, chalk can be quickly erased.

Why Whiteboard markers frequently permanently stain fabric; chalk may be wiped off most garments with ease.

2. A PRELIMINARY STUDY ON THE EFFECT OF CHALK DUST ON HUMAN HEALTH

ISSN: 2455-9571

The main component of chalk is Calcium carbonate ($CaCO_3$), a fundamental type of limestone, is the major ingredient in chalk. To meet the demands of artists, it was initially created as sticks. Teachers found it useful to utilise it in addition to blackboards for informational purposes as time went on and more kids enrolled in school.

Small chalkboards were used for homework practice and study, particularly by the youngest kids.

Most of the chalk produced now is dust-free. As the chalks that were previously utilised were of the dusting variety, many people began to experience respiratory problems. Manufacturers of chalk developed the concept of non-dusting chalk to meet the demands of its clients. It has been established that non-dusting chalk has more chemical components than dusting chalk, and as a result, the dust particles that are produced are larger and heavier. The current study will shed light on the different health problems that can be brought on by using the two forms of chalk that are frequently used in educational settings.

3. "DESIGN AND DEVELOPMENT OF DUSTLESS DUSTER"

ISSN-2349-5162

Since the beginning of the concept of classroom instruction, blackboard chalk and duster rubber have been essential components. Green boards eventually took the role of blackboards, but no substitute for chalk and duster erasers could be discovered. Even in affluent nations like the United States and the United Kingdom, they are not being replaced in this age of mechanisation, automation, and advanced electronics. Today, projectors are used in classrooms, but up to this point, no technology has been developed that can replace the convenience and simplicity of a blackboard and chalk. The biggest issue emerges when the work of cleaning the duster rubber is presented. Writing on the board is a pretty simple process, and erasing is even simpler. The duster rubber eventually becomes saturated and stops effectively cleaning the blackboard after a while. Then cleaning is required. The duster rubber is quite easy to clean; all you must do is rub it against the wall in a manner like beating a rug, and the majority of the dust will fall off. Usually, the blackboard must be cleaned by the teacher while he is instructing.

4. FINITE ELEMENT ANALYSIS OF BLACKBOARD DUSTER CLEANING MACHINE

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The Roller Follower and Cam concept governs how the suggested machine functions. As soon as the power is turned on, the 12V DC motor's shaft starts to rotate, which forces the cam to also rotate. The cam causes a constant circular motion in the roller follower. The striking plate practically becomes vertical due to the follower's movement. As the follower leaves the impacting plate, the self-weight of the plate causes it to collide with the duster holders. Therefore, the dust is cleaned, and the complete assembly is enclosed in a case, to stop dust from dispersing into the surroundings. The dust can be collected using Hoover pumps if necessary.

5. SMART CHALK DUST REMOVER

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Teachers and kids are developing skin allergies and respiratory problems as a result of the continuous use of chalk.

Human vision is negatively affected by chalk dust as well. Dust contains microscopic chalk particles that can cause health problems since they tend to build up in the respiratory system. Chalk dusters are traditionally cleaned by slamming them against a wall or floor, which pollutes the environment. Therefore, it is essential to build tools that eliminate dust from classrooms and laboratories and clean chalkboard dusters.

With the aid of the motor and suction created inside the model, the system uses a vacuum procedure to clean the blackboard duster. The motor is attached to a driveshaft and a brush. The system that starts and stops the vacuum pump and motor uses a sensor. A dust collecting device is used to collect and hold dust on the duster, preventing it from moving in the air and fostering a hazardous environment. When the duster is put in the designated spot, the sensor activates, forcing the brush to rotate and starting a vacuum process that lasts for 10 seconds, sucking up the chalk dust through the vacuum pump's suction. By doing this, chalk dust is kept out of the atmosphere. After 10 seconds the process stops automatically.

6. Fault diagnosis of vacuum cleaner motors

Vibration analysis

Technically speaking, vibration measurements are not difficult to perform. However, several factors that affect the accuracy of the diagnosis must be taken into consideration. Indeed, a few highly intricate dynamic processes lead to vibrations. There are two main parts to what the piezoelectric sensor "feels". The "shaking" of the motor, which is brought on by rotor imbalance, is the cause of the first component.

Sound analysis

There are three reasons to use sound analysis. First, sound analysis is the only method that can be used to reveal unwanted sounds. Second, the underlying Hoover motor no longer exhibits the same characteristics as the situation described by Yang and Penman (2000), in which minute fluctuations in load (such as those caused by bearing defect) could be easily recognised in the motor current.

A prototype design of a diagnostic system for vacuum cleaner motors is presented. The system allows for realisation of short test runs during which six different signals are

recorded. The main contribution of the paper concerns algorithms for feature extraction, which enable unambiguous isolation of all the faults. Moreover, multiple faults can be recognized.

7. Modelling and fabrication of automatic blackboard dust remover

Here, it's important to reduce the work required to clean the chalkboard after each use. Even though the use of smart boards is growing, many organisations in the developed and developing globe continue to use slate or blackboards. the chalk powder inhaled by the pulmonary system of the human reason from pieces of chalk used to erase the writing board. several problems, including eye ageing, baldness, and so forth. To combat these issues, a programmable board is used with remote sensing, which helps with functioning from a specific distance. A programmed blackboard is a device that is used to clear the slate, which reduces human labour and increases efficiency.

