

BIODEGRADABLE AIR FILTER USING BANANA FIBER

A PROJECT REPORT

Submitted by

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to

The APJ Abdul Kalam Technological University

in partial fulfilment of the requirements for the award of the Degree

of

Bachelor of Technology

in

MECHANICAL ENGINEERING



DEPARTMENT OF MECHANICAL ENGINEERING

SREE BUDDHA COLLEGE OF ENGINEERING, PATTOOR

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DEPARTMENT OF MECHANICAL ENGINEERING
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CERTIFICATE

This is to certify that the project preliminary report entitled '**BIODEGRADABLE AIR FILTER USING BANANA FIBER**' submitted by **L K DEVAN (SBC20ME055)**, **MUHAMMAD ASHFAQ N (SBC20ME058)**, **SHINAS SHERIEF (SBC20ME068)** to the APJ Abdul Kalam Technological University in partial fulfilment of the requirements for the award of the Degree of Bachelor of Technology in Mechanical Engineering, is a bonafide record of the project work carried out by them under our guidance and supervision.

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DECLARATION STATEMENT

We, the undersigned students, confirm that the work submitted in this the project report is entirely our own work and has not been copied from any other source or person. Any material that has been copied from any other sources has been properly sited and acknowledged in this project.

We are very much aware that any kind of copying or improper citation of references/sources used in this report will be considered as plagiarism, which is a direct violation of Code of Ethics of KTU and Sree Buddha College of Engineering (SBCE).

We are fully aware of legal consequence of committing any such violations of the KTU and SBCE Code of Ethics.

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ABSTRACT

This project aims to design and develop a biodegradable air filter using banana fiber as the primary filtering material. With increasing concerns over environmental pollution and the disposal of non-biodegradable materials, there is a growing need for sustainable alternatives in various industries, including air filtration. Banana fiber, derived from agricultural waste, offers a promising solution due to its natural abundance, low cost, and biodegradability. This involves the extraction and processing of banana fiber to create a porous filtering medium suitable for trapping airborne particles and pollutants. The filtration efficiency and durability of the banana fiber-based filter will be tested using standard air quality testing procedures. Additionally, the biodegradability of the filter will be assessed to evaluate its environmental impact and sustainability. The outcomes of this project have the potential to contribute to the development of eco-friendly air filtration solutions that reduce dependence on synthetic materials and minimize environmental pollution. The biodegradable air filter using banana fiber could find applications in various settings, including indoor air purification, automotive cabin filtration, and industrial air treatment systems.

Keywords: Air Purifier, Air Quality Index, Degradable Filter

CONTENTS

Chapter No.	Title	Page No.
	CERTIFICATE	ii
	DECLARATION	iii
	ACKNOWLEDGEMENT	iv
	ABSTRACT	v
	LIST OF TABLES	vii
	LIST OF FIGURES	viii
	ABBREVIATIONS	ix
1	INTRODUCTION	1
2	LITERATURE REVIEW	3
3	INFERENCE OF LITERATURE SURVEY	7
4	PROJECT OBJECTIVE	9
5	BIODEGRADABLE BANANA FIBER FILTER	10
	5.1 WHY BIODEGRADABLE BANANA FIBER FILTER	10
	5.2 NANOFIBRE MATERIAL	10
	5.3 CLEANING PROCESS OF BANANA FIBRE	12
	5.4 TESTING METHODS	14
	5.5 METHADODOLOGY	15
6	SYSTEM DESIGN AND COMPONENTS	16
	6.1 CAD MODEL	16
	6.2 COMPONENTS DESCRIPTION	16
7	FABRICATION OF THE SYSTEM	20
8	WORKING OF THE SYSTEM	22
9	COST ANALYSIS	24
10	RESULT AND DISCUSSIONS	25
11	CONCLUSIONS	26
12	FUTURE SCOPE OF WORKS	27
	REFERENCES	29

LIST OF TABLES

No.	Title	Page No.
3.1	Literature survey	7
9.1	Materials and its cost	24

LIST OF FIGURES

No.	Title	Page No
5.1	Banana fiber	11
5.2	Testing equipment: APM-550-MINI	15
6.1	3D view of the system	16
6.2	Blower	17
6.3	Electronic thyristor controller	18
6.4	Chemically treated banana fiber	18
6.5	Anemometer	19

ABBREVIATIONS

PM	Particulate Matter
AQI	Air Quality Index
HEPA	High Efficiency Particulate Air
HVAC	Heating, Ventilation and Air Conditioning

CHAPTER 1

INTRODUCTION

Global air pollution has become a significant challenge, leading to approximately 9·0 million premature deaths in 2019 alone. The primary contributor to this staggering figure is air pollution, encompassing both household and ambient sources, which accounted for 6·7 million deaths in the same year. Ensuring quality air, whether at home or in the workplace, is a fundamental human need. Despite ongoing efforts to curb emissions and pollution, the situation has not witnessed substantial improvement. Recent data highlights Delhi as the world's most air-polluted capital for four consecutive years.

