Preparation of Air Filters Using Coir Fibres

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Abstract - *Nonwoven fabrics are widely used as filters due to their unique characteristics such as effective collection of dust particles. The nonwoven filters have advantages over woven fabric in many aspects like higher air permeability, higher filtration efficiency and good cake discharge. Developments of nonwoven filters are being prepared by needle punched, hydro entanglement technique, chemical and thermal bonded. Various product and process variables are influencing the filtration performance of nonwoven fabric. Since needle punched nonwoven fabrics are widely used as filter due to its lengthy flow path for the particles more than one micron. Needle punched nonwoven were bulkier, when compared to thermal bonded nonwoven fabric. The performance of nonwoven fabric as a filter media has been influenced by various variables such as thickness of fabric, type of fibre used, proportion of fibres used, carrier/ binder fibre proportion, etc. This proposed work is focused on the development of surface modification of coir fibre composite for filtration application, due to the abundant availability of coir fibre with cheaper cost. White coir fibre is taken as the carrier fibre and Araldite resin with respective hardener as the binder. The objective of fibre selection is to improve the filtration efficiency as white coir fibre is finer than brown coir fibre. The properties such as air permeability and filtration efficiency have been tested and analyzed. The influence of process variable on other physical properties is also analyzed*

Key Words: Air filter, coir fiber, Alkali treatment, NAOH, Air permeability, Frictional efficiency.

1. INTRODUCTION

Filtration is defined as the process of separating dispersed particles from a dispersing fluid by means of porous media. The dispersing medium can be a gas or gas mixture, most frequently air. Nonwoven fabrics are widely used for filtration application. The nonwoven fabric manufacturing technology involves producing nonwoven fabric with fibre of lower diameter (finer fibre), higher the mass per unit area (GSM) for obtaining required filtration efficiency but the filtration efficiency is decreased by increasing the air permeability. The air flow rate is one of the important factors to decide the filtration performance. The surface roughness and variation in surface enhances the filtration efficiency of the filters. In Air conditioning system, mostly synthetic fibres were used. AC systems were frequently used in residential and industrial applications. Filter has to be changed yearly once for better energy consumption, synthetic filters when disposed causes landfills to our environment. Hence, Coir fibres were used to replace the synthetic fibres. In AC systems, the filters that are used has lower thickness, so needle punched nonwoven has been neglected. By chemical bonding, pores in the filter may be clogged during curing process. Thus, Coir fibre filter is developed by adhesion bonding, using resin as binder.

1.1 Objective

The objective of the filtration medium is to supply the required quantity of air without dust particles. Hence, the filter media pore size should be less than the size of dust particles and also it should supply required quantity of air. For better filtration, the filter medium should have the property of high air permeability and distributed micro pores. This property can be obtained by using nonwoven fabrics. Nonwoven filter media is a simplest form of random fibre structure, usually in sheet form. In general needle punched, spun bonded, chemical bonded fabrics are suitable for many filtration applications.

1.2 Application

In Air conditioning system, mostly synthetic fibres were used. AC systems were frequently used in residential and industrial applications. Filter has to be changed yearly once for better energy consumption, synthetic filters when disposed causes landfills to our environment. Hence, Coir fibres were used to replace the synthetic fibres. In AC systems, the filters that are used has lower thickness, so needle punched nonwoven has been neglected. By chemical bonding, pores in the filter may be clogged during curing process. Thus, Coir fibre filter is developed by adhesion bonding, using resin as binder.

2. MATERIALS AND METHOD

Table -1: Materials and its composition

Epoxy resin	Araldite (AV138 1N)
Hardener	HV998 1N
Curing Temp	60˚C
Acetone	15168 (0129135)
Density of resin	1.72 g/cc
Densityof Hardener	1.72 g/cc

The methodology of the sample preparation is given as follow

Selection of Raw material

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Experimental design

↓

NaOH Treatment

↓

Construction of Web

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Performance evaluation

↓

Analysis of properties of web

The following step by step procedure was employed:

- At first, the Pressure is set at 0 MPa and temperature is set at 60℃ for both top and bottom plate.
- Now, the pressure is raised to 100 kg/cm^2,the fibre contained mould is placed under this pressure and temperature and is is maintained for 30 minutes.
- After 30 minutes, the temperature is lowered to attain the room temperature.
- The mould contained fibre is removed from the compression moulding.

3. RAW MATERIAL CHARACTERIZATION

A scanning electron microscope (SEM) has become a powerful and versatile tool for material characterization. It is a type of electron microscope that produces images of a sample by scanning the surface with a focused beam of electrons. The electrons interact with atoms in the sample, producing various signals that contain information about the surface topography and composition of the sample[4],[5]. The signals used by a scanning electron microscope to produce an image result from interactions of the electron beam with atoms at various depths within the sample. With the help of the scanning electron microscope, images of alkali treated fibres have been clearly investigated and analyzed. In the SEM images, surface roughness, lumen of coir fibres can be seen clearly.

ASTM D 3776 - Standard Test Method for Mass per Unit Area (GSM) of Fabric. Length and Width in meters of each samples are measured and followed by measuring the weight of the samples in grams. Mass per unit area of the calculated by dividing the weight and product of the length and width, it gives the value in terms of grams per square meter [16]

ASTM D 737 - Standard Test Method for Air Permeability of Textile Fabrics. Air permeability test is done at a water pressure differential of 125 Pa (12.7 mm or 0.5 in. of water) and test is carried out at 5 cm² at different places in the test sample [15]

4. RESULT AND DISCUSSION

Characterization of nonwoven filters such as mass per unit area, porosity, air permeability and filtration efficiency are tested.The filtration efficiency of prepared samples has been analyzed as per standard ASTM F 2299[14]. Table 4.1 shows the filtration efficiency.

The air permeability of prepared samples have been analyzed as per standard and the results is given in Table 4.2. Air permeability is one of the most important factors in the performance of nonwoven filters. It provides a means of fabric porosity and is related directly to fabric thickness .The physical parameters of the nonwoven fabric such as mass per unit area and thickness affect the air permeability of fabric. As a result of adhesive bonding under pressure and temperature, the fibres become more tightly packed, thus reducing pore size. The observations have been made in this study are, the air permeability of the fabric reduces while increasing the mass per unit area (mass per unit area).

Table -2: Filtration efficiency of the individual samples

S.No	A	B	C	D	E	F
1	55.6	25.6	42.6	33.4	76.79	13.04
2	49	27	23.8	34	48.74	12.59
3	53.3	24.5	49.9	29.5	93.75	12.04
4	54	22.8	32.7	30	60.66	13.15
5	50.4	26.5	32.6	34.4	64.71	12.98
6	51	29.4	46.8	35.8	91.91	12.17
7	49.4	24	48.	32.5	97.33	13.54
8	51	23.5	24.9	31	48.83	13.19

Where,

A - 2 CM FELT (KG)
B - 1.5 CM FELT (KG)
C - 2 CM FELT (KG)
D - 1.5 CM FELT (KG)
E - EFFICIENCY (%) (2 CM) FELT
F - EFFICIENCY (%)(1.5 CM) FELT

Table -3: Properties of surface modified coir fibre composites

S.No.	A	B	C	D	E
1	2.13	1347.7	53.25	23.53	76.79
2	2.16	1362.9	53.52	78.33	48.74
3	2.04	1640.9	31.50	35.05	93.75
4	2.05	1679.7	30.06	44.36	60.66
5	2.15	1128.0	55.51	98.90	64.71
6	2.29	1123.0	57.60	64.03	91.91
7	2.25	1831.7	36.2	44.53	97.33
8	1.96	1881.9	33.78	37.56	48.83

Where,

X - Fiber content in terms of grams
A - Thickness in terms of mm
B - Mass per unit area in terms of g/m^2
C - Porosity in %
D - Air permeability in terms of $cm^3 / cm^2 / s$
E - Filtration Efficiency in %

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