

FABRICATION OF VACUUM CLEANER FOR DRY AND WET ENVIRONMENTS

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ABSTRACT: Cleaning floors and surfaces is an important task in homes, offices, and public places. Traditional cleaning methods require more time and physical effort. This project proposes a compact multipurpose cleaning device that combines vacuum suction, water spraying, air blowing, and wiping functions in a single handheld machine. The device uses a small vacuum motor to remove dust, a mini water pump to spray cleaning liquid, and a cloth or wiper to clean and dry the surface. The system is operated using simple switches and powered by a battery or external supply. The design is lightweight, low-cost, and easy to operate. This multipurpose cleaning machine helps save time, reduce effort, and improve cleaning efficiency in indoor environments.

KEYWORDS: Vacuum Cleaner, Wet and Dry Cleaning, Multipurpose Cleaner, Dust Suction, Water Spray, Air Blower, Portable Device, Floor Cleaning System

I. INTRODUCTION

A. Introduction :

vacuum cleaner is an electrically operated cleaning device that uses suction pressure to remove dust, dirt, debris, and liquid waste from surfaces such as floors, carpets, upholstery, walls, and industrial equipment. The suction is created by a high-speed electric motor coupled with a centrifugal fan or impeller. When the motor rotates, it creates a low-pressure region inside the vacuum chamber, allowing atmospheric pressure to push air along with dust particles into the machine. The dust-laden air passes through filters where dirt is trapped,



Fig. 1. Professional-grade wet and dry vacuum cleaner (Kärcher NT 22/1 Ap L) with semi-automatic filter cleaning. and clean air is expelled back into the environment. Vacuum cleaners have become an essential appliance in domestic, commercial, and industrial sectors due to increasing awareness of hygiene, sanitation, and health. Modern vacuum cleaners are designed with advanced filtration systems such as HEPA filters, cyclonic separation mechanisms, and multi-stage filtration units to ensure efficient dust removal and clean air discharge. The wet and dry vacuum cleaner is a versatile improvement over conventional dry vacuum cleaner. It is capable of cleaning both solid dust particles and liquid spills. This makes it suitable for workshops, industries, hospitals, households, and construction sites. The fabrication of a wet and dry vacuum cleaner involves the integration of mechanical components (motor, tank, impeller,

filters), electrical systems (wiring, switches, power supply), and structural elements (casing, wheels, hose assembly). The design aims to provide strong suction power, durability, easy handling, and safe operation.

B. History of Vacuum-Cleaning Technology:

The concept of vacuum-cleaning dates back to the 19th century when cleaning was done manually using brooms and brushes. The first mechanical cleaning device was invented in 1860 by Daniel Hess, which used bellows to generate suction. However, it was manually operated and not very effective. In 1901, Hubert Cecil Booth invented the first powered vacuum cleaner that used an electric motor to create suction. It was a large machine and mainly used for industrial purposes. Later, James Murray Spangler developed a portable electric vacuum cleaner in 1907, which was later commercialized by William Hoover, making the Hoover brand popular worldwide. Initially, vacuum cleaners were bulky, expensive, and limited to dry dust cleaning. Over time, advancements in electric motors, lightweight materials, and compact designs made vacuum cleaners more affordable and efficient. The introduction of plastic materials reduced weight and manufacturing cost.

C. Types of Vacuum Cleaners:

Vacuum cleaners are available in various shapes and designs, each developed to meet different cleaning requirements, user preferences, and space conditions. The selection of a suitable vacuum cleaner depends on factors such as floor type, size of the area, portability, storage space and required suction power. Based on design and form factor, vacuum cleaners are mainly classified as upright, canister, stick, handheld and robotic types.

1. Upright Vacuum Cleaner:

Upright vacuum cleaners are the most traditional and commonly used models. In this design, the motor, suction head, and dust collection unit are combined into a single vertical body. These machines provide strong suction power and wide cleaning coverage, making them suitable for homes with large carpeted areas. They are easy to store in a standing position but may be bulky and less flexible when cleaning narrow or hard-to-reach spaces.