The World Health Organization (WHO) emphasizes that indoor air pollution surpasses outdoor air pollution by 5 to 10 times, attributing 4% of global diseases to indoor air quality. Alarmingly, about two million premature deaths annually result from diseases linked to indoor air pollution, as reported by the WHO in 2002. Individuals often resort to natural ventilation as a strategy to enhance indoor air quality and diminish PM_{2.5} concentration indoors, according to Wong and Huang (2004). However, during hazy weather conditions, outdoor PM_{2.5} concentration exceeds that indoors. Consequently, when natural ventilation proves insufficient for air purification, the most effective solution is the use of an air purifier. Amidst an era characterized by industrialization and an increasing dependence on fossil fuels, the consequential rise in air pollution has emerged as a critical global issue. The adverse effects of polluted air on human health, plant life, and the overall environment underscore the need for innovative remedies to restore and preserve air quality. In response to this challenge, our project is dedicated to advancing the development and application of a sophisticated air purifier that employs a degradable nanofiber filter. Unlike conventional air purifiers that use standard filters, which contribute to environmental problems like annual landfill waste and inefficient recycling, our initiative seeks to transform air purification by adopting a degradable nanofiber filter. This state-of-the-art technology not only aims to efficiently eliminate particulate matter and toxic gas pollutants from the air but also strives to minimize the environmental impact associated with traditional air filtration methods. The project holds particular significance in densely populated urban areas where compromised air quality frequently leads to various health issues. By introducing an innovative and environmentally conscious approach to air purification, our project endeavors to contribute to the creation of healthier living environments, aligning with the imperative of sustainable and eco-friendly practices. Through the exploration of degradable nanofiber filters, we aim to alleviate the

repercussions of air pollution while advocating for a sustainable solution that benefits both individuals and communities.

CHAPTER 2

LITERATURE REVIEW

[1] How efficiently can HEPA purifiers remove priority fine and ultrafine particles from indoor air?

Scott D. Lowther^{a,b}, Wei Deng^b, Zheng Fang^b, Douglas Bookerc

Standard air filters are pivotal elements of HVAC (Heating, Ventilation, and Air Conditioning) systems, aiming to enhance indoor air quality by capturing airborne particles like dust, pollen, pet dander, and mold spores. Constructed from materials such as fiberglass or pleated paper, these filters are encased in a cardboard or plastic frame. As air flows through the filter, particles are trapped, preventing their dispersion into indoor environments. The particle filtration efficiency of standard air filters is evaluated using the Minimum Efficiency Reporting Value (MERV) scale, which spans from 1 to 16. Filters with higher MERV ratings demonstrate enhanced effectiveness in capturing smaller particles. However, it's important to consider that higher-rated filters may also impede airflow to some extent. While standard air filters play a vital role in mitigating indoor air pollution, specialized air purifiers offer more comprehensive air purification solutions. These purifiers leverage various technologies, including:

HEPA (High-Efficiency Particulate Air) filtration: Renowned for their exceptional particle capture efficiency, HEPA filters can trap particles as small as 0.3 microns with an efficiency rating of at least 99.97%

Activated carbon filtration: Utilizing activated carbon media, these filters effectively adsorb odors, gases, and volatile organic compounds (VOCs) from the air, enhancing overall air freshness.

UV-C light: UV-C light technology is employed to deactivate and eliminate airborne pathogens such as viruses, bacteria, and mold spores, contributing to a cleaner and healthier indoor environment.

While standard air filters and specialized air purifiers offer significant benefits for indoor air quality, their non-biodegradable nature poses environmental challenges. Most air filters are made from materials that do not readily decompose, such as fiberglass, plastic, and metal components. Improper disposal of used filters can result in environmental pollution and harm to ecosystems. Therefore, it's crucial to implement responsible disposal practices, such as recycling where feasible, to minimize the ecological impact of air filter waste.

In conclusion, while standard air filters and air purifiers play essential roles in improving indoor air quality, their non-biodegradable nature necessitates mindful disposal practices to mitigate harm to the environment. Additionally, advancements in eco-friendly filter materials and recycling initiatives are crucial for reducing the environmental footprint of air filtration systems.

[2] Potential of banana based cellulose materials for advanced applications: A review on properties and technical challenges

Vinay Kumar a, Pritha Chakraborty b, Poonam Janghu c, Mridul Umesh d

The quest for environmentally friendly and non-toxic alternatives to synthetic polymers has led to a surge in interest in biobased materials. Among these, bananas stand out as a natural resource that can be tailored into biocompatible biopolymers, offering non-toxic, biodegradable, and sustainable properties. Banana-derived wastes present a valuable source for extracting commercially significant biopolymers like starch, cellulose, and nanocellulose, which find extensive applications across various fields.

In the medical realm, banana-derived biopolymers and their composites are utilized for diverse purposes such as wound healing, bone plate fabrication, and manufacturing cellulose-based components for medical devices like insulin pumps and pacemakers. Additionally, banana-based nanocellulose holds promise in tissue engineering, biosensing, drug delivery, bioimaging, wound healing, and enzyme immobilization, along with tablet preparation for oral administration.

Beyond medical applications, banana-based polymers find utility in food packaging, biofuel production, and the production of multilayered papers, contributing to environmental sustainability and resource efficiency.

This review delves into the extraction processes of starch, cellulose, nanocellulose, and biopolymers from banana-derived wastes, focusing on extraction and composite preparation methods. It also explores the wide-ranging applications of these derived materials in both health and environmental sectors. The comprehensive discussion provided serves to elucidate the conversion strategies of banana-based waste into value-added products, highlighting their potential in addressing contemporary challenges in medical care and environmental sustainability.

