

# Development of Environmental Protection Air Filter Media

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**Abstract:** This article briefly summarized the production process, products structure, performance and wide application range of non-woven filter materials which were made of glass fiber, analyzed the importance in the filter fields and its' development direction, and pointed out the application prospects in the future.

**Keywords:** Air filter material; glass fiber; non-woven fabric; composite media

## 1. Introduction

The problem of environmental pollution is becoming more and more serious because of the development of industry, especially in air pollution, with the increasing improvement of environmental regulations and investment in environmental protection, the air filters, as the important means of air pollution control, are used more and more widely in Atmospheric Environment Management.

Based on the current situation, the targeted and applicability of the air filter material is the future direction of development; Low resistance and high efficient air filter material is focus of our future research; In addition, the development of eco-friendly filter material which has solved the second pollution of itself, making filter material into a completely environmentally friendly products is our common goal.

## 2. Development of filter material

Which have been used for air filter are woven fabric, knitted fabric and non-woven fabric [1], Woven and knitted fabrics are used less and less due to their limited application, but non-woven fabric has many merits, for example, a good Permeability, high Collection efficiency, low pressure loss, short process and low cost, so it's application prospect is very good [2].

Cotton, wool, synthetic fibers, glass fibers, ceramic fiber, metal fibers and basalt fiber are common fibers for the non-woven filter materials. But the glass fiber and synthetic fiber is the main [3~5].

In the flue gas filter industry, many of flue gas temperature are above 200°C, and some reach more than 300°C. Cotton, wool and synthetic fiber only able to bear below 150°C, while the glass fiber can long-term work under the conditions of 260°C/280°C, its performance is very stable, it's instantaneous temperature can reach to 350°C. and its smooth appearance and the cylindrical surface make the filtration resistance very low, can withstand a large part of the acid(except hydroflu-

oric acid) [6~12], based on the basic physics, chemical and filtration performance indicators of glass fiber into account, glass fiber is ideal filter material. Japanese environmental experts say "where there is dust pollution, there is glass fiber filter". This article summarized the production process, products structure, performance and wide application range of non-woven filter materials which are made of glass fiber, analyzed the importance in the filter fields and its' development direction, and pointed out the application prospects in the future.

## 3. Glass fiber non-woven filter material

As early as 1940, United States acquired a patent about glass fiber air filter. In 1950's, China has begun to use glass fiber filter materials in filter filed, with the improvement and development of filtering technology, glass fiber filter in the application of various industrial sectors increased, the types are constantly updated, and more Specific and targeted.

Glass fiber filter which have been developed include: (a) glass fiber needle filter material; (b) glass fiber needle composited filter material; (c) coated glass fiber filter material.

### 3.1 Glass fiber filter materials

Glass fiber filter material was made of 100% glass fiber as raw material, after processing of the needle felt.

a) The production process is [13]:  
 Glass fiber → spinning → weaving → fabric }  
 Glass fiber → carding → network }  
 → Pre-acupuncture → needle punch → finishing → products

In the acupuncture process, due to poor wear and folding performance of glass fiber, so the needle density should low, in order to prevent fibers from loosing, we may increase the depth of needle [14].

b) The structure shown in Figure1(1: glass fiber mat layer, 2: glass fiber fabric)

In addition to the general characteristics of glass fiber, it have merits of high porosity(more than 80%),

small interspacing, low resistance, high filtering speed. so dust removal efficiency as high as 99.9% [15,16]. it broke the previous speed pulse bag filter in the restricted area used to solve the high temperature gas bags to small-scale development of the problem, when the temperature of the gas filter at 260°C below and the filtration velocity is less than 0.8m/min, pure glass fiber needle felt filter is the preferred [17].