2. Canister Vacuum Cleaner:

Canister vacuum cleaners consist of a separate motor and dust collection unit mounted on wheels, connected to a suction head through a flexible hose. This design provides greater manoeuvrability and ease of use, especially for cleaning stairs, furniture, curtains, and corners. They are versatile and effective for multi-surface cleaning, though they require slightly more storage space.

3. Stick Vacuum Cleaner:

Stick vacuum cleaners are slim, lightweight, and often cordless. They are designed for quick and everyday cleaning tasks. Due to their compact design and rechargeable battery operation, they are convenient for small apartments and hard floors. However, they generally offer lower suction power and limited operating time compared to larger models.

4. Handheld Vacuum Cleaner

Handheld vacuum cleaners are compact and highly portable devices intended for small cleaning jobs such as car interiors, sofas, and minor spills. They are easy to handle and store but have limited dust capacity and shorter battery life.

5. Robotic Vacuum Cleaner

Robotic vacuum cleaners are automated machines that clean floors independently using sensors and smart navigation systems. They are suitable for daily maintenance cleaning and provide hands-free operation. Although convenient, they may not be ideal for deep cleaning or heavily cluttered areas.

D. Need for Dry and Wet Vacuum Cleaner

In modern environments, cleaning requirements are not limited to dry dust removal alone. In homes, industries, workshops, and commercial spaces, both solid waste and liquid spills are commonly generated. Traditional vacuum cleaners are designed only for dry dust collection and may get damaged if used for cleaning liquids. This limitation creates the need for a wet and dry vacuum cleaner.

A wet and dry vacuum cleaner is specially designed to handle both dry debris and liquid waste safely and efficiently. It is equipped with a powerful suction motor, a durable collection tank, special filtration systems, and a float mechanism that prevents water from entering the motor compartment. This design ensures safe operation during wet cleaning tasks.

The need for such a vacuum cleaner arises from its multipurpose functionality. Instead of using separate machines for dry and wet cleaning, a single machine can perform both tasks. This reduces equipment cost, saves time, minimizes manual

effort, and improves overall cleaning efficiency. In industrial areas where metal chips, dust, oil spills, and chemical liquids are common, a wet and dry vacuum cleaner becomes essential for maintaining cleanliness and safety. Similarly, in homes and commercial places, it helps in quickly removing water spills and preventing accidents caused by slippery surfaces.

E. Applications:

Wet and dry vacuum cleaners are widely used in various sectors due to their versatility and efficiency. In residential areas, they are used for cleaning floors, carpets, sofas, garages, and outdoor spaces. They are especially useful for cleaning water spills, clogged sinks, and damp surfaces. In commercial establishments such as hotels, offices, shopping malls, and hospitals, these machines help maintain hygiene and cleanliness in large areas. They are effective in removing both dust and accidental liquid spills and in industrial environments like factories, workshops, and construction sites, wet and dry vacuum cleaners are used to collect metal chips, sawdust, cement dust, oil spills, and other industrial waste. They improve workplace safety and ensure proper maintenance of equipment also in the automotive sector, they are used to clean vehicle interiors and service stations. Overall, their wide range of applications makes them an essential cleaning device in modern environments.

F. Basic Principle of Vacuum Cleaner

Vacuum cleaning is an efficient method of removing dust, dirt, and unwanted particles from surfaces using suction force. The basic principle of vacuum cleaning is the creation of a pressure difference that causes air to move from a high-pressure region to a low-pressure region. This airflow carries dust particles into the vacuum cleaner for collection. The operation of a vacuum cleaner is based on air pressure variation, fluid mechanics, and energy conversion.

Under normal conditions, atmospheric air exerts pressure equally in all directions. When the pressure inside the vacuum cleaner is reduced below atmospheric pressure, air naturally flows into the machine to balance the pressure difference. This movement of air is the fundamental working principle of vacuum cleaning.

Inside the vacuum cleaner, an electric motor rotates a blower fan at high speed. The rotating fan pushes air out through the exhaust outlet, reducing the pressure inside the chamber and creating a partial vacuum. Due to higher atmospheric pressure outside, air rushes into the vacuum cleaner through the suction nozzle and hose. The incoming air carries dust, dirt, hair, and small debris along with it.

The air and dust mixture passes through a filtration system or dust bag where solid particles are separated and stored. Clean air is then expelled back into the atmosphere. The cleaning performance depends on suction pressure, airflow rate, motor power, and filter efficiency. A well-designed nozzle increases airflow velocity, helping to lift and remove dust effectively. In wet and dry vacuum cleaners, the same pressure difference principle is used to collect both solid and liquid waste. Liquid is stored in a separate tank, and safety mechanisms such as float valves prevent water from entering the motor.

Thus, vacuum cleaning works by converting electrical energy into mechanical energy to create airflow and suction, ensuring efficient and hygienic cleaning.

II. LITERATURE REVIEW

James Dyson (1993) conducted research on the development of cyclonic vacuum cleaner technology which eliminates the use of traditional dust bags. His study showed that cyclonic separation uses centrifugal force to separate dust particles from air, thereby maintaining constant suction power and improving cleaning efficiency in vacuum cleaners [1]. J. A. Brockmann and H. R. Johnson (2001) investigated the performance of filtration systems used in domestic vacuum cleaners. Their research focused on particle penetration through filters and concluded that high-efficiency particulate air (HEPA) filters significantly reduce the release of fine dust particles into indoor environments [2]. S. W. Lee and J. H. Kim (2005) conducted an experimental study on airflow characteristics inside vacuum cleaner suction systems. The results demonstrated that optimizing the internal airflow path reduces turbulence and improves suction efficiency, which enhances overall vacuum cleaner performance [3]. R. Brown (2008) studied the effectiveness of wet vacuum-cleaning systems in removing liquid spills and fine dust particles. The study revealed that wet vacuum cleaners are capable of collecting both liquid and solid contaminants simultaneously, making them suitable for industrial and

commercial cleaning applications [4]. M. K. Gupta and P. Sharma (2012) researched the design and performance of a portable wet and dry vacuum cleaner for domestic cleaning purposes. The results indicated that combining high-speed suction motors with efficient filtration systems significantly improves cleaning efficiency and reduces dust emissions [5]. A. Kumar, S. Verma and R. Singh (2014) conducted a study on the design and fabrication of a multipurpose floor cleaning machine capable of sweeping and vacuuming operations. The study concluded that integrating multiple cleaning functions into a single machine reduces cleaning time and increases operational efficiency [6].

T. Nakamura and Y. Tanaka (2016) performed a detailed analysis on cyclone dust separator technology used in vacuum cleaners. Their research demonstrated that multi-cyclone systems can effectively separate fine dust particles from airflow and maintain strong suction performance [7]. L. Wang, H. Zhang and X. Chen (2018) carried out a computational fluid dynamics (CFD) analysis on airflow patterns within vacuum cleaner ducts. The study showed that optimized duct design reduces pressure losses and enhances the overall suction efficiency of the vacuum cleaner [8]. R. Patel and K. Shah (2019) investigated the performance of wet and dry vacuum cleaners in industrial cleaning applications. Their research showed that these vacuum cleaners are capable of removing both liquid waste and dry debris effectively in workshops and factories [9]. S. Ahmed and M. Rahman (2021) conducted research on energy-efficient vacuum cleaner design using improved motor technology. The study concluded that brushless motors and advanced filtration systems can significantly reduce power consumption while maintaining strong suction performance [10]. D. Miller (2003) studied the impact of vacuum cleaner exhaust on indoor air quality. The research indicated that poorly designed vacuum cleaners may release fine particles into the air, emphasizing the need for proper filtration systems [11]. K. Thompson and J. Walker (2006) analyzed the efficiency of bagless vacuum cleaners. Their findings suggested that bagless designs reduce maintenance costs and maintain stable suction performance when combined with cyclonic dust separation [12]. H. Suzuki and T. Yamamoto (2007) conducted research on noise reduction in vacuum cleaners.