This project is primarily powered by a dc engine that operates at limited rates. Dust is removed from the area surrounding the slate using a board duster that is powered by a remote detection device and rollers installed in an auto tic. The created device intuitively detects writing board chalk stains, removes the text style, and maintains the chalkboard's cleanliness. These endeavours provide excellent solutions for human job whenever devouring. When the equipment is fully done, the cleaning productivity of a programmed writing board cleaner is better to everything the manual chores.

8. Ergonomic evaluation of ergonomically designed chalkboard erasers on shoulder and hand-arm muscle activity among college professors

For many years, teachers have utilised dusters or chalk board erasers as a necessary piece of equipment to wipe the boards. Even though there are a lot of cutting-edge teaching tools being routinely offered on the market, the chalk and talk approach cannot be entirely replaced. The work-related musculoskeletal disorders (WMSD) that teachers encounter in the upper extremity’s region, such as the shoulder, hand, neck, wrist, and upper back region, go unnoticed when using the chalk and speak approach (Sirajudeen et al., 2018; Senthilkumar et al., 2019). The cause of the WMSD that teachers suffer is determined to be prolonged standing, raised arm position, and repetitive arm movement (Damayanti et al., 2017; Solis-Soto et al., 2017).

Dusters or chalk board erasers cause agronomical issues which lead to work related musculoskeletal disorders among teaching professionals. In this work, initially a questionnaire survey was made with 60 college professors to identify the risks while using existing chalk board erasers. Then, an attempt is made to redesign the chalkboard erasers (Model A, Model B & Model C) by considering various design aspects and fabricated using 3D printing technique by altering the commercially available.

9. A Design of Remote-Controlled Chalkboard Eraser

The automatic chalkboard eraser we designed has a satisfying ability in decreasing the amount of powder produced during the teaching process and can be remote controlled. However, it still requires a person to control it. In “Automatic positioning and dust-free blackboard writing removal system” the author states that the Radio Frequency Identification (RFID) technology could help the eraser to locate the writing on the chalkboard. RFID technology is composed of RFID tags, Reader, and eraser. The RFID tag can be placed on the writing that needs to be erased and the Reader under Wireless Local Area Network will locate the position of the tag by scanning and send the signal to the eraser so that the eraser can clean the writing automatically. With the help of RFID technology, it is possible to design a chalkboard eraser that can clean the chalkboard without any control from people. Besides, the eraser we designed may not be suitable for intense teaching paces in classes as the ability to clean the dust sets a limit for the speed of moving around. If the eraser goes too fast, the ability to clean the dust will be weakened and vice versa. Therefore, it is important to find a balance between two factors, where the eraser can take in most of the dust produced while does not affecting the pace of teaching. As technology develops, the microfiber in the eraser could also be replaced with better quality and functional materials to improve durability and ability to absorb the dust. In addition, the Arduino UNO board is used only for some basic functions, we can update it to other micro boards, e.g., Arduino Due, which have faster processing speed and behave more accurately.

To decrease the amount of dust produced and inhaled by teachers and students during the use of chalks, we successfully designed a remote-controlled blackboard eraser that can be remote-controlled to clean the writing on the blackboard. With a rotary vane pump we could adhere the eraser to the blackboard by taking out the air inside a sealed chamber between the eraser and the blackboard. With the Arduino UNO board, PIR sensor and the differential wheel system, we could write a program to the Arduino board and connect it to the PIR sensor so that it can recognize signals coming from different buttons on the controller. If we want to turn the eraser to the right, we can press the button on the controller that will instruct the Arduino board to turn the left side of the wheel to rotate faster than the right side one, which will turn the eraser to the right. The microfibers, a strong cleaning material, enable us to collect most of the dust produced while cleaning the blackboard due to its small diameters and outstanding strength.

10. **Chalk dust fall during classroom teaching: particle size distribution and morphological characteristics.**

DOI 10.1007/s10661-008-0164-2

Since it is one of the least expensive methods of teaching, classroom instruction using whiteboards and chalk is still the norm in many parts of the world. With the use of white boards, audio visual aids, and other relatively modern teaching techniques, many schools, colleges, and other institutions have recently made this transition. Despite having a higher ongoing cost, these innovative teaching techniques will undoubtedly enhance the dingy traditional classrooms.

Without a doubt, dust from fans or outside can stir up the dust in a classroom, making it easy for the teacher and students to inhale it. Chalk particles can also enter and impact the human respiratory system while settling. Chalk dust can fly around in classrooms when pedestal and ceiling fans are utilised, as they are in many schools in India and other tropical and subtropical nations.

Many teachers lament how difficult it is to deal with chalk dusts, which irritate the eyes, throat, and condition of those who are already allergic to them.

Additionally, a man's respiration rate typically ranges between 12 and 13 breaths per minute (Thibodeau and Patton 1996; Berne and Levy 1998), but it can significantly increase during lectures. Therefore, during instruction, whether the teacher is in the partial or continuous talking mode, air inhalation would be increased due to frequent mouth opening and deep inhaling, increasing chalk dust inhalation.

Further research on the nature and health impacts of airborne particulate chalk dusts in classrooms is now necessary considering these findings.