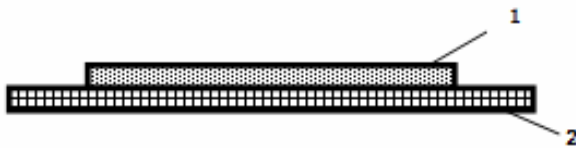


Figure1. the structure of glass fiber filter material

In order to improve the performance of filter material, Broad lane in England used different diameters of glass fiber to make filter material, H.I.Thompson company in United States got High silica glass fiber by adjusting the Original composition of glass fiber, the Holling Sworth & Vose company in United States developed low borosilicate glass fiber filter material and high performance E-glass fiber filter material.

Glass fiber needle felt is a traditional filtering material which has wide range of applications. They have achieved remarkable economic, environmental and social benefits in the environmental protection departments, the prospects is very bright.

### 3.2 The filter material of glass fiber composite needle

Although glass fiber needle felt have excellent performance of three-dimensional structure, dimensional stability and filtration resistance, the filtration velocity and lifetime is relatively poor, mainly due to poor wear and folding resistance of glass fiber, and easy separation between the strong support fabric and the needle felt, so development of complex needle punched filter materials will be an inevitable trend.

Glass fiber composite media [18, 19] is mixing glass fiber and other synthetic fiber into a network, and processing needle with glass fabric into the carpet, then after post-processing techniques. This cheap and new filter overcomes the shortcomings of intolerance high temperature of Chemical fiber and poor folding of glass fiber.

The composite filter media has two mixing ways: namely fiber mixing and layer mixing.

a) the production process is

Chemical fiber + glass fiber → open and mixing → carding → cross-lapping }  
 Glass fiber fabric  
 Chemical fiber + glass fiber → open and mixing → carding → cross-lapping }  
 → Pre-acupuncture → needle punch → finishing → products

b) The structure shown in Figure 2 (1, 3: glass/chemical fiber layer of chopped strand mats, 2: glass fiber fabric)

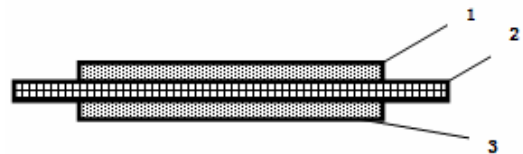


Figure 2. the structure of glass fiber composite filter material

c) the production process is:  
 Chemical fiber → open and mixing → carding → cross-lapping }  
 Glass fiber fabric  
 Glass fiber → open and mixing → carding → cross-lapping }  
 → Pre-acupuncture → needle punch → finishing → products

d) The structure shown in Figure3 (1: glass fiber layer of chopped strand mat, 2: chemical fiber layer of chopped strand mat, 3: glass fiber fabric)

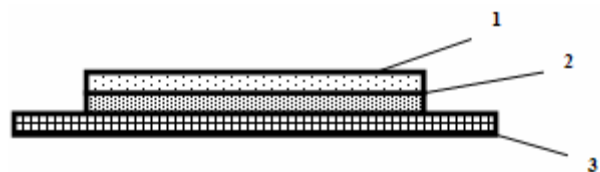


Figure 3. the structure of glass fiber composite filter material

In the mixing process, a reasonable proportion of mixed is very important to satisfy the performance and cost requirements.

Take P84/glass fiber composite filter material for an example, P84 needle felt fiber ratio on properties of composites in Table 1 [19, 20].

Table 1. Different proportions of P84/glass fiber composite needle felt performance

P84 fiber ratio (%)	0	15	30	100
Breaking strength(Mpa)	5.9	6	6	6
Permeability (cm/s)	32.69	41.18	42.32	43.01
Peel strength (N/25mm)	24.0	44.5	46.8	93.5
Wear number (times/mm)	62	207	221	249

From this, we can see that the media have a notable increase in performance when the P84 fiber ratio reach to 15%, so 15% P84 and 85% glass fiber mixed can not only improve performance but also improve the cost-effective.

At present, China National Materials Technology Corporation researchers have developed a new type of hybrid needled felt. They have made a major breakthrough in the raw materials and processing technologies, not only meet the high-performance and low-cost requirements, but also improve the environmental performance [21].

In addition to processing to solve the poor wear folding of glass fiber composite needle felt media, we can consider the glass fiber diameter [22]. Generally, the thinner the fiber, the better resistance for bending, the greater the specific surface area, the higher the collection efficiency, the lower the filtration resistance.

### 3.3 Coated glass fiber filter

Coated glass fiber filter is a new type of filter developed in recent years. Expanded PTFE and other materials to be a porous breathable film, and then using a special process to composite in glass fiber composite film or needle felt which is made of other fibers, it is a new type of porous film composite filter, it is also named as (FMS) needle felt filter.

a) the production process is

Glass/chemical fibers → felting → treatment → needle felt filter

PTFE powder → biaxial tensile → ePTFE film  
→ Hot film → coated filter

This film not only has function of waterproof and ultra-fine dust, but also protects the fibers and improves the filtration velocity. When this media filter is used, the dust stop at the surface can not penetrate the internal fabric, FMS filter improved filter catching dust function and stripping.

Some Patent reported that the composite filter with high filtration efficiency, low resistance, high temperature, corrosion-resistant properties which use PTFE for surface film and glass fiber for the basement membrane. Japanese company developed a glass fiber composite filter material, sucked PTFE film attached to the glass fiber mat. Recently, the Nanjing Glass Research Institute has successfully developed glass fiber mat coated with PTFE filter, the developed film filters' efficiency for removal of the 5µm below dust is 99.9%, 5µm more can reach to 100%.

Table 2 shows the performance of FMS needle felt which has been successfully developed by domestic and foreign [22], From table2, we know that FMS needle felt filter has greatly increased in the filtration velocity, life, permeability compared to the glass needle felt. Because of many advantages, they obtained highly appraise in the application process.

**Table2. The proportions of FMS composite needle felt performance**

material	thick-ness (mm)	permeability (m <sup>3</sup> /m <sup>2</sup> min)	operating temperature (°C)	filtration velocity (m/min)
P84/glass fibers	2.2~3.2	10~30	260 (short 300)	1~1.5
Ara-mid/glass fibers	2.5~3.5	8~20	260 (short 300)	1~1.5
PPS/glass fibers	2.5~3.5	10~20	200 (short 230)	1~1.5
P84/glass /Stainless steel fibers	2.2~3.2	10~20	300~400	1~1.5
Ba-soiil/glass /chemical fibers	2.5~3.5	8~20	240~260	1~1.5
Procon/glass fibers	2.5~3.5	10~20	200~220	1~1.5
carbon /glass /stainless steel /chemical fibers	2.5~3.5	10~20	400~450	1~1.5

### 4. Finishing of glass fiber filter material

There are many differences among the Smoke generated by the industrial sector, for example, the chemical composition of dust, the temperature and humidity of flue gas. Especially, in some unusual occasions such as military, nuclear industry, and so on. Filter material should have waterproof, fireproof, resistant to mildew and other special properties [23]. Therefore, the filter material can get these properties after finishing. Finishing is very important for Glass fiber filter material.

The filtering material finishing consists of two aspects: one of them is chemical treatment: selection of polymer organic polymer, coating the surface of the carpet. The other one is the surface treatment: on the surface of singeing, calendaring finishing. After finishing technology, the media have a smooth surface and the advantages of easy cleaning.

### 5. Comparing domestic and foreign

At present, domestic filter material reach or exceed Imports filter material level in filtration efficiency, tensile strength and other technical indicators, but there is still a gap on the whole.

Reflect in practice, mainly in life, folding and processing. Therefore, introduction of foreign advanced technology and development in higher performance and

lower price new environment protection media has broad market prospects.

## 6. Conclusion and Outlook

a) Today, almost all filtration efficiency are close to 100%, so development of eco-friendly, low resistance, long life of the filter material will be the further development of air purification materials.

b) At present, the development of filter material is still in its baby-stage, we should improve on the process conditions to enhance manufacturability and product performance to reduce cost, development of non-woven fabric and composite media technology is the focus of our research on filter material.

c) Compared with other filter materials, glass fiber filter material has many special advantages, satisfy the increasingly stringent environmental requirements, have wide range of applications in the field of air purification, so the glass fiber filter material is an important study subject.

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