[3] Smart indoor air quality monitoring for enhanced living environments and ambient assisted living

Jagriti Saini a, Maitreyee Dutta b, Gonçalo Marques

The Air Quality Index (AQI) functions as a crucial metric employed to assess and disclose the condition of outdoor air in a specific geographical area. Its primary purpose is to furnish comprehensive information concerning the degree of air pollution present and the potential ramifications for human health. Calculations of AQI typically hinge on the concentration levels of various pollutants, encompassing particulate matter like PM_{2.5} and PM₁₀, ozone, nitrogen dioxide and other pertinent elements

Whether presented numerically or through a system of color-coded indicators, the AQI scale spans from 0 to 500 or extends beyond, categorizing distinct levels. Each category signifies a different tier of air quality, thereby delineating the associated health risks. This scale provides a structured framework for gauging and comprehending the implications of air quality for diverse stakeholders, including the general public, environmental agencies, and policymakers. The multifaceted utility of AQI is evident in its capacity to serve as a valuable tool for public awareness, environmental governance, and policymaking. Its significance lies in facilitating a collective understanding of prevailing air quality conditions and their potential impacts. Essentially, the AQI empowers individuals to make well-informed decisions regarding outdoor activities, offering insights into the potential risks associated with varying levels of air pollution. Moreover, it aids in the formulation and implementation of strategic measures aimed at enhancing air quality and safeguarding public health.

An integral facet of AQI is its representation on a scale that categorizes air quality into different levels, each associated with specific health implications. This categorization enables the public to discern the severity of air pollution and its potential effects on well-being. By providing a clear and accessible framework, For individuals, the AQI acts as a practical guide, influencing decisions about outdoor engagements based on the current air quality status. Ranging from excellent to hazardous, the categories delineate the level of health concern associated with prevailing air conditions. This assists in minimizing exposure to pollutants during periods of compromised air quality, safeguarding individuals, particularly those with respiratory conditions or heightened susceptibility.

The AQI stands as a cornerstone in the collective effort to comprehend, communicate, and address the complex issue of air quality. Its numerical or color-coded representation serves as a universal language for conveying the severity of air pollution, enabling diverse stakeholders to collaborate in safeguarding public health. From individual decision-making to informing environmental policies, the AQI plays a pivotal role in fostering a proactive and informed approach to mitigating the detrimental effects of poor air quality on both human well-being and the environment.

[4] Degradable nanofiber for eco-friendly air filtration: Progress and perspectives

Ye Bian a, Chencheng Zhang a, Hui Wang b, Qi Cao

Air pollution is a major global health threat, but traditional filters contribute to waste issues. Unlike non-degradable counterparts, these filters don't disrupt waste disposal systems. This review explores the latest in degradable nanofiber filters, detailing their composition, filtration performance, and various functionalities. The aim is to create sustainable air filters that meet future needs while being kind to the environment.

Amid these challenges, nanofiber filters have emerged as a promising solution, demonstrating the remarkable capability to achieve both high removal efficiency and low pressure drop. This innovation represents a significant step forward in the quest for sustainable air filtration technologies. The distinctive feature of degradability and environmental sustainability positions degradable nanofiber filters as key players in ensuring efficient filtration while minimizing ecological impact. The focus of this paper is on the state-of-the-art degradable nanofiber filters, specifically tailored for the removal of particulate matter. The categorization based on filter composition allows for a nuanced exploration of diverse categories and their desired filtration performance. By delving into the various functionalities of degradable nanofiber filters, the review provides a thorough understanding of the multifaceted nature of these advanced filtration media. Crucially, the advantages of degradable nanofiber filters extend beyond their filtration prowess. The emphasis on degradability aligns with the imperative of environmental sustainability, addressing the challenges posed by non-degradable filters. This dual benefit makes degradable nanofiber filters pivotal in the quest for a sustainable ecosystem.

Air pollution seriously endangers human health globally. Therefore, the awareness of being unaffected by air pollution has been raised by the public. The global spread of COVID-19 especially urged the use of personal protective equipment. Due to the large specific surface area, small diameter, and porous structure, nanofiber filters have been regarded as promising candidates for achieving high PM removal efficiency and low pressure drop.

CHAPTER 3

INFERENCE FROM LITERATURE SURVEY

Serial no:	Authors	Title	Year	Inference
1	Scott D. Lowthera,b, Wei Dengb, Zheng Fangb, Douglas Bookerc	How efficiently can HEPA purifiers remove priority fine and ultrafine particles from indoor air?	2020	Standard air filters in HVAC systems capture particles to enhance indoor air quality. They're rated by MERV; higher ratings capture smaller particles but may restrict airflow. Specialized air purifiers use HEPA, activated carbon, and UV-C light for comprehensive purification. However, their non-biodegradable nature poses environmental risks, urging responsible disposal and eco-friendly material advancements for reduced environmental impact
2	Vinay Kumar a, Pritha Chakraborty b, Poonam Janghu c, Mridul Umesh d	Potential of banana based cellulose materials for advanced applications: A review on properties and technical challenges	2023	Banana-based biopolymers offer eco-friendly alternatives to synthetic materials, serving various industries from medical to environmental sectors, showcasing their potential for sustainable solutions and waste utilization

3	Jagriti Saini a, Maitreyee Dutta b, Gonçalo Marques	Smart indoor air quality monitoring for enhanced living environments and ambient assisted living	2023	The AQI serves as a tool for the public, environmental agencies, and policymakers to understand and communicate the air quality status. It helps individuals make informed decisions regarding outdoor activities, and it aids in implementing appropriate measures to improve air quality and protect public health.
4	Ye Bian a, Chencheng Zhang a, Hui Wang b, Qi Cao	Degradable nanofiber for eco-friendly air filtration: Progress and perspectives	2023	Air pollution is a major global health threat, but traditional filters contribute to waste issues. Unlike non-degradable counterparts, these filters don't disrupt waste disposal systems. This review explores the latest in degradable nanofiber filters, detailing their composition, filtration performance, and various functionalities. The aim is to create sustainable air filters that meet future needs while being kind to the environment

Table 3.1: Literature review

CHAPTER 4

PROJECT OBJECTIVE

- Developing an air filter using banana fibers
- Achieve sustainability and reduce the environmental impact
- Banana fiber offers a cost-effective alternative to traditional air filter materials

CHAPTER 5

BIODEGRADABLE AIR FILTER

5.1 WHY BIODEGRADABLE BANANA FIBER FILTER

Biodegradable banana fiber filters offer a multifaceted solution to pressing environmental, economic, and technological challenges. By utilizing banana fibers, a renewable and biodegradable resource abundant in regions where bananas are cultivated, these filters address the urgent need to reduce reliance on environmentally harmful materials. The production process of banana fiber filters typically involves repurposing agricultural by-products or waste materials, thereby minimizing waste generation and contributing to the circular economy. Moreover, the biodegradability of banana fibers ensures that once these filters reach the end of their usable life, they naturally decompose, reducing the burden on landfills and mitigating plastic pollution. Beyond their environmental benefits, banana fiber filters offer significant socio-economic advantages, particularly in rural communities where bananas are grown. Furthermore, the adoption of banana fiber filters can stimulate local economies by establishing processing facilities and creating employment opportunities. From a technological standpoint, banana fiber filters demonstrate biocompatibility and safety, making them suitable for a wide range of applications including water purification, food processing, air purification, pharmaceutical manufacturing etc. As industries and consumers increasingly prioritize sustainability, the demand for biodegradable filtration solutions continues to grow. By embracing banana fiber filters, companies can enhance their environmental credentials, differentiate themselves in competitive markets, and contribute to the global transition towards a more sustainable future.

5.2 FIBRE MATERIAL

Material used as fiber: Banana fiber

Banana fiber, derived from the pseudostems of banana plants, has garnered attention as a sustainable and biodegradable material with diverse applications. Among its innovative uses is its application as a biodegradable nanofiber filter, presenting a promising solution to environmental challenges.

Nanofiber filters are characterized by their extremely small diameter, typically in the nanometer range, offering high surface area-to-volume ratios and superior filtration performance compared to conventional filters. Banana fibers possess inherent characteristics that make them well-suited for nanofiber production through processes such as electrospinning. Electrospinning involves the extrusion of a polymer solution or melt through

a charged spinneret to form ultrafine fibers, resulting in nanofibers with diameters on the nanoscale.

One of the key advantages of banana fibers as a nanofiber material is their renewable and biodegradable nature. Being derived from natural sources, banana fibers offer a sustainable alternative to synthetic nanofibers, which are often derived from non-renewable fossil fuels. Moreover, banana fibers are biodegradable, meaning they can be naturally decomposed by microorganisms over time, reducing environmental pollution and waste accumulation.

In addition to their environmental benefits, banana nanofiber filters exhibit excellent filtration properties. The high aspect ratio and surface area of nanofibers enable efficient capture of particulate matter, microorganisms, and pollutants from air or water streams. The nanoscale pore structure of these filters enhances their filtration efficiency while maintaining high airflow rates, making them suitable for various filtration applications.

Furthermore, banana nanofiber filters offer versatility and customization potential. By modifying the processing parameters during electrospinning, the diameter, porosity, and surface chemistry of the nanofibers can be tailored to meet specific filtration requirements. This adaptability allows for the development of filters optimized for different applications, such as air purification, water treatment, and biomedical filtration.

The use of banana nanofiber filters extends beyond environmental applications to include healthcare and biomedical fields. These filters can be utilized in medical masks, respirators, wound dressings, and drug delivery systems, leveraging their biocompatibility, antimicrobial properties, and biodegradability.



Figure 5.1: Banana fiber

However, challenges such as scalability, cost-effectiveness, and mechanical stability need to be addressed to facilitate large-scale production and commercialization of banana nanofiber filters. Research efforts focusing on process optimization, material characterization, and

composite formulations are underway to overcome these challenges and unlock the full potential of banana fibers in nanofiber filtration technology.

In conclusion, banana fiber-based nanofiber filters represent a sustainable, biodegradable, and efficient solution for various filtration applications. Their unique combination of environmental benefits, filtration performance, and versatility positions them as a promising alternative to traditional synthetic filters, contributing to a more sustainable and eco-friendly future

5.3 CLEANING OF BANANA FIBRE PROCESS

Banana fibers, derived from the pseudostems of banana plants, offer a sustainable and eco-friendly alternative to traditional fibers like cotton or polyester. However, before these fibers can be utilized in various applications, they must undergo a thorough cleaning process to remove impurities and enhance their quality. Here's a detailed explanation of each step in the cleaning process