11. **Design and Implementation of a Dust Remover from a Conventional Blackboard Duster to Prevent Respiratory Problems**

ISSN: 2349-2163

An AC motor, a plastic abrasive wheel, a sheet metal tray, and a wooden enclosure make up the system. The motor's extended shaft is attached to the abrasive wheel. The duster could be able to fit through the front door's rectangular aperture and meet the abrasive wheel. As soon as the system is powered on, the motor engages, and the abrasive wheel begins to spin. If the dust touches the wheel while it is spinning, the abrasive action of the wheel removes it off the old duster. The dust then collects in the metal tray just below the

wheel, where it may be routinely emptied. Our idea is modelled around a conventional duster cleaning equipment.

The components are selected, and the specific designs of the components described below are done with the goal of creating a product that is small, portable, strong, and efficient in mind. The automation of our suggested idea is made possible by the electrical components. The cleaner's four sides are covered by a cuboidal hardwood box that serves as the foundation frame. The frame is constructed using the conventional duster's measurements as a guide. The components are tightly fastened to this crucial supporting section. Its framework encloses all of the parts, gathers all of the dust released during cleaning, serves as a sound barrier, and lessens distortion and vibrations brought on by the action of the cleaning brush.

To give a more effective method of dust cleaning than the outdated blackboard duster. This process was began by identifying the project's requirements and conducting a literature review. It consists of many steps. The literature study contains information on past methods for cleaning the dust from the blackboard, such as grippers and automation. The second stage of the idea development process, in which the best concepts are selected using the Pugh-Matrix method, is described. The detailed design stage, which takes place in the third step, contains design data for the manufactured and assembled component.

Chapter 3

AIM AND SCOPE

3.1 AIM OF THE PROJECT

The project aims to clean the chalkboard duster efficiently by creating a vacuum using a motor. This project also aims to collect the used chalk powder, improving air quality. Blackboards have been used for decades, and cleaning the duster was challenging. It is important to clean the duster regularly to improve the cleanliness of the environment and to prevent serious respiratory problems.

This project is also focused on collecting the chalk powder without releasing it into the environment which could be sent for recycling. This decreases exposure to the harsh chemicals of the chalk powder and makes it a fit environment for teachers and students. Cleaning the duster regularly can increase the lifespan of the duster by reducing the clogging of the chalk powder in the fiber cloth.

3.2 SCOPE OF THE PROJECT

The scope of vacuum-based blackboard chalk dusters is significant, especially in educational institutions where blackboards and whiteboards are still widely used for teaching purposes. The use of this specialized cleaning tool can save time, effort, and money by reducing the need for manual cleaning methods, such as erasing the chalk with a traditional duster or cloth. In addition, vacuum-based blackboard chalk dusters can provide a more hygienic environment by reducing the amount of chalk dust and other debris in the air, which can cause respiratory problems, especially for those with asthma or other respiratory conditions. There is also a growing demand for eco-friendly and energy-efficient cleaning solutions, and vacuum-based blackboard chalk dusters are an ideal solution as they reduce the need for chemical cleaning products, and they are also energy efficient, helping to save electricity costs. In conclusion, the scope for vacuum-based blackboard chalk dusters is significant, and with the growing demand for more efficient, effective, and eco-friendly cleaning solutions, their popularity is likely to increase in the future.

<u>The scope of this project includes the following:</u>

3.2.1 Research and Analysis- Conducting research and analyzing the current market for duster cleaners, identifying customer needs, and evaluating the competition to identify opportunities for innovation and improvement.

3.2.2 Product Design and Development- Developing a design for the duster cleaner that meets the needs of the target audience, including the size, shape, and materials used in the construction of the product.

3.2.3 Prototype Development and Testing- Developing a prototype of the duster cleaner and testing it to ensure that it meets the required performance standards, including dust collection efficiency, ease of use, and durability.

3.2.4 Manufacturing- Establishing a manufacturing process that is cost-effective and efficient, including sourcing materials, developing production processes, and establishing quality control measures.

3.2.5 Marketing and Sales- Developing a marketing and sales strategy for the duster cleaner, including branding, advertising, and sales channels, and developing partnerships with retailers and distributors.

3.2.6 Distribution and Customer Support- Establishing distribution channels and providing customer support, including product training and troubleshooting, to ensure customer satisfaction and loyalty.

3.2.7 Continuous Improvement- Developing a process for continuous improvement and innovation to ensure that the duster cleaner remains competitive in the market and meets the evolving needs of customers.

This project can be applied in various schools and colleges. Also, this paves the way for the development of new blackboard duster-related technologies. This project can be modified using new attachments and this can be converted to fully automatic.

Chapter 4

MATERIALS USED IN THE PROJECT

4. 1 METHODOLOGY

The methodology of the project is creating a vacuum in a sealed chamber and collecting the chalk powder. The duster surface can be cleaned by using the vacuum pump and power source. A vacuum pump is a device that creates a partial vacuum by removing gas or dirt molecules from a sealed chamber or system.

Rotary vane pumps are a type of positive displacement pump commonly used in a wide range of industrial, scientific, and medical applications. They are designed to move fluids by using a rotating mechanism that creates a partial vacuum and forces the fluid to flow into the pump.

Working Principle of Rotary Vane Pumps

The basic working principle of a rotary vane pump is quite simple. The pump is composed of a rotor with several vanes that rotate inside a cavity. The rotor is mounted off-center in the cavity, creating a crescent-shaped space between the rotor and the cavity walls.

