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Development of Nonwoven Fabric for Air Filtration

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Abstract: Textile filter fabrics are an important part of the domestics and industries life, contributing to healthy environment by product purity and efficiency. Filters save energy and production costs by suitable selection of the filter for specific application. This paper implies principles of filtration in textiles, factors affecting filtration efficiency and testing methods as per American Society of Heating, Refrigeration and Air-conditioning Engineers (ASHRAE). The pore structure and permeability of filters play a major role in getting quality air, filters reduce the air pollution. The work of an air filters is to filter the dirt particles from intake air and supply cleaner air. Optimum utilization of filters can significantly reduce the cost of filters replacement frequently and keep the filters in used for longer time, this can be done by knowing the actual working condition (i.e. air flow rate and differential pressure) of the filters and select best filters which suits for that condition. In this study the main focuses are the effect of air flow rate (CFM) and differential pressure on dust concentration and performance on nonwoven filter media, the selection of the conditions (air flow rate and differential pressure) is done by simulating with air- conditioners, refrigerators and vacuum cleaners is taken under this study. A needle punched nonwoven fabric 200 and 120 GSM is used as filter and during testing filtration efficiency shows good co-relation with calculated value.as air flow rate increasing the service life of filter fabric reduces. The differential pressure decreases as filter clogs. Pressure drop is directly proportional to the temperature during filtration. It is found that the calculated service life of filter fabric helps the manufacturer to design a fabric with a better filtration efficiency and more service life. The air filtration efficiency tester designed simulates the actual working condition of filter fabric with more accuracy.

Keywords: Size of Particles, Air Velocity, Air Flow, Filtration Efficiency.

Objectives:

1. To manufacture needle punched nonwoven fabric of 200 GSM with polyester and polypropylene.
2. To evaluate physical properties of fabric required for air filtration.
3. Test fabric for filtration efficiency under working condition (e.g. vacuum cleaner, motor cycle filter) for evaluation best suitable fiber for air filtration.

Scope:

The scope of the project will be to discover the new air filter through the nonwoven manufacturing process. Today, almost all filtration efficiency is close to 100%, so developing eco-friendly, low resistance and long life of filter material will be the further development of air purification materials.

I. INTRODUCTION

Air pollution is a major environmental health problem affecting everyone. It occurs when the environment is contaminated by a chemical, physical or biological agent that modified the natural characteristics of the atmosphere. Stoves at home, tobacco smoke, motor vehicles, industrial facilities and forest fires are common sources of air pollution. It is responsible for exacerbation of asthma and increase in respiratory infections especially in children. Increased morbidity and mortality, due to cardiovascular diseases including stroke, chronic respiratory diseases and cancers have also been attributed to air pollution. These facts indicate that air pollution is now the world's largest single environmental health risk. Today nonwoven fabrics have the largest market in the world. Nonwoven technology with developing new products like as decorative fabrics, blanket, filter media coated and blended fabrics. Filtration is to improve the quality with freedom from contamination. A filter media is a part of the filter that does the filtering means to protect that humankind from the environment. People need clean air to breathe. The main importance's of air filter in air conditioning system to improve air quality with respect to removing allergens, microbes. In textile filter material is generally used for solid gas filtration (dry filtration) and solid liquid filtration (wet filtration). There are many types of filtration mechanism as like surface straining, depth filtration and cake filtration. An air purifier is a device, which remove contaminants from

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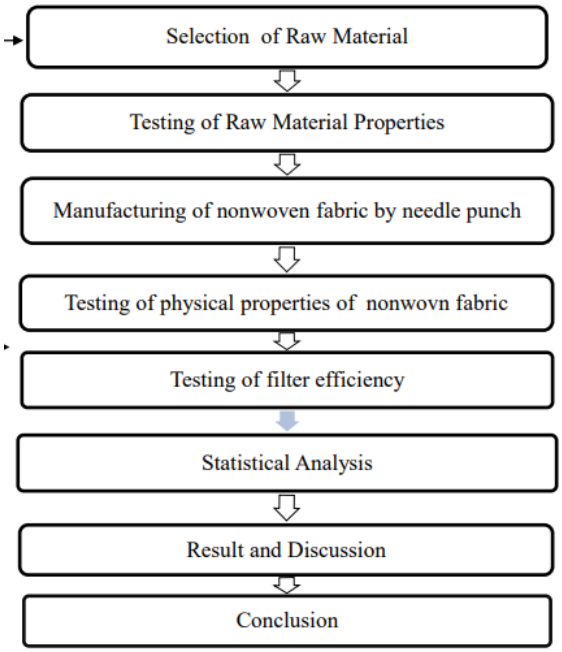
the air in a room. These devices are commonly marketed as being beneficial to allergy sufferers and at reducing or eliminating second hand tobacco smoke. Also, mechanism of particle capture for particle separation after the particle penetration the surface medium like as internal impaction filtration mechanism, interception, diffusion and electrostatic attraction. Filtration may be used to separate contaminants from fluid or separate value added material, such as minerals, chemicals in a process operation.

II. PLAN OF WORK

As per the literature survey stated above, the following plan of work prepared to consider research gaps. Details of materials, methodology and various testing procedures were discussed in this chapter.



III. RESULT AND DISCUSSION

In this chapter the point to be discussed will be on the result and discussion which has been carried out through this project. In this the results of filtration efficiency tester for nonwoven filter will be elaborated briefly. The data obtained from tests is presented in this chapter and discussed with the concepts obtained from literature review.

3.1Thickness:

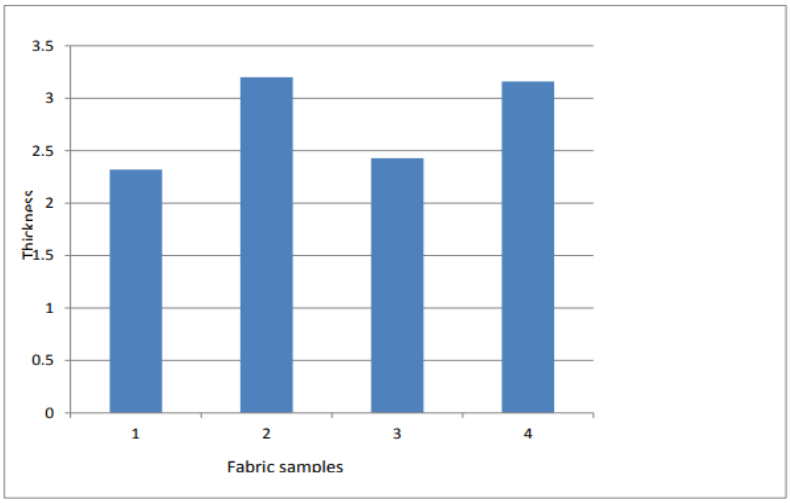


Table 3.1: Thickness

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Fabric sample	Calculated value	Tabulated value
PP 1003d & PP 1006d	0.000416383	2.776
PET 100 6d & PP 1006d	0.010338496	2.776
PP 100 6d & PP 100 3d &6d	0.00282001	2.776
PP 6d & All mix	0.422455618	2.776

Calculated 't' value for fabric thickness between 100% polypropylene 3 denier and 100% polypropylene 6 denier was 0.000416383 This value is less than tabulated value (0.05,3) =2.776, so we observe that there is significant difference in fabric thickness made from above fabric.

Similar trend was observed in fabric thickness made from 100% polyester 6denier and 100 % polypropylene 6 denier,100% polypropylene 6denier and 100% polypropylene 6denier +3 denier, 100% polypropylene 6 denier and mixture of 100% polyester 6denier, 100% polypropylene 6denier, 100% polypropylene 3denier100% polyester 3denier. So we can say that fabric thickness is affected by fiber, fiber denier , % of fiber and mixing of denier.