- **Selecting the Cleaning Agent:** Hydrogen Peroxide is used as the cleaning agent. Because it is effective in breaking down organic materials and removing impurities from natural fibers. Compared to some other bleaching agents, hydrogen peroxide is relatively mild and less damaging to fibers. It is considered environmentally friendly compared to chlorine-based bleaching agents, which can produce harmful by-products such as chlorinated organic compounds. Hydrogen peroxide decomposes into water and oxygen during the bleaching process, minimizing environmental impact and reducing the risk of pollution.
- **Scouring:** Scouring involves washing the fibers with hot water and a detergent to remove natural waxes, oils, and other non-cellulosic impurities. This step is crucial for effective bleaching. Typically, the fibers are soaked in a scouring solution consisting of water and a mild detergent or alkali, followed by gentle agitation to facilitate the dissolution and removal of impurities. Temperature control is crucial to optimize the scouring process, with elevated temperatures enhancing the solubility of contaminants while avoiding fiber damage. Thorough rinsing with clean water is then performed to remove any residual scouring solution and dissolved impurities, followed by drying to eliminate excess moisture and prevent fungal growth. Scouring plays a vital role in maintaining the quality and integrity of natural fibers, including banana fiber
- **Bleaching Process:** In the bleaching process for natural fibers, particularly to avoid fungal attack, stringent measures are implemented. Firstly, thorough cleaning and

drying of the fibers before bleaching are essential to remove any existing moisture and organic matter that could serve as a breeding ground for fungi. Secondly, the selection of bleaching agents like hydrogen peroxide, known for its less conducive nature to fungal proliferation compared to chlorine-based bleaches, is crucial. Thirdly, optimizing process parameters such as temperature, pH, and processing time helps create an environment less favorable for fungal growth. Hydrogen peroxide is used as a bleaching agent in banana fiber processing primarily because of its effectiveness in removing natural coloration and impurities from the fibers while maintaining their structural integrity. Its oxidative properties enable it to break down pigments and chromophores present in the fibers, resulting in a desired level of whiteness or brightness. Moreover, hydrogen peroxide is relatively mild compared to chlorine-based bleaching agents, minimizing the risk of fiber damage and environmental pollution

- **Rinsing:** The rinsing process in the cleaning of natural fibers is a critical step aimed at removing residual cleaning agents, impurities, and contaminants from the fibers. After the fibers undergo scouring or bleaching treatments, they are thoroughly rinsed with clean water to ensure complete removal of any remaining detergents, alkalis, or bleach. Multiple rinses may be necessary to ensure thorough cleansing and to prevent any potential residues that could affect the quality or integrity of the fibers. Proper rinsing helps to restore the pH balance of the fibers and eliminates any lingering odors or chemical residues, ensuring that the fibers are clean and ready for further processing. Additionally, rinsing helps to prevent any adverse effects on the environment by minimizing the release of harmful chemicals into wastewater. Overall, the rinsing process is essential for maintaining the cleanliness and purity of natural fibers, such as banana fiber, throughout the cleaning process.
- **Drying:** The drying process in the cleaning of natural fibers is crucial for removing excess moisture and ensuring the preservation of fiber integrity. After rinsing, the fibers are dried to prevent mildew formation and maintain their quality. Proper drying conditions involve spreading the fibers in a well-ventilated area away from direct sunlight to avoid potential damage from heat or UV radiation. Air drying is preferred as it allows moisture to evaporate gradually without subjecting the fibers to harsh conditions. Careful monitoring of drying time is essential to prevent over-drying, which can lead to brittleness or fiber damage. Once thoroughly dried, the fibers are

ready for further processing or storage, ensuring their cleanliness and suitability for various applications.

5.4 TESTING METHODS

Particle Filtration efficiency testing (PM 2.5)

Particle filtration testing for the degradable banana fiber filter is a crucial step in evaluating its efficacy in removing airborne contaminants. With the goal of determining its filtration efficiency, our team has embarked on a comprehensive testing procedure. At the outset, it's essential to establish the baseline airflow rates of both the testing machine and the air purifier. The testing machine, operating at a consistent airflow rate of 10 liters per minute, serves as the controlled environment for assessing the filter's performance. In contrast, the air purifier boasts an airflow rate surpassing 10 cfm which is more than the required testing level, highlighting its potential for high-capacity air purification. However, such a rapid airflow may not be conducive to accurate testing, necessitating the use of a thyristor controller.

By employing a thyristor controller, we can modulate the airflow rate of the air purifier, aligning it with the controlled conditions of the testing machine. This adjustment ensures uniformity across testing parameters, facilitating precise evaluation of the banana fiber filter's filtration efficiency. Through meticulous experimentation, we seek to ascertain the filter's ability to capture and retain particles of varying sizes and compositions.

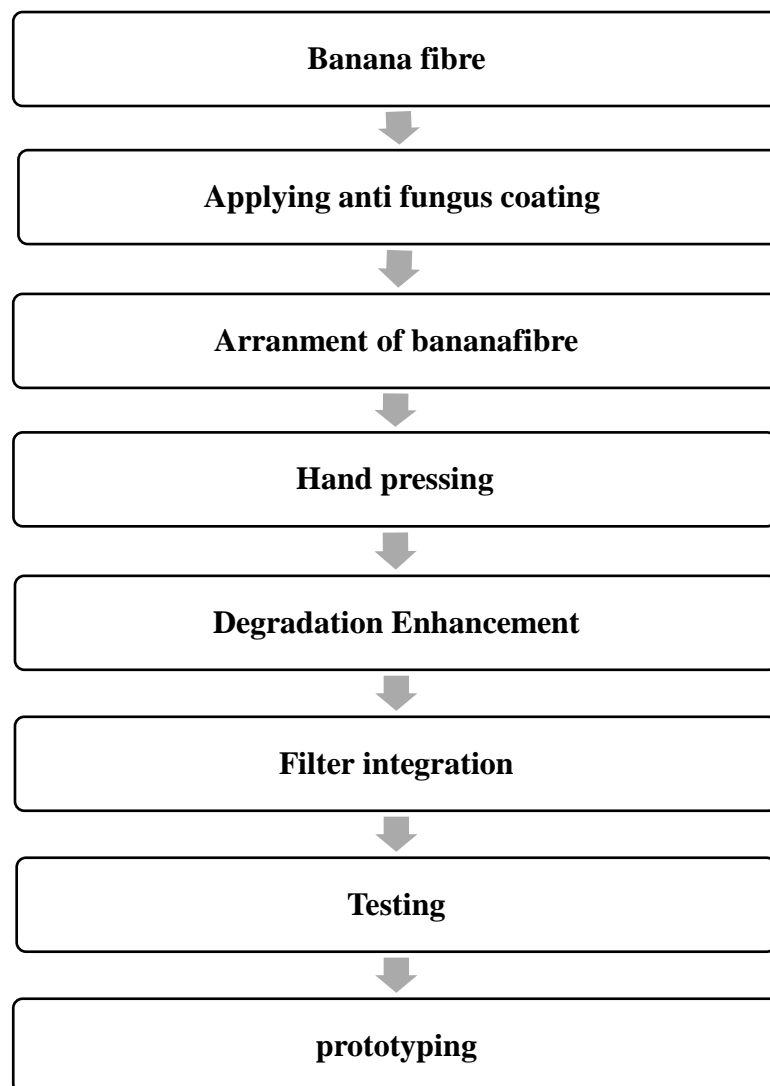
The significance of this research extends beyond mere product evaluation. It holds implications for industries ranging from air quality management to sustainable materials development. As the global emphasis on environmental sustainability intensifies, innovative solutions like degradable banana fiber filters offer promising avenues for mitigating air pollution while minimizing ecological impact.

In summary, our endeavor to assess the filtration efficiency of the degradable banana fiber filter underscores a commitment to advancing both environmental stewardship and technological innovation. Through rigorous testing and analysis, we aim to elucidate its potential as a sustainable solution for improving air quality in diverse settings.



Figure 5.2: Testing equipment: APM-550-MINI

5.5 METHODOLOGY



CHAPTER 6

SYSTEM DESIGN AND COMPONENTS

6.1 CAD MODEL

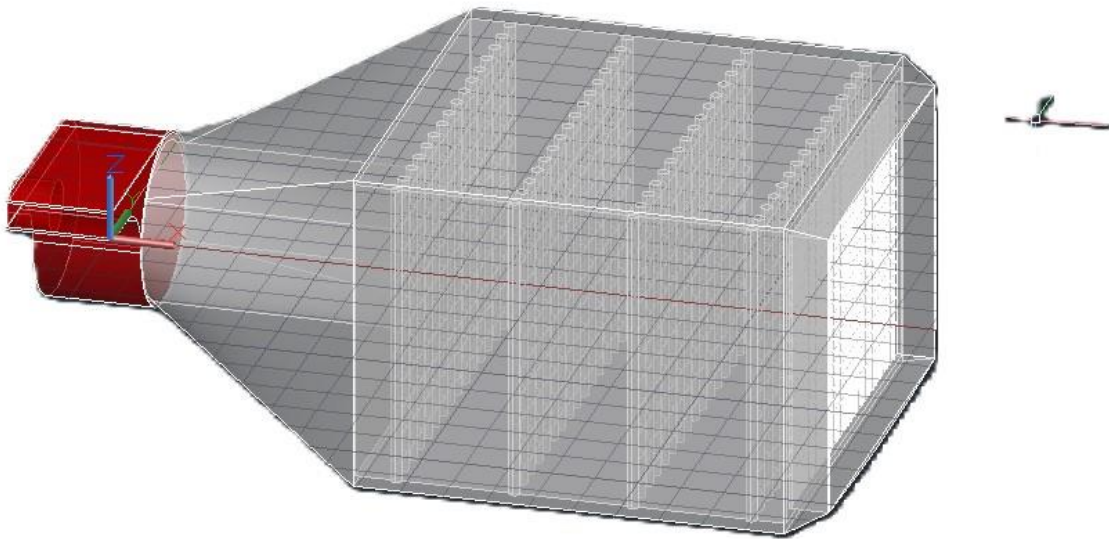


Figure 6.1: 3D view of the system

A biodegradable air filter utilizing banana fiber offers an eco-friendly solution for air purification. Derived from banana stems, this sustainable material is naturally biodegradable, reducing environmental impact. The fiber's fine texture effectively traps airborne particles like dust and allergens, enhancing indoor air quality. Unlike synthetic filters, banana fiber filters decompose over time, minimizing waste and promoting sustainability. With advancements in manufacturing techniques, these filters can provide efficient air purification while remaining environmentally conscious, making them an attractive choice for eco-conscious consumers seeking clean indoor air without sacrificing sustainability.

6.2 COMPONENTS DESCRIPTION

BLOWER

An AC blower, or air conditioner blower, plays a crucial role in air purifiers by circulating air through the device's filtration system. These blowers are typically equipped with high-efficiency motors to ensure quiet operation while effectively moving air through the filters. By continuously circulating air, the blower helps to capture and remove airborne particles

such as dust, pollen, pet dander, and other pollutants, thus improving indoor air quality. The efficiency and performance of the AC blower are key factors in the effectiveness of an air purifier in maintaining clean and healthy indoor air.



Figure 6.2: Blower

THYRISTOR CONTROLLER DEVICE

Thyristor controllers, also known as silicon-controlled rectifiers (SCRs), offer valuable advantages when integrated into air purifiers. By regulating the power delivered to the AC blower motor, thyristor controllers enable precise control over airflow rates, enhancing energy efficiency by allowing the motor to operate at optimal speeds tailored to air quality requirements. This variability in motor speed not only saves energy but also reduces noise levels, making the air purifier suitable for quiet environments and nighttime use. Additionally, thyristor controllers facilitate customized air purification by adjusting airflow rates to match specific needs, ensuring effective filtration tailored to the environment. Furthermore, by operating the blower motor at lower speeds during periods of low air purification demand, thyristor controllers help prolong the lifespan of filters, minimizing wear and tear. In essence, the integration of thyristor controllers enhances overall performance, energy efficiency, noise reduction, customized purification, and filter longevity, resulting in an improved user experience with air purifiers.



Figure 6.3: Electronic thyristor controller

BANANA FIBRE

Chemically treated banana fiber enhances air filter performance by modifying its surface properties to optimize particle capture. Treatments involve applying coatings or additives tailored to augment filtration capabilities, such as positively charged substances to boost electrostatic attraction to particles. Surface morphology alterations increase capture area, often through techniques like etching. Antimicrobial agents inhibit pathogen growth, ensuring clean air. In summary, chemically treated banana fiber offers advanced filtration, bolstering particle capture efficiency, surface area, and antimicrobial properties, making it a reliable choice for air filters aiming to enhance indoor air quality



Figure 6.4: Chemically treated banana fiber

ANEMOMETER

An anemometer is a device utilized to measure the velocity of airflow. When applied in the context of a blower, an anemometer serves the purpose of determining the flow velocity generated by the blower. This measurement is crucial in assessing the performance and

efficiency of the blower system, ensuring that it operates within desired parameters. Anemometers come in various forms, including cup anemometers, vane anemometers, and hot-wire anemometers, each suited to different applications and environments. By accurately measuring airflow velocity, anemometers contribute to the optimization of blower systems, facilitating efficient operation and effective air movement for various industrial, commercial, and HVAC (Heating, Ventilation, and Air Conditioning) applications.



Figure 6.5: Anemometer

CHAPTER 7

FABRICATION OF THE SYSTEM

The fabrication process of a biodegradable air filter incorporating banana fiber begins with the careful selection and preparation of high-quality fibers sourced from the outer sheath of banana stems. These fibers are meticulously cleaned and processed to remove impurities, ensuring optimal filtration performance. Optionally, chemical treatments may be applied to enhance the fibers' filtration properties or durability, further improving their effectiveness in capturing airborne particles.

Once prepared, the banana fibers are assembled into a filter medium designed to fit within a sturdy cuboid-shaped structure measuring 190mm×190mm×61mm. This configuration provides a compact and efficient form factor for the air filter, maximizing its compatibility with various air purification systems. The filter medium is carefully arranged within the cuboid frame, ensuring uniform coverage and optimal airflow through the filter.

To house the filter medium and protect it from external elements, a metal case is utilized. The metal case is specifically designed to enclose the air filter while allowing air to enter through one opened portion. The other end of the metal case is fixed with a blower unit, which plays a crucial role in facilitating the airflow through the filter. The blower unit is equipped with an additional opening, which serves as the outlet for the filtered air to exit the unit.

Integration with the blower unit is a critical step in the fabrication process, as it ensures the efficient flow of air through the filter for effective purification. The blower unit is securely affixed to the metal case, forming a seamless connection that enables the filtered air to be expelled from the unit. This arrangement ensures that the air passing through the filter undergoes thorough purification before being released into the environment.

Throughout the fabrication process, stringent quality control measures are implemented to verify the performance and durability of the biodegradable air filter. Testing procedures assess various factors, including particle capture efficiency, airflow resistance, and overall filtration effectiveness. Only filters that meet stringent quality standards are deemed suitable for distribution and installation in air purification systems.

Once finalized, the biodegradable air filter units are carefully packaged using environmentally friendly materials, aligning with sustainability goals. Clear labeling ensures ease of identification and installation for end-users, promoting widespread adoption of eco-friendly air purification solutions.

So, the fabrication process of biodegradable air filters utilizing banana fiber combines meticulous fiber preparation with innovative design elements, such as the incorporation of a sturdy cuboid-shaped frame and metal case housing. Through careful integration and rigorous quality control, these filters offer effective air purification while minimizing environmental impact, making them a sustainable choice for indoor air quality improvement.



Figure 7.2: Biodegradable air filter

CHAPTER 8

WORKING OF THE SYSTEM

The working principle of a biodegradable air filter, particularly one incorporating banana fiber, involves several key mechanisms aimed at effectively capturing and removing airborne contaminants while promoting sustainability and environmental responsibility. Here's a detailed explanation:

1. Filtration Mechanism:

At the heart of the biodegradable air filter is its filtration mechanism. The filter medium, typically composed of biodegradable materials such as banana fiber, is engineered to trap and capture airborne particles as air passes through it. The fibers in the filter medium act as a physical barrier, intercepting particles of various sizes suspended in the air. Additionally, the fine texture of banana fiber provides ample surface area for particle capture, enhancing the filter's efficiency.

2. Particle Capture:

As air flows through the filter medium, particles in the air stream come into contact with the fibers. Larger particles are captured through inertial impaction, as they collide with and adhere to the fibers due to their mass. Meanwhile, smaller particles are captured through diffusion, as they follow the airflow and collide with fibers due to Brownian motion. Electrostatic attraction may also play a role, particularly if the fibers are treated to enhance their electrostatic properties, thereby improving particle capture efficiency.