As the rotor rotates, the vanes slide in and out of the rotor slots, creating a seal that divides the crescent-shaped space into two compartments. One compartment is the intake side, where the fluid is drawn into the pump. The other compartment is the discharge side, where the fluid is pushed out of the pump.

The rotation of the rotor creates a partial vacuum on the intake side, causing the fluid to be drawn into the pump. As the vanes pass through the intake side, the fluid is trapped between the vanes and the rotor walls. The fluid is then carried around to the discharge side of the pump, where it is forced out through the discharge port.

VACUUM BASED BLACKBOARD DUSTER CLEANER

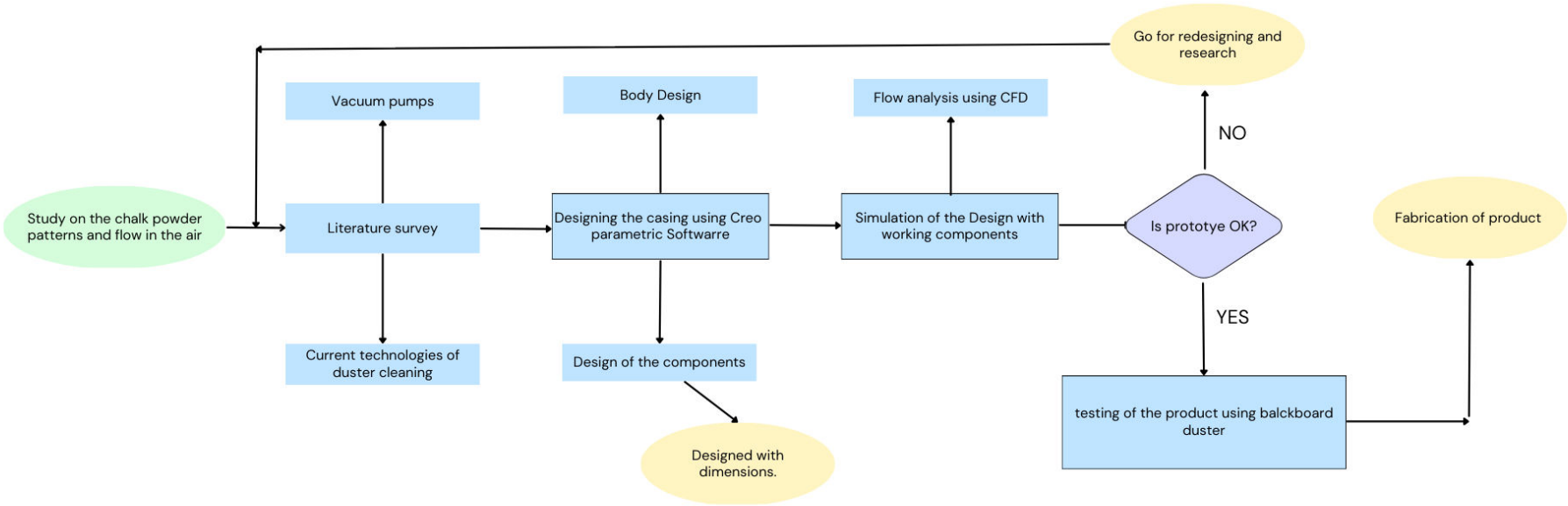

Fig1. Flowchart of the project

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Components of Rotary Vane Pumps

A rotary vane pump typically consists of the following components:

i. Rotor-
The rotor is the central rotating part of the pump that is mounted off-center in the cavity. It is typically made of steel or another high-strength material and has a cylindrical shape. The rotor has several slots or grooves cut into it, which are used to hold the vanes in place.

ii. Vanes-
The vanes are flat or curved blades that slide in and out of the rotor slots as the rotor rotates. They are typically made of high-strength material, such as steel or carbon fiber, and are designed to create a seal between the rotor and the cavity walls. The number of vanes varies depending on the size and design of the pump, but most rotary vane pumps have three or four vanes.

iii. Cavity-
The cavity is the space in which the rotor rotates, and it is divided into two compartments by the vanes. The cavity has a crescent shape, with the rotor mounted off-center to create a larger compartment on the intake side and a smaller compartment on the discharge side.

iv. Intake Port-

The intake port is the opening through which the fluid enters the pump. It is typically located on the side of the pump housing, and the size and shape of the port can vary depending on the design of the pump.

v. Discharge Port-

The discharge port is the opening through which the fluid leaves the pump. It is typically located on the opposite side of the pump housing the intake port and is connected to the discharge line.

vi. End Plates-

The end plates are the covers that seal the ends of the pump housing. They are typically made of high-strength material, such as steel or aluminium, and are bolted to the housing to create a secure seal.

vii. Bearings-

The bearings support the rotor and allow it to rotate smoothly. They are typically located at each end of the rotor and are designed to withstand the forces generated by the rotation of the rotor.

viii. Seals-

The seals prevent fluid from leaking out of the pump and into the environment. They are typically made of high-strength material, such as rubber or silicone, and are located at various points throughout the pump, including the vanes, the rotor, and the end plates.

