

Bilayer Non-Woven Fabric for Air Filtration

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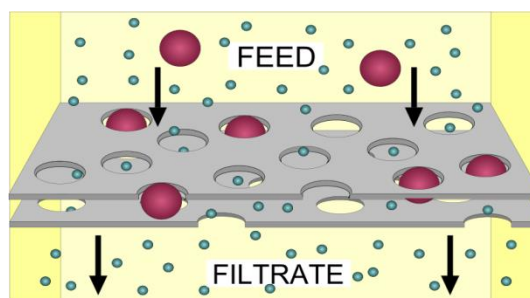
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Introduction

In today's global world the importance of air filtration is become necessary in our day to day life as the rapid development of the countries all over the world causing pollution in the environment. Atmospheric contaminates come from different media especially chemical industries, transport vehicles, etc. So, the sufficient air pollution control is necessary to protect public health, and if not then it causes different types of the diseases which are very harmful for the human beings, severe effect of air pollution may cause even death of a person. For avoiding this issues, the air filtration acts a fruitful part in our regular life. The end application of the filter fabrics may varies according to their end-use. According to the end application, the selected raw material used with bearing specific characteristics, can be used for the manufacturing of the filter fabric. It observed from several research that filter fabric media controls both gaseous and liquid environmental pollutants very efficiently. Dry particles can be removed from gaseous emission with the help of air pollution control systems, in water pollution control system, air filtration removes suspended solids, while in solid-waste disposal filtration concentrates solids, reducing the landfill area required. Whereas, air filtration processes effectively minimize air, water, and solid-waste disposal problems. An air pollution control system removes particles and / or gases from an emission source as it consist of a scrubbing device which removes particulates by impaction and the gases by chemical absorption. Formation of crystalline sludge occurs due to the reaction products of gases and chemicals. A filter fabric can be used for removal of solids from water so that the water can be recycled. As a result, water pollution problem can be minimize for effluent slurry. Effective use (optimization) of a fabric-filter system would minimize problems with waste disposal. It is seen that nonwovens fabric have some advantage over woven fabric for filtration applications due to unique characteristic like random orientation and three dimensional arrangements of fibers, bulkiness of the fabric, higher fluid flow rate and are also cheaper to produce. Other improvements may be possible in nonwoven filters because its methods of fabrication allow a greater scope for some of the properties then can be achieved with woven structure. Nonwoven fabric is used as an air filtration media in vacuum cleaner or in the air conditioner. In this, we have taken the bilayer fabric for the air filtration to improve the air quality and avoid the air pollution and the problem creates by that air pollution.

Importance of Air Filtration

Air filtration is the main parameter in day to day life because due to the advancement of the science the pollution in the environment also get increased and due to that the human are not feel comfortable in the polluted environment and get difficult to survived. So to overcome this pollution the filtration phenomenon should be used due to that the contaminants which are harmful for the human being are get filtered from the air and purified the air with help of the nonwoven fabric.

Concept of Air Filtration**Fig.1- Mechanism of filtration**

Air filtration is nothing but the separation of the solid particles from the air. Separation of solids from air is carried out by applying proper media, so that only liquid can pass and more common filtration can be done by Mechanical or Physical operation. The separation of airborne particulate from an air stream is called air filtration and is accomplished through mechanical, aerodynamic, and electrostatic phenomenon. The enhancement of the purity of source media through filtered material is the main purpose of the filtration. The action of filtration is performed through the interaction between the filter media and the substances to be filtered out.

Filtration process can be carried out in a continuous batch or semi continuous mode, with the periodic separation of the retained solids from the filter medium. Application of filtration systems can be designed to operate in a continuous manner for resulting in optimum performance. As with other filtration techniques, an accumulating solid cake performs the bulk of the filtration.

Material:

Two high lofts nonwoven air laid fabric sample were manufactured by using 6 denier and 15 denier polyester fiber on Rando Webber Feeder Machine. Then binding these two fabric by using PVA binder by using Spray binding technique, formation of bilayer (6+15 denier) fabric takes place.

Properties of Polyester Fiber:-

Table 1. : Properties of polyester fiber

Sr. no.	Property	6 Denier	15 Denier
1	Microscopic appearance		
	Longitudinal	Rod like	Rod like
	Cross sectional	Circular	Circular
2	Strength (GPD)		
	Dry	3-9	3-9
	Wet	3-9	3-9
3	Elastic Recovery (%)	90-100	90-100
4	Resiliency	Excellent	Excellent

5	Density	1.38	1.38
6	Moisture Regain (%)	0.4%	0.4%
7	Dimensional Stability	Excellent	Excellent
8	Melting Point	250 ^o C	250 ^o C
9	Safe Ironing Temp.	250 ^o C	250 ^o C
10	Length	64 mm	64 mm

Test Results and Discussion**1) GSM Test Results:****Table no. : 2**

Sr. No.	Denier	Average GSM
1	6	200
2	15	200
3	15+6	400

Tests were carried out $65 \pm 2\%$ R.H. $27 \pm 2^{\circ}\text{C}$.

The pore size of 6 denier fabric is 200 and of 15 denier is 200. The 6 denier fabric and 15 denier fabric is spray bonded so that the GSM of that fabric is 400 GSM. As the count of relative fabric is increase the GSM of the fabric is increase.