3. Airflow Optimization:

The design of the air filter is optimized to ensure adequate airflow while maintaining effective filtration. The size and arrangement of the fibers in the filter medium, as well as the overall geometry of the filter, are carefully engineered to minimize airflow resistance and pressure drop. This ensures that the filter does not impede the flow of air through the ventilation system, thereby maintaining optimal air circulation within the indoor environment.

4. Sustainable Materials:

One of the key distinguishing features of a biodegradable air filter is its use of sustainable and environmentally friendly materials. Banana fiber, derived from the outer sheath of banana stems, is a renewable resource that offers several advantages in terms of sustainability. Unlike synthetic filter materials derived from petrochemicals, banana fiber is biodegradable and compostable, reducing environmental impact and promoting circularity in material usage.

5. Biodegradation:

Over time, the biodegradable components of the air filter naturally break down and decompose, returning to the environment in a harmless manner. Banana fiber, being a natural plant-based material, is readily biodegradable under appropriate conditions, such as exposure to moisture, microbes, and oxygen. This ensures that at the end of its lifespan, the air filter does not contribute to environmental pollution or waste accumulation, aligning with principles of sustainability and ecological stewardship.

6. Integration with Air Purification Systems:

Biodegradable air filters are designed to seamlessly integrate with existing air purification systems, including HVAC (Heating, Ventilation, and Air Conditioning) systems, portable air purifiers, and industrial filtration units. The filters are available in various sizes and configurations to accommodate different applications and airflow requirements. This versatility allows for widespread adoption of biodegradable air filtration solutions across residential, commercial, and industrial settings.

So, the working of a biodegradable air filter involves a combination of effective filtration mechanisms, sustainable materials, and eco-friendly design principles. By capturing airborne contaminants, promoting airflow optimization, and utilizing renewable resources such as banana fiber, these filters offer a sustainable and environmentally responsible solution for improving indoor air quality while minimizing environmental impact.

CHAPTER 9

COST ANALYSIS

SL NO:	Materials	Quantity	Cost (Rupees)
1	Rubber pad	3	2400
2	Silicon paste	3	600
3	Blower	1	1250
4	Cable tie	6	60
5	Banana fiber	1500 gram	1500
6	epoxy	3	750
7	MS Sheet metal	6 sq feet	800
	Total cost		7360/-

Table 9.1: Materials and its cost

CHAPTER 10

RESULT AND DISCUSSIONS

All the prerequisite information for the biodegradable banana fiber filters has been gathered. Further experiments and characterization can be done when the situation is favorable.

CHAPTER 11

CONCLUSION

The development of biodegradable air filters using banana fiber marks a significant stride in advancing sustainable and environmentally conscious air purification technology. By seamlessly integrating the exceptional filtration capabilities of banana fibers with degradability, this innovation addresses critical environmental concerns related to traditional filter materials. The inherent ability of these filters to naturally decompose aligns with the overarching goal of reducing the environmental impact of air purification systems, particularly in contexts where disposable filters are prevalent. The promising applications of air purifiers with biodegradable banana fiber filters, contributing to a more sustainable approach to indoor air quality management, underscore the need for a delicate balance between degradability and effective contaminant removal. . Ultimately, the development and adoption of biodegradable air filters using banana fiber represent a significant step towards achieving cleaner air and a healthier planet for present and future generations.

CHAPTER 12

FUTURE SCOPE OF WORKS

The future scope of the biodegradable air filter project is marked by significant potential for innovation and impact across various key areas. Firstly, in response to escalating concerns about environmental degradation and climate change, there's a growing demand for sustainable solutions across all aspects of life. Biodegradable air filters emerge as a promising avenue for addressing this need by reducing waste and minimizing the environmental footprint of air purification systems. To further enhance sustainability, future endeavors can delve into advancements in biodegradable materials, manufacturing processes, and disposal methods.

Secondly, the utilization of renewable resources such as banana fiber and other plant-based materials presents an opportunity to decrease reliance on finite resources while promoting circular economy principles. Upcoming phases of the project could focus on optimizing the use of renewable resources, exploring alternative sources of biodegradable materials, and devising innovative techniques for sustainable sourcing and production.

Furthermore, advancements in technology, encompassing areas like materials science, nanotechnology, and additive manufacturing, can drive innovation in biodegradable air filter design and performance. Future research and development efforts might explore novel materials, advanced filtration mechanisms, and smart sensor technologies to enhance filtration efficiency, airflow optimization, and overall effectiveness in capturing airborne contaminants.

Moreover, the project holds promise in the realm of health and wellness. Indoor air quality significantly impacts human health, with poor air quality contributing to respiratory problems and allergies. Biodegradable air filters have the potential to mitigate these issues by improving indoor air quality while reducing exposure to harmful pollutants and allergens. Subsequent phases could focus on conducting comprehensive studies to examine the health benefits of biodegradable air filtration systems through clinical trials and longitudinal studies. Lastly, the market for air purification systems is rapidly expanding, driven by increased awareness of indoor air pollution and the importance of clean air for health and productivity. Biodegradable air filters, with their unique sustainability advantages, represent a niche segment within this market. Future endeavors can concentrate on market research, product

development, and commercialization strategies to expand the adoption of biodegradable air filtration solutions across residential, commercial, and industrial sectors.

In conclusion, the future scope of the biodegradable air filter project presents a multitude of opportunities for innovation, impact, and market growth. By leveraging renewable resources, advancing technology, and promoting environmental sustainability, biodegradable air filters have the potential to revolutionize the air purification industry and contribute to a healthier, more sustainable future for all.

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