ix. Springs-

The springs are used to hold the vanes against the rotor and create a seal between the rotor and the cavity walls. They are typically located between the vanes and the end plates and are designed to withstand the forces generated by the rotation of the rotor.

x. Drive Mechanism-
The drive mechanism is used to rotate the rotor and drive the pump. It can be a motor, a gearbox, or another type of drive system depending on the application.

xi. Relief Valve-
The relief valve is used to prevent the pump from generating too much pressure and causing damage to the system. It is typically located on the discharge line and is set to open at a predetermined pressure.

xii. Pressure Gauge-
The pressure gauge is used to monitor the pressure generated by the pump. It is typically located on the discharge line and can be used to adjust the pump settings to achieve the desired pressure output.

xiii. Strainer-
The strainer is used to filter out any debris or particles that may be present in the fluid being pumped. It is typically located on the intake side of the pump and can be easily removed and cleaned as needed.

In the first stage of the project, the patterns of the chalk powder are studied and explored different cleaning methods for the duster. Many improvements have been made to the duster and blackboard to improve the cleanliness of the board. The Study on patterns has been recorded. After completion of the study on patterns, the body is modelled in PTC Creo software. The casing used in the project is completely new and designed in Creo software. It is designed with final dimensions. Using Creo software flow analysis is completed to find the flow of air from the propellers. The casing can be designed using SolidWorks software.

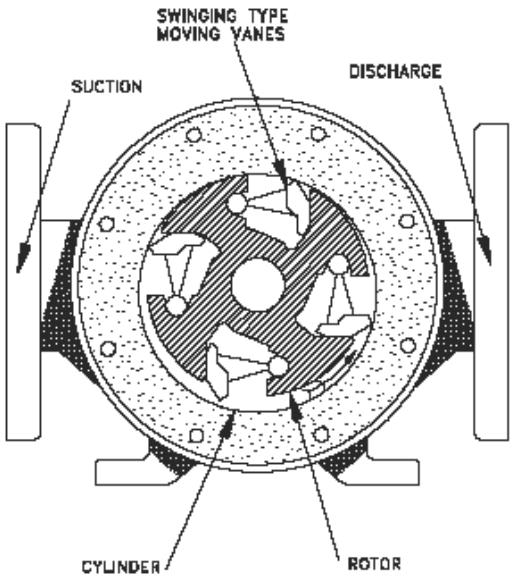

Fig2. Rotary vane-type pump

4.2 WORKING

This project works on the principle of the vacuum. It cleans the chalkboard duster by changing the pressures of the air around the vacuum pump. The working principle of a vacuum pump is based on the concept of creating a pressure differential between two different regions. The vacuum pump creates a region of low pressure within the chamber or system, which is lower than the atmospheric pressure outside the system. The pressure differential forces gas molecules to move from high-pressure regions to low-pressure regions, resulting in the removal of gas molecules from the system.

The motor drives the fan, which creates a low-pressure area inside the machine. The low-pressure area sucks in air and debris through the nozzle at the end of the vacuum inlet chamber. The air and debris then pass through a series of filters, which trap the dust, dirt, and other particles. The first filter is typically a foam or cloth filter, which captures large particles. The second filter is a HEPA (High-Efficiency Particulate Air) filter, which captures small particles and allergens.

The DC motor is powered by the UPS battery which relates to the same terminals. This electrical power is converted to mechanical power, therefore, rotating the fins of the propeller. The DC motor rotates at a very higher rpm and the suction of air is directly proportional to the speed of the motor. The DC motor live wire is connected to the live wire of the battery whereas the neutral wires are connected to the switch for operating the vacuum pump as per requirement. Instead of a battery, an AC-to-DC converter can

be used. This adapter changes the flow of current and feeds it to the motor. The lithium acid battery is rechargeable and it powers the motor.

The DC motor rotates the propeller blade and creates a vacuum near the inlet chamber. The suction power depends upon the speed of the motor and the fins present on the propeller blade. The air (which is chalk powder), flows from the top of the casing and flows out from the bottom. This process involves the purification process of the air and releasing the cleaned air into the environment. Various filters have been tested for filtering the air. The air passes through filter to separate the chalk powder particles. The chalk powder can also be collected by using dust bags. The size of the chalk powder varies from 60-100 micrometers. Muti-layered filters are used in the experiment and these filters are mounted rigidly to sustain the air pressure of the propeller. Filters are placed below the DC motor so that air is purified and released to the environment.

DC This project can potentially reduce the exposure of the chalk powder to the environment and improve the air quality in surroundings. Long exposure of chalk powder can lead to serious problems such as respiratory problems, teachers and students are exposed to this environment most of the time. The filtered air passes through the holes that are below the casing. The vacuum pump can be operated by a switch, which is used to turn ON/OFF the motor.

The motor can be powered by using the domestic current. The system can be fitted with AC to DC converter to power the DC motor which creates the vacuum. An AC to DC converter, also known as a rectifier, is an electronic device that converts alternating current (AC) to direct current (DC). The basic operation of an AC to DC converter involves the use of diodes, which are electronic components that allow current to flow in one direction only. There are two main types of AC to DC converters: half-wave rectifiers and full-wave rectifiers.