3.2 Air permeability

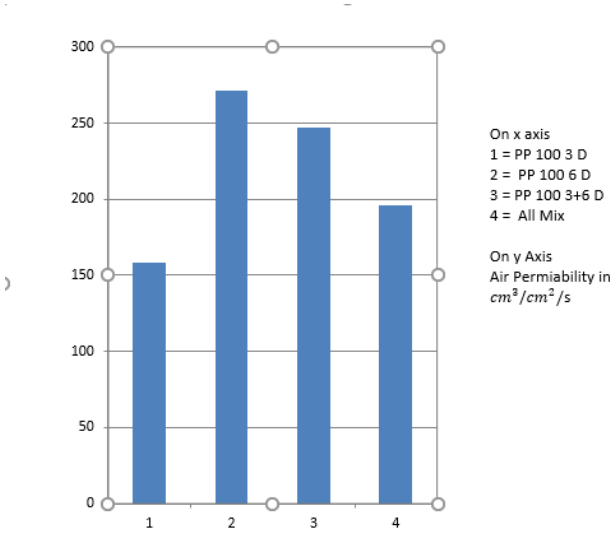

Table 3.2: Air permeability

Fabric sample	Calculated value	Tabulated value
PP 1003d & PP 1006d	3.58	2.045
PET 100 6d &PP 1006d	0.000983378	2.045
PP 100 6d & PP 100 3d &6d	0.057368777	2.045
PP 6d & All mix	4.69591	2.045

Calculated 't' value for fabric Air permeability between 100% polyester 6 denier and 100% polypropylene 6 denier was 0.000983378. This value is less than tabulated value (0.05, 29) =2.045, so we observe that there is significant difference in air permeability made from above fabric.

Similar trend was observed in air permeability made from 100% polyester 6denier and 100 % polypropylene 6 denier,100% polypropylene 6denier and 100% polypropylene 6denier +3 denier,100% polypropylene 3 denier and polypropylene 6 denier 100% polypropylene 6 denier and mixture of 100% polyester 6denier, 100% polypropylene 6denier, 100% polypropylene 3denier100% polyester 3denier. So we can say that Air permeability is affected by fiber, fiber denier, fibre density and pore size.

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3.3 Pore size:

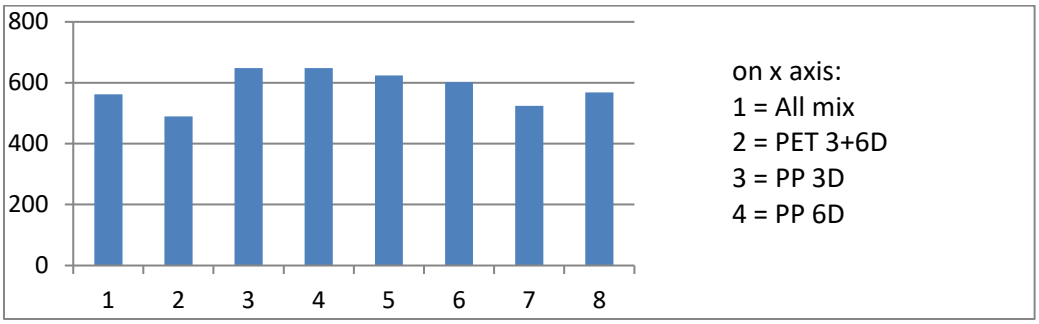

Table 3.3: Pore size

Fabric sample	Calculated value	Tabulated value
PP 3d & PP 6d	0.473663185	4.3
PP pet 3d &PP pet 6d	0.085193171	4.3
PP 3d+ 6d & PET 3d +6d	0.00641885	4.3
PET 3+6d & All mix	0.008451708	4.3

Calculated 't' value for fabric pore size between 100% polyester 6 denier and 100% polyester 6 denier was 0.473663185. This value is less than tabulated value (0.05,2) =4.3, so we observe that there is significant difference in fabric pore size made from above fabric.