The study introduced improved muffler designs and airflow control methods to reduce operational noise without affecting suction performance [13]. P. Anderson and R. Clark (2010) investigated dust collection efficiency in industrial vacuum cleaners. Their results showed that multi-stage filtration systems improve dust capture efficiency and prevent the release of harmful particles [14]. S. Gupta and N. Sharma (2011) developed a compact vacuum cleaner design for small households. The research highlighted the importance of lightweight materials and compact motor design for improving portability [15]. A. Rodriguez and L. Martinez (2013) studied cyclone separator efficiency in vacuum cleaner systems. Their research found that cyclone separators can remove a large percentage of dust particles before the air reaches the filter [16]. Y. Li and Z. Chen (2015) investigated airflow optimization in vacuum cleaner suction motors. The study showed that improved motor blade design can increase airflow rate and enhance cleaning performance [17]. R. Singh and P. Verma (2016) conducted research on the development of an automatic robotic vacuum cleaner. The study demonstrated that sensors and navigation systems enable robots to clean floors autonomously without human intervention [18].

M. Johnson and K. Peters (2017) analyzed the durability and performance of industrial wet and dry vacuum cleaners. Their study concluded that stainless steel collection tanks improve durability and corrosion resistance [19]. B. Kumar and S. Patel (2018) studied the effect of suction pressure on vacuum cleaner performance. The research revealed that higher suction pressure improves debris collection efficiency but requires proper motor cooling [20]. N. Zhang and L. Huang (2019) performed a study on filtration efficiency in modern vacuum cleaners. The results showed that multi-layer filtration systems significantly improve dust retention [21].

R. Mehta and A. Shah (2020) conducted an experimental study on portable wet and dry vacuum cleaners for workshop environments. Their research concluded that portable systems improve cleaning flexibility and reduce manual labour [22]. S. Das and P. Roy (2021) analyzed energy consumption in household vacuum cleaners. The study recommended energy-efficient motors and optimized airflow designs to reduce electricity usage [23]. H. Kim and J. Park (2022) researched the use of smart sensors in robotic vacuum cleaners. Their study showed that sensor-based navigation improves cleaning coverage and avoids obstacles effectively [24]. A. Verma and S. Mishra (2023) conducted research on the design and development of a multifunctional wet and dry vacuum cleaner for industrial applications. The study demonstrated that combining strong suction motors with efficient filtration and durable tanks improves cleaning performance and reliability [25].

III. METHODOLOGY

G. Introduction

The design and fabrication of the dry and wet vacuum cleaner. The methodology includes problem identification, design planning, selection of materials, fabrication of components, assembly of the system, working process, and performance testing. The main objective of this methodology is to develop a simple, efficient, and low-cost vacuum cleaner capable of removing both dry dust particles and liquid waste from different environments such as homes, laboratories, workshops, and industries.

H. Problem Identification

In many environments such as homes, laboratories, workshops, and industrial areas, cleaning activities involve both dry dust and wet liquid waste. Most conventional vacuum cleaners are designed only for dry dust cleaning and cannot handle liquids effectively. If liquids are sucked into a normal vacuum cleaner, it may damage the motor and internal parts. Due to this limitation, users often require separate equipment for dry and wet cleaning, which increases cost and effort. Therefore, the problem identified in this project is the need for a single vacuum-cleaning system capable of handling both dry dust and liquid waste efficiently and safely.

I. Design Planning

The design of the dry and wet vacuum cleaner is based on the principle of suction and pressure difference. A high-speed electric motor drives a suction fan or impeller that creates a pressure difference inside the collection container. Due to this pressure difference, air along with dust particles or liquids is drawn into the vacuum cleaner through the suction pipe.

The main components included in the design are:

Electric motor, Suction fan or impeller, Collection tank, Flexible suction hose, Nozzle attachments, filter system, Supporting body or frame.

The design ensures that the system can work effectively in both dry and wet cleaning conditions without causing damage to the motor.



Fig. 2. System components and materials used for assembly

J. Selection of Materials:

Material selection is an important step in the methodology. Materials are selected based on durability, availability, cost, and resistance to moisture.

The main materials used in the fabrication of the vacuum cleaner include:

Plastic or metal container used as the collection tank

High-speed electric motor to generate suction

Flexible PVC pipe used as the suction hose

Filter materials such as cloth or sponge filters

Metal or plastic frame for structural support

Rubber wheels for easy movement

These materials ensure that the vacuum cleaner can operate efficiently and withstand both dust and liquid waste.



Fig. 3. Fabrication components ready for assembly

K. Fabrication of Components:

After selecting the required materials, the fabrication process begins. The major components are prepared according to the design. Container Preparation:

A suitable airtight container is selected to collect both dust and liquid waste. The container must be properly sealed to maintain suction pressure inside the system.

1) Motor Mounting

The electric motor is mounted securely on the top portion of the container. The motor is connected to a suction fan or impeller that produces airflow and suction.

a) Suction Pipe Installation

A flexible suction pipe is connected to the inlet opening of the container. This pipe helps collect dust particles and liquids from the surrounding environment.

b) Filter Installation

Filters are installed inside the container to separate dust particles from the airflow. In wet cleaning mode, the filter also helps prevent water droplets from reaching the motor.

L. Assembly of the Vacuum Cleaner

After fabrication, all the components are assembled together to form the complete vacuum-cleaning system. The motor, suction fan, container, hose pipe, and filter system are connected properly. Special attention is given to airtight sealing to prevent air leakage. Electrical connections are insulated properly to ensure safe operation. The assembled vacuum cleaner is then checked for stability and proper functioning.



Fig. 4. Fabricated model of Wet and dry Vacuum Cleaner

M. Working Method in Dry Environment

In dry cleaning mode, the vacuum cleaner is used to remove dust, sand, and small debris from surfaces such as floors, carpets, and workbenches.

When the motor is switched on, the impeller rotates at high speed and creates a low-pressure region inside the container. Due to this pressure difference, air carrying dust particles enters through the suction hose.

The dust particles are collected in the container, while the air passes through the filter and exits through the motor outlet. The filter prevents dust from entering the motor.

N. Working Method in Wet Environment

In wet cleaning mode, the vacuum cleaner is used to remove liquids such as spilled water or wet dirt from surfaces. The suction process is similar to dry cleaning. However, in this case, liquid waste is sucked through the hose pipe into the collection container.

The container is designed to hold liquids safely without leakage. Some designs also include a float mechanism or special filter to prevent liquid from reaching the motor. After cleaning, the collected liquid can be drained easily.

O. Testing and Performance Evaluation

After assembly, the vacuum cleaner is tested under both dry and wet conditions to evaluate its performance.

The testing includes:

Checking suction power

Observing dust collection efficiency

Testing liquid suction capability

Inspecting for air leakage

Ensuring motor safety during wet operation

These tests help determine the efficiency and reliability of the system.

P. Safety Considerations

Safety measures are necessary to ensure proper operation of the vacuum cleaner. Electrical connections should be properly insulated to prevent electric shock. The motor should be protected from water contact during wet cleaning. Regular cleaning of filters and proper sealing of the container also help maintain efficient performance and safety.

IV. RESULTS AND DISCUSSION

Q. Testing of Dry Vacuum Operation

The vacuum cleaner was first tested in a dry environment to evaluate its ability to collect dust and small solid particles. Materials such as dust, sand, and small debris were placed on a flat surface and the vacuum cleaner was operated. During the test, the vacuum cleaner successfully sucked the dust particles through the suction hose and collected them in the container. The filter system prevented dust from entering the motor and allowed clean air to pass through the outlet. The test confirmed that the system can effectively remove dry dust and small debris from surfaces such as floors, workbenches, and carpets.