4.3 CONSTRUCTION OF THE PROJECT

The casing is the chamber where all the components are placed and mounted. The material of the casing should have high strength to hold the battery and the motor. Some of the materials are hard cardboard, plastic and wood which can be used to build the casing as per dimensions. Plastic is a better material that provides high strength, high stiffness, low moisture, impact resistance and abrasion resistance. The casing is made with dimensions accounting for all the component sizes. The plastic material is cut into required dimension pieces and sealed with heat application. For the development of a prototype, Hard cardboard is used to make the casing for the project. The cardboard is cut into pieces as per the dimensions mentioned in the table. The edge of the cardboard is sealed using MSeal and using fevicol which sealed the edges of the casing. The casing should be properly sealed to make it an airtight container. The casing contains two chambers, one for the vacuum chamber other is to mount the battery and switch.

The top of the casing has a hole which is the inlet chamber and vacuum is created in this area. The air flows from this hole into the vacuum chamber. When the duster is rubbed over the suction area, the dust particles are sucked inside the chamber. A hard brush is used to disturb the particles of the chalkboard duster. Brush is used to free the particles present on the fiber cloth. When the duster is rubbed against the brush, the chalk powder is released, and the powder will flow inside the vacuum chamber. The brush is mounted in center of the hole.

Air flowing through the vacuum chamber passes through the filters to purify and collect the chalk powder from the air. Filters are placed just above the discharge port and as well as below the motor. The filter placed below the motor is bigger in size and traps bigger particles and the filter placed above the discharge port is of very fine size. This filter is typically and sponge of thickness 4mm. Air purifications occurs throughout the process.

A steel mesh is attached above the propeller blade to prevent bigger components such as chalk. The mesh stops the particles, and these can be manually removed. This mesh is attached to prevent the propeller blades from being damaged.

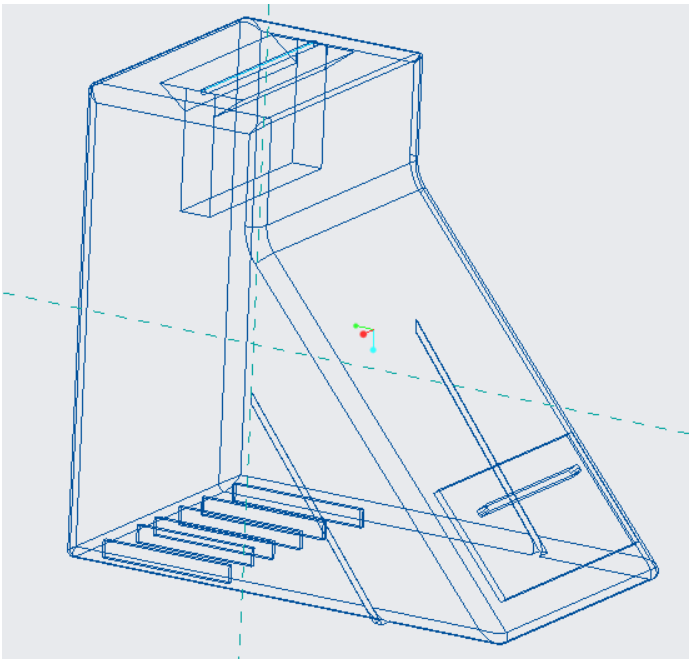

Fig. Extension of present casing with storage tank

4.4 The materials and the components used in the project to achieve the suction of the dust are:

4.4.1 DC Motor AFC0912DE-

The DC motor used in this project is the brushless type with Model No. AFC0912DE. The DELL P/N is P2780. It is 12 volts and has a 2.50A motor.

This motor was chosen due to its high efficiency, compact size and low maintenance cost.

Fig. DC Brushless type motor with propeller blade.

4.4.2 Propeller blade-

The propeller blade is connected to the motor and rotates at the speed of the DC motor. The width of the propeller blade used in the project is 100mm wide and of 9 angled fins to create more suction. The more the number of fins the more suction from the inlet.

4.4.3 UPS Battery-

The battery used in the project is the lead acid battery. UPS battery is used to power the DC motor to create a vacuum over the surface. The specification of the battery is 12V and 7.50A. The battery has six cells and two terminal posts of positive and negative. The dimensions of the battery are 150*100*75 mm. This battery is a secondary battery, and it can be recharged when the battery voltage drops below 9V.

Fig. UPS Battery (12V)

4.4.4 Air Filters-

It is the main component of the project which purifies the chalk powder from the air and collects it in a separate place. The paper filter is used along small-sized meshes around the filters to separate the chalk powder.

4.4.5 Vacuum Bag-

The vacuum bag is attached below to the DC motor. The material of the dust bag is fiber. It is lightweight and washable. It collects all the chalk powder, and it is a porous material. The air flows through the bag collecting only chalk powder.

4.4.6 Casing-

The casing is the body of the project which is composed of plastic. The casing can be made from hard cardboard. The edges of the casing should be properly sealed making it a proper vacuum. The edges of the casing are sealed using a plastic of Paris material which seals the edges properly.

Fig. Casing with two chambers for vacuum and battery

4.4.7 Wiring and clamps-

The wiring is connected in such a way that the live wires are connected directly and taped to prevent short circuits. The neutral wire is attached to the switch and the wires are connected to the battery using the clamps on the terminals.

Other components like steel mesh, mesh, plaster puncher, hard rubber, and mounting hard brush are used in the project.