2) Thickness Test Results:**Table no. : 3**

Sr. No.	6 Denier fabric (mm)	15 Denier fabric (mm)	6+15 denier fabric(mm)
1	11	17	24
2	13	19	19
3	9	11	24
4	11	16	18
5	10	14	18
6	12	18	23
7	11	19	17
8	15	19	21
9	10	22	22
10	13	19	22
Average	11.5	17.4	20.8

Tests were carried out $65 \pm 2\%$ R.H. $27 \pm 2^{\circ}\text{C}$. The test is carried out on Shirley thickness tester.

The above table shows the thickness of the 6 denier ,15 denier and 6+15 denier fabric. The thickness of the 6 denier fabric is 11.5 and of 15 denier fabric is 17.4. The thickness of the bilayer (6+15) fabric is 20.8. The thickness of the fabric is increase as the count of the fabric is increase.

3) Air Permeability Test Results:**Table no.: 4**

Sr.	Denier	Method	Pressure	Result
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No.			(Pascal cubic cms./sq.cms/sec)	(Pascal cubic cms./sq.cms/sec)
1	6	ASTM D 737-04	200	500.4
2	15	ASTM D 737-04	200	712
3	6+15	ASTM D 737-04	200	370.9

Tests were carried out 65 ± 2 % R.H. 27 ± 20 c

From the above table it can be seen that, the air permeability of 6 denier fabric is 500.4 Pascal cubic cms/sq.cms/sec and of 15 denier is 712 Pascal cubic cms/sq.cms/sec. The air permeability of 15+6 denier Pascal cubic cms/sq.cms/sec fabric is lower because of pore size of that fabric and it is very suitable for air filtration. From the above reading it is found that air permeability of 15+6 denier is lower, and this is very suitable for air filtration. Because the fabric is made with the combination of two different fabric which having two different counts. The fabric is specially used for air filtration purpose where air and dust separation is necessary. The dust particle first prevented by the 15 denier fabric and the dust particle which are not captured by first layer may captured by 6 denier fabric which is fine one. It is the reason for the fabric having lower air permeability as compared 15 and 6 denier fabric.

4) Bursting Strength Test Results:

Table no. : 5

Sr. No.	Sample no.	Denier	Bursting Strength (Kg/Sq Cm)
1	M-14024	6	7.35
2	M-14025	15	8.33
3	M-14026	15+6	15.45

Tests were carried out 65 ± 2 % R.H. 27 ± 20 c.

From above table it can be seen that, the bursting strength of 6 denier fabric is 7.35 kg/sq cm and of 15 denier sample is 8.33 kg/sq cm .The bursting strength of 15+6 denier is 15.45 kg/sqcm. From the above results we found that the bursting strength of 15+6 denier is high. From the above reading we found that bursting strength for different denier is varied. As the denier is increase the bursting strength of relative fabric is increase.

Air Filtration Efficiency Test Results:

Table no. : 6

Sr. no.	6 Denier fabric	15 Denier fabric	6+15 Denier fabric
1	85	81	95
2	87	85	96
3	85.5	86	97.5
4	86	84	98
5	87	85	97.5
6	88	82	98.5
7	89.5	83	96.5
8	89	81	99.5
9	88.5	83	99
10	90	82	98
Average	87.55	83.22	97.55

Tests were carried out 65 ± 2 % R.H. 27 ± 20 c.

The above table shows the Air Filtration Efficiency Test for the non-woven fabric. The filtration efficiency of the 6 denier non-woven fabric is 87.55 and of 15 denier is 83.22. The filtration efficiency of 15+6 denier bilayer non-woven fabric is very high that is 97.55. The above table shows the various reading for filtration efficiency. As the denier of the fabric is increase the filtration efficiency is increase.

Application

- The fabric is used in vaccum cleaner .In vaccum cleaner the air bag collects the dust and other trash particle.



Fig.12 Air Bag and Vacuum Cleaner

- It is also used in air conditioning system.



Fig.13 Air Conditioner

Conclusion:

From the results and discussion it was observed that:

1. The bilayer nonwoven fabric is more suitable for air filtration.
2. Air permeability of bilayer non-woven fabric decreases with increase in the thickness of the fabric.
3. Bursting strength increases for bilayer non-woven fabric.
4. Filtration efficiency increases with the increase in the thickness, GSM. The air filtration efficiency for bilayer fabric is increase as compared to 15 and 6 denier non-woven fabric. The bilayer fabric is best suited for air filtration efficiency and it giving the filtration efficiency up to 97.55% when tested on high volume sampler.

The problem of air pollution and its effect on the human health is the main things which have to overcome and this is possible with the help of the air filtration. In air filtration the nonwoven fabric have some advantages over the woven fabric for dry filtration applications due to their unique characteristics. Nonwoven filters for dry filtration can be characterized as high-tech products. Non-woven is highly used in the filtration and it gives the best result and due to the use of this the environment should be harmless and the hygienic to the human being to survive. With the development of this fabric we can improve the air quality in minimum cost. In future also it is use to improve the quality of the air and reduce the health problem of the humans and filtered the contaminants present in the air.

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