Similar trend was observed in pore size made from polypropylene, polyester 3denier + 6denier each and polyester 3denier+6denier, polypropylene 3denier+6denier and polyester 3denier+6denier, mixture of 100% polyester 6denier, 100% polypropylene 6denier, 100% polypropylene 3denier100% polyester 3denier. So we can say that pore size is affected by fiber denier and fiber density.

3.4 Filtration Efficiency

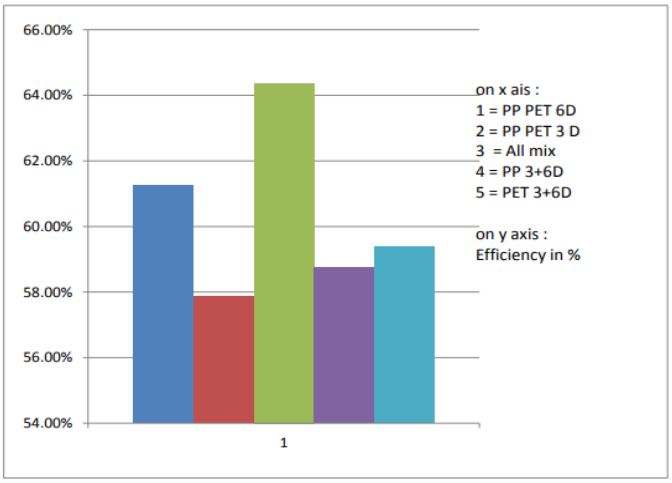

Table 3.4 Filtration Efficiency

Fabric sample	Calculated value	Tabulated value
PP PET 3+3 & PET 3+6	0.31201807	4.3
All mix & PP PET 6+6	0.304961395	4.3
PP PET 3+3 & PP 3+6	0.062832958	4.3

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Calculated „t" value for filtration efficiency of fabric between 100% polypropylene 3 denier +polyester 3 denier and 100% polyester3denier+ 6 denier was 0.31201807 This value is less than tabulated value (0.05,2) =4.3, so we observe that there is significant difference in filtration efficiency of fabric made from above fabric. Similar trend was observed in filtration efficiency of fabric made from polypropylene + polyester 3 denier and polypropylene 3+6 denier, polypropylene + polyester 6denier and mixture of 100% polyester 6denier, 100% polypropylene 6denier, 100% polypropylene 3denier100% polyester 3denier. So we can say that filtration efficiency of fabric is affected by fabric thickness, air permeability, pore size and fiber denier.

IV. CONCLUSION

An experiment was conducted to assess the filtration efficiency of Needle Punched Nonwoven fabric which has 200GSM for the application of air conditioner, vacuum cleaner, face masks, motor cycles with air-flow rate of 50 CFM and dust of 8 gram weight containing 72% of actual dust , 5% cotton lint and 23% of cement and coal. From above experiment following conclusions were drawn

1. Needle Punched Nonwoven Fabric thickness was significantly affected by type of fiber that is fiber density and fiber denier i.e. for lower fiber density and coarse denier fabric thickness is higher.
2. Needle Punched Nonwoven Fabric air permeability was significantly affected by fiber density and denier of fiber. Fiber with higher density and higher denier had shown high air permeability.
3. Pore size of Needle Punched Nonwoven Fabric was significantly affected by fiber density and denier of fiber. Fabric made from Polyester and Polypropylene with 3Denier, 6Denier with proportion of 25% each shown finer pore size.
4. From above experiment we found that the filtration efficiency of Needle Punched Nonwoven Fabric made from Polyester and Polypropylene with 3Denier, 6Denier with proportion of 25% each shown highest Air filtration efficiency, because of finer pore size, more thickness, less air permeability compared to other fabrics

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