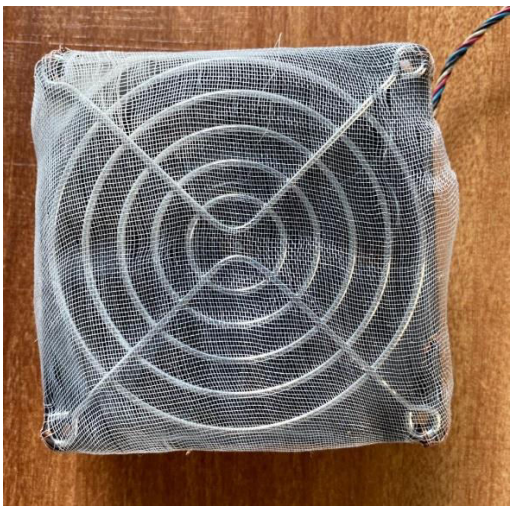

Fig. DC motor with steel casing and mesh

Chapter 5
RESULTS AND DISCUSSIONS

5.1 RESULTS OF THE PROJECT

This is a project that aims to develop a device that can clean blackboard dusters efficiently and with minimum human intervention. This project was achieved in cleaning the surface of the duster using the vacuum pump. It showed a positive result. This project is able to clean the duster to about 80% and store the collected chalk powder. It was able to clean the full fiber surface in around 12 seconds. Also, it showed the following results:

5.1.1 Increased Efficiency: Manual cleaning of blackboards can be a tedious and time-consuming task, especially in larger classrooms or lecture halls where multiple blackboards need to be cleaned. A vacuum-powered blackboard duster would help to speed up the cleaning process, reducing the time and effort required for manually cleaning the duster's surface.

The device could be designed to automatically move across the surface of the blackboard and collect chalk dust and debris, eliminating the need for a person to wipe down the board manually. This would help to increase efficiency, allowing teachers to focus on other important tasks.

5.1.2 Improved Cleanliness: Cleaning the blackboard can often leave behind chalk dust or streaks on the blackboard surface. A vacuum-powered cleaner would be more effective at removing all traces of chalk dust from duster, resulting in a cleaner duster which cleans the blackboard surface.

The device could be designed other attachments that can scrub the surface of the blackboard duster to remove stubborn marks or stains.

5.1.3 Reduced Health Risks: Teachers and students can be exposed to harmful dust particles from chalk, which can cause respiratory problems over time. A vacuum-powered blackboard cleaner would help to reduce the amount of dust released into the air, resulting in a healthier environment.

The device could be designed to capture and contain the chalk dust, preventing it from being released into the air. This would help to reduce the risk of health problems for teachers and students who spend time in classrooms with blackboards.

5.1.4 Cost Savings: A vacuum-powered blackboard cleaner could lead to cost savings for schools and other institutions that use blackboards regularly. It could reduce the amount of time and effort required for manual cleaning, allowing teachers to focus on other important tasks.

The device could also reduce the need for cleaning supplies such as rags, cleaning sprays, and other materials. This would help to reduce costs over time, resulting in savings for schools and other institutions that use blackboards regularly.

5.2 DISCUSSIONS

The cost of developing and implementing a vacuum-powered blackboard cleaner could be a significant concern for schools and institutions. In addition to the initial cost of purchasing the device, there may be ongoing costs associated with maintenance and repairs. Schools and institutions may need to weigh the potential benefits of the cleaner against these costs and determine whether it is a worthwhile investment.

The effectiveness of a vacuum-powered blackboard cleaner could depend on a variety of factors, such as the size and material of the blackboard, the design of the cleaner, and the skill of the user. Schools and institutions may want to consider testing the device on different types of blackboards to ensure that it is effective in a range of settings.

As with any piece of equipment, a vacuum-powered blackboard cleaner would require some maintenance over time. This could include cleaning or replacing filters, replacing worn-out parts, and ensuring that the device is functioning properly. Schools and institutions may need to allocate time and resources for this maintenance to ensure that the cleaner remains effective over time.

The potential health and safety risks associated with a vacuum-powered blackboard cleaner could be a concern for schools and institutions. For example, the device may generate noise or emit harmful fumes or particles. Schools and institutions may want to ensure that the cleaner is designed to minimize these risks and that it is safe for use in a classroom setting.

To ensure that the vacuum-powered blackboard cleaner is used effectively, schools and institutions may need to provide training to teachers and other staff. This could include training on how to use the device properly, how to clean and maintain it, and how to troubleshoot any issues that arise. Providing adequate training could help to ensure that the cleaner is used safely and effectively.

By considering these factors and discussing them openly, schools and institutions may be able to develop a vacuum-powered blackboard cleaner that is effective, safe, and beneficial for educators and students.

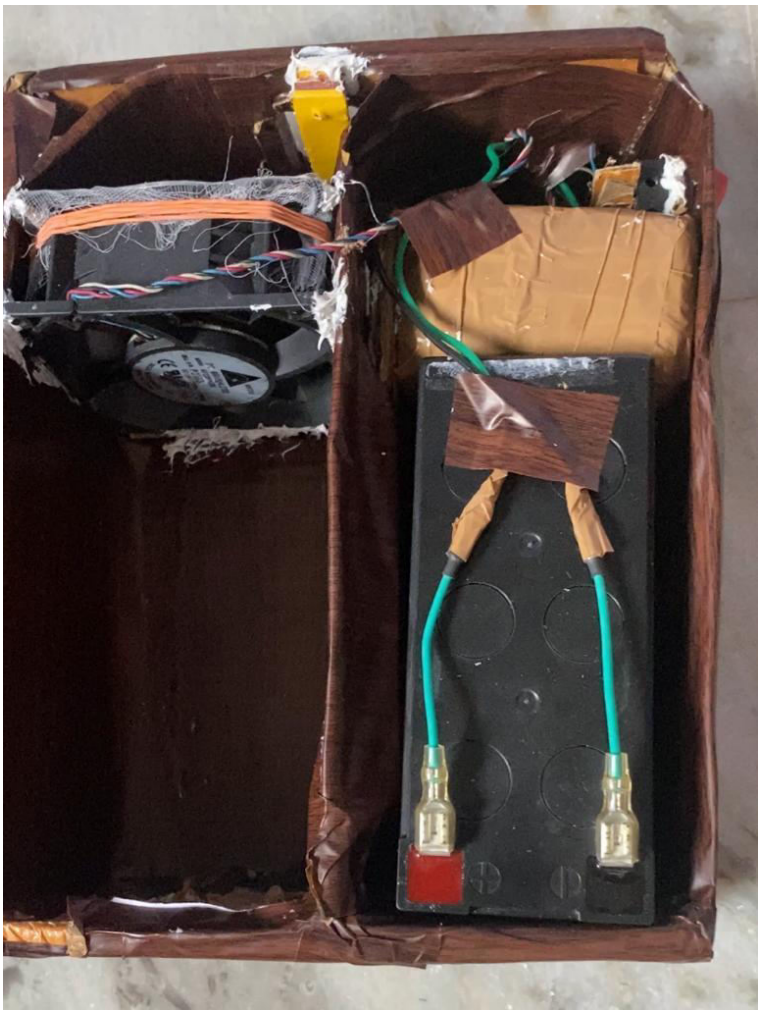

Fig. Casing with all components mounted.

Chapter 6

SUMMARY AND CONCLUSIONS

This project is an innovative idea that seeks to use modern technology to improve the classroom environment. The vacuum-powered blackboard duster cleaning project involves developing and implementing a device that uses vacuum technology to clean dusters in classrooms. While the project offers potential benefits, such as reducing the amount of chalk dust released into the air and saving time for teachers, it also raises concerns about cost, effectiveness, maintenance, health and safety, and training. To address these concerns and ensure that the device is safe, effective, and beneficial for educators and students, schools and institutions may need to carefully consider the potential benefits and challenges associated with introducing this type of technology into the classroom. By doing so, they may be able to develop a vacuum-powered blackboard cleaner that is effective, safe, and easy to use, ultimately improving the classroom environment for both teachers and students.

One of the main concerns with the vacuum-powered blackboard cleaner is cost. Schools and institutions may not have the financial resources to invest in this type of technology, particularly given other pressing needs such as updating technology infrastructure or hiring additional staff. Additionally, there may be ongoing costs associated with maintenance and repairs, which could further strain limited budgets. To address these concerns, developers of the vacuum-powered blackboard cleaner may need to consider ways to keep costs low, such as using affordable materials or designing the device for easy maintenance and repair.

Another concern is effectiveness. The device must be able to effectively clean blackboards of different sizes and materials, and it must be easy to use for teachers and other staff. To ensure that the device is effective, schools and institutions may need to conduct testing in a range of settings to determine whether the cleaner is able to effectively remove chalk residue and other markings. Additionally, designers may need to consider the ergonomics of the device, such as its weight and size, to ensure that it is easy for teachers and other staff to use without causing strain or injury.

Maintenance is another key consideration. Like any piece of equipment, a vacuum-powered blackboard cleaner will require some maintenance over time, such as cleaning or replacing filters and ensuring that parts are functioning properly. Schools and

institutions may need to allocate time and resources for this maintenance to ensure that the device remains effective over time. Additionally, designers may want to consider how easy the device is to repair, so that minor issues can be quickly addressed without requiring costly repairs or replacements.

Health and safety are also a major concern. The device must not generate any harmful fumes or particles that could affect the health of teachers or students. Additionally, the noise generated by the device could be a concern, particularly for students with hearing impairments or sensory sensitivities. To address these concerns, designers may need to consider ways to minimize noise and emissions, such as using high-quality filters or developing a quieter motor.

Finally, training is critical to ensuring that the vacuum-powered blackboard cleaner is used effectively. Teachers and other staff may need training in how to use the device properly, how to clean and maintain it, and how to troubleshoot any issues that arise. Providing adequate training could help to ensure that the cleaner is used safely and effectively, ultimately improving the classroom environment for both teachers and students.

In conclusion, the vacuum-powered blackboard cleaning project offers potential benefits to schools and institutions but also raises a range of concerns around cost, effectiveness, maintenance, health and safety, and training. To address these concerns and ensure that the device is safe, effective, and beneficial for educators and students, developers may need to carefully consider the potential benefits and challenges associated with introducing this type of technology into the classroom. By doing so, they may be able to develop a vacuum-powered blackboard cleaner that is effective, safe, and easy to use, ultimately improving the classroom environment for both teachers and students.

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