R. Testing of Wet Vacuum Operation

The vacuum cleaner was also tested in a wet environment to evaluate its liquid suction capability. Small quantities of water were spread on a surface and the vacuum cleaner was used to remove the liquid. The system successfully sucked the liquid through the hose pipe and collected it inside the container without leakage. The motor operated safely, and the filter system helped prevent water droplets from reaching the motor. This test showed that the vacuum cleaner can handle wet cleaning tasks such as removing spilled water and wet dirt.

S. Performance Analysis

The performance of the fabricated vacuum cleaner was evaluated based on several factors:

Suction Power: The motor generated sufficient suction to collect dust and small amounts of liquid.

Dust Collection Efficiency: The vacuum cleaner effectively removed dust particles from surfaces.

Liquid Collection Capability: The system successfully collected small quantities of liquid without leakage.

Motor Protection: The filter system helped protect the motor from dust and moisture.

The overall performance of the vacuum cleaner was found to be satisfactory for small-scale cleaning applications.

T. Advantages of the System

The fabricated dry and wet vacuum cleaner offers several advantages: Capable of cleaning both dry dust and liquid waste

Simple design and easy operation

Low cost and easily available materials

Suitable for various environments such as homes, workshops, and laboratories Reduces manual cleaning effort

U. Limitations

Although the system performs effectively, some limitations were observed: The suction power may be lower compared to commercial vacuum cleaners. It is suitable mainly for small-scale cleaning tasks.

Large quantities of liquid may require a larger container capacity.

V. Discussion

From the experimental results, it can be concluded that the fabricated dry and wet vacuum cleaner performs effectively in both dry and wet cleaning conditions. The system demonstrates the practical application of suction and pressure difference principles for cleaning purposes.

The results indicate that the project successfully achieved its objective of developing a simple and efficient vacuum cleaner capable of handling both dry and wet waste.

V. ADVANTAGES

Wet and dry vacuum cleaners offer several advantages compared to conventional cleaning methods. One of the main advantages is their versatility, as they can clean both dry dust and liquid spills using a single machine. This eliminates the need for separate equipment for wet and dry-cleaning tasks. They provide efficient and powerful suction, which ensures deep cleaning of surfaces such as floors, carpets, and industrial work areas. These machines help in maintaining better hygiene by preventing dust particles from spreading into the air, thereby improving indoor air quality.

Wet and dry vacuum cleaners save time and reduce manual effort compared to traditional cleaning methods like sweeping and mopping. They are especially useful in industrial and commercial environments where both solid and liquid waste are generated regularly. The presence of safety features such as float valves prevents water from entering the motor, ensuring safe operation. Another advantage is their durability and large storage capacity, particularly in industrial models. They are capable of handling heavy debris, metal chips, sawdust, and liquid waste efficiently.

VI. LIMITATIONS

Despite their advantages, wet and dry vacuum cleaners also have some limitations. These machines are generally more expensive than regular dry vacuum cleaners due to their advanced features and dual functionality. They are usually heavier and bulkier, which may reduce portability and require more storage space. Regular maintenance is necessary to keep the machine functioning properly, especially cleaning filters and emptying the tank after wet use to prevent odor and bacterial growth.

Noise level can also be higher in powerful industrial models. Additionally, improper handling during wet cleaning may lead to electrical hazards if safety precautions are not followed. Overall, while wet and dry vacuum cleaners have a few limitations, their versatility, efficiency, and wide range of applications make them highly beneficial in modern cleaning systems.

VII. CONCLUSIONS

The dry and wet vacuum cleaner was successfully designed and fabricated to remove both dust particles and liquid waste. The system operates based on the principle of suction created by an electric motor and impeller. During testing, the vacuum cleaner effectively collected dry dust and small amounts of liquid from different surfaces. The filter system helped protect the motor from dust and moisture, ensuring safe operation. The materials used were simple, low-cost, and easily available. The device can be used in homes, laboratories, workshops, and small industries for cleaning purposes. This project demonstrates that a single device can perform both dry and wet cleaning efficiently. With further improvements in motor power and filter design, the performance of the vacuum cleaner can be enhanced. Overall, the system provides a simple, economical, and effective cleaning solution.

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