



PTFE material in the application of high temperature resistant filter material

The development situation of filter material with PTFE material

PTFE material was put into commercial production in the 1940 s, named “Teflon”. Its products are diverse, used for high temperature filter material of PTFE fiber and microporous membrane, liquid impregnation. PTFE has three varieties of supply market, that is, concentrated dispersion, dispersion resins and resin suspension method, the enrichment dispersion is mainly used for impregnation and spinning fiber by emulsion method.

PTFE fiber

PTFE fiber developed by DuPont as early as 1953, in 1957, it realize industrial production. Silk method is emulsion spinning method, membrane crack spinning method, paste extrusion spinning, and melt spinning method. Emulsion spinning method makes the fiber denier lesser, but the strength is low and with a brown or black; the spinning method of Membrane crack get white fiber, strength slightly higher, the uneven thickness of defect is fibers; Paste extrusion spinning method, the fiber strength is higher, the larger the size; Melt spinning method, the fiber high strength, rarely used. PTFE fiber in the world major producers include the United States DuPont, Gore companies in the United States, Austrian Lenzing company, Japan Daikin and Toray company, such as commodity market with TEFLON, PROFILEN, TOYOFLON and RAS TEX, etc.

PTFE microporous membrane

Bulk PTFE microporous membranes by the Gore company developed in the late 1970 s, the thickness of 10 ~ 25 microns, the aperture size is adjustable according to the craft.

PTFE impregnated liquid

PTFE impregnated liquid is concentrated by PTFE dispersion according to certain proportion configuration and its dispersion particle average particle diameter 0. 18 ~ 0. 30 microns and is mainly used for filter material after finishing, ash removal performance of the filter, filter efficiency and mechanical properties.

The application of PTFE in the high temperature filter material

Filter material by filtering type can be divided into deep filter material (conventional needled felt, compound needled felt), surface filter material, such as gradient compound needled felt), surface filter material (microporous membrane, tectorial membrane filter material).PTFE material with fiber and microporous membrane filter material, a variety of forms such as impregnation liquid used in all kinds of base cloth, spread nets, laminating and finishing.

The application of the PTFE fiber in high temperature filter material





PTFE fiber properties and advantages of currently used for high temperature filtration fiber are mainly of glass fiber, Nomex fiber, P84 fiber and PPS fiber, PTFE fiber. PTFE fiber and other fiber performance and price comparison as shown in table 1.

Table 1 Performance and price comparison of PTFE fiber and other fibers

Fiber varieties	Density (/g.m ⁻³)	The fracture stress /MPa	Temperature resistance /°C		LOI/%	Chemical resistance	Price (Million /t)
			The use temperature	The highest temperature			
E glass fiber	2.5~2.6	1500~2700	260	290~450	No	general	1.7
No mex fiber	1.38	500~800	180	250	29	general	14
P84 fiber	1.35~1.41	200	195	300	50	general	42
PPS fiber	1.35	280~360	190	230	40	good	9~12
PTFE fiber	2.1~2.3	15~34	260	300	95	good	domestic 25~30

High-performance fibers of E glass fiber, Nomex fiber, P84 fiber, PPS fiber etc. due to their own characteristics, which have been affected to serviceable range. Among them, E glass fiber is fragile, poor wear resistance and folding and friction are prone to electrostatic hitches in weaving, cause fiber splitting, napping, and even rupture, processing difficult. Glass fiber alkali resistance, generally not H F resistance; Nomex is hydrolyzed fiber; its oxidation resistance is poor, when high temperature smoke contains water and oxide, hydrolysis and damaged soon. It cannot be used for temperature over 190 °C, containing water and oxide of high temperature flue gas filtration; PPS has general oxidation resistance, the higher oxygen content, using the lower the temperature, when the oxygen content of 12%, can only use under 140 °C; P84 fiber hydrolytic stability, easy to hydrolyze aging; And PTFE fiber resistance to chemical corrosion, high temperature resistant, can be used in all kinds of bad environment and can obtain good effect, the service life of the other fiber filter bag is 1 year commonly, PTFE and the service life of the filtering material up to 3 years.

The application of PTFE fiber in high temperature resistant needled felt

Mónica Lupión and others studies the filter and cleaning properties about 100% PTFE filter under 235°C that its thickness is 1.4mm, poriness is 78%, vertical and horizontal elongation were 15% and 30%, and found that 100% PTFE has good filtration, to run stable at higher wind speeds. In the particle concentration 14g/Nm³, size 0.43 ~ 47.39 μ m, cleaning pressure 14 ± 0.1x10⁵ Pa condition, dust filtration efficiency of greater than 99.98, filtered particle concentration is less than 3mg/Nm³. PTFE filter is stable when pressure drop at wind speeds of 1.6cm/s, it is unstable





when 1.9cm/s; 3M FB700 (glass fiber filter) pressure drop at wind speeds of 1.0CM/s steadily, 1.2cm/s is unstable.

Pure PTFE needled filter felt with good corrosion resistance, high temperature resistant, low friction, insulating combustion and insulating stays hard, can withstand all kinds of strong oxide oxidation corrosion, has a good filtering and ash removal performance, it is a deal filter material under the condition of high temperature, strong corrosion resistance, such as steel, electric power, municipal waste incineration flue gas. Pure PTFE filter material is expensive, however, compared with other high performance fiber filter material amount less.

DuPont developed Tefaire filter felt is PTFE fiber and super fine glass fiber blend of acupuncture composite filter materials, of which 100% PTFE filament fabric as skeleton material, the whole Tefaire mat, PTFE occupy its 85%, the rest of super fine glass fiber. PTFE fiber is the main base material of Tefaire, so the filter material is the characteristics of PTFE filter material. From figure 1 you can see most of fine dust adsorption on the PTFE fiber. After joining the superfine glass fiber, the effective area is multiplied, and reduces the porosity of mat, thus improve the filtering efficiency. Cleaning Tefaire is better than 100% PTFE needled felt in 0.375 microns particle filter, the efficiency increase nearly forty percent, it up to 88%. Tefaire is also better than 100% PTFE needled felt in air permeability, so under the same filtration velocity filtering resistance is much smaller. Because PTFE fiber has good lubricity, thereby reducing the mechanical damage of the glass fiber in the processing. But its alkali resistance is poor; this glass filter strength is almost zero after alkali treatment. Due to the glass fiber folding performance is poor, so Tefaire filter felt relatively pure glass fiber filter material has a better performance of folding. Tefaire filter felt under 250 °C, harsh chemical environment for more than 4 years of continuous service life.



Figure 1 electron microscopy of Tefaire filter felt after dust filtering

The HBT developed by one technology development center, used has surface superfine fiber layer, and by layer gradually used more CF of gradient structure; filter layer main used PTFE and PPS composite fiber, bottom used PTFE and amount glass fiber, fabric used PTFE and glass fiber mixed, on made of acupuncture filter material for overall impregnated processing, to its surface





stick attached PTFE film, on non-PTFE fiber anti-corrosion resistance temperature water repellent has major meaning. Filter structure before the formation of narrow width, slowing filtration resistance in the late problem caused by long-term use. Microfiber surface for the formation of learned the advantage of surface filtration, filter media has better durability. Yan Changyong tested the HBT performance, filter the wind of 1.0~3mm/min. Under 0mm/min of PM1.0, PM2.5 and PM10 filtration efficiency at 88.3%~91.5%, 91.0%~ 93.4% and 92.4%~ 94.4%, 2 micron above the basic particle filtration efficiency is 100%. H BT filtration efficiency and Tefaire, under the same rate of filtration, filtration resistance is much lower. When the filtration speed is 3M/s, Tefaire resistance is about 1150Pa and HBT is only 33Pa.

Application of PTFE microporous membrane in high temperature filter media

PTFE microporous membrane can be alone used for high temperature flue gas filtration, it can also be used with other filter material composite coated filter material. PTFE microporous membrane has high efficiency for micro particle filter, high initial resistance, with the increase of soot cleaning frequency, filtration resistance is less than the other filter materials; Due to surface friction coefficient is small and stable chemical performance, not with dust, dust stripping ratio is high, the soot cleaning performance is good.

Through the study of PTFE microporous membrane, it was found that the filtration efficiency of small particles over 99.99%. Using the expansion of PTFE membrane with different structure parameters, choose different nature of the gas (H₂, H_e, N₂, O₂, CO₂, water vapor) and study its through behavior. Found that the gas in the form of Knudsen diffusion and viscous flow through the membrane pores, and it is inverse proportion that through coefficient and gas molecular weight of 0.5 times, and is inversely proportional to the film thickness, single span through coefficient and the hole radius into 3.6 to the power relationship. The greater the average pore size and pore size distribution is wider, gas permeability is better. As the gas diffuses through the membrane with molecular diffusion and Poiseuille flow, the elevated temperature contributes to gas permeation.

PTFE microporous membrane filtration efficiency is high, but the poor for mechanical properties, when filtration resistance is large, it easy to disable the rupture membrane. PTFE coated filter material is filter material which PTFE microporous membrane and deep filter material or surface of filter material composite, mechanical performance is very good to strengthen, able to withstand the high filtration resistance, using a wider range. It's main by PTFE microporous membrane filter, particle entrapment in the thin film surface, rarely particles into the filter material inside. Compared with other filter material, the comprehensive performance of PTFE coated filter material is best, but the effect of filter material cost is higher, about ordinary filter material 2 ~ 6 times.





The deep filter media and its coated filter media were compared, found that the effect of filter material dust removal efficiency is high, the soot cleaning thoroughly, steady pressure loss and keep the low level, small abrasion of filter bag, dust the applicable range, long life, especially for PM 1.0 of ultrafine particles of dust filter, coated filter material shows a greater advantage. We can see from figure 2 PTFE coated filter material with normal nonwoven filter material of filtering efficiency along with the change of particle size. Effect of filter material clean and dust resistance condition of filtration resistance is higher than H BT filter material is about 30%, to 10 PM, PM2.5, 1 PM.0 filtering efficiency is about 10% higher than our HBT filter material. In the process of studying the filtration resistance of the expanded PTFE microporous membrane composite filter media, it was found that the main factors influencing the filtration resistance at the initial stage of filtration are the thickness of the dust layer. After certain filtering time, the change of porosity on the influence of the resistance increase gradually increased, and finally become the dominant factor of increased resistance. The study on the formation of filter cake on the surface of expanded PTFE membrane filter shows that the concentration of dust-laden gas mainly affects the thickness of filter cake per unit time and does not affect the porosity of filter cake. Particle diameter size and its distribution on porosity of filter cake has a great influence, the smaller the particle size, particle size distribution, the greater the porosity of filter cake formed by the smaller; Impact force of the filter cake filtration direction, from the bottom up filter, fluid drag force to offset the gravity of the filter cake, formed by the filter cake porosity is small; By the filter down, the gravity of the fluid drag force and the particle exerts same direction on the filter cake, cake prone to compression movement, and has lower porosity. From experiment results, the dust removal rate of glass fiber membrane filter is 93.88%, while that of uncoated filter media is only 74.42%.

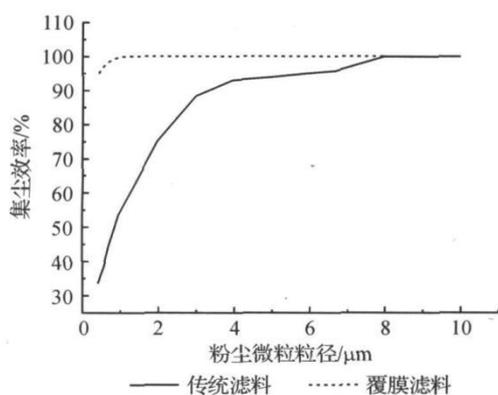


Figure 2 Comparison of Filtration Efficiency between Membrane Filter and Conventional Media

Application of PTFE impregnating liquid in high temperature filter media

In order to improve the use of filter material performance, composite filter material in spine needle composite surface is bright and clean after processing. Due to the high temperature resistant fiber heat melt glue not easily, generally using PTFE impregnated method, can add graphite by PTFE





impregnated liquid or silicone oil emulsion to improve the antistatic performance of filter material and condensation resistance. First, at the time of filter material of PTFE surface impregnating solution, drying and hot rolling make the solution to a film, the main process parameters are shown in table 2

Table 2 Impregnation method of main process parameters

project	parameter
The concentration of PTFE / %	18 ~ 22
The drying temperature / °C	105, 120, 110
Hot pressing roller temperature / °C	280±2

Filter material after treatment, fiber surface and fiber form discontinuous membrane, make among fibers, between fiber and fabric can't relative sliding under certain stress range, increase the density of the structure of the fibers, not only improve the peel resistance, folding strength and wear-resisting performance, but also improve the performance of the filter, filtration precision, ash removal and chemical resistance. In concentration, temperature of 85 °C and 10% NaOH solution for 1 h under the condition that the 15% PTFE emulsion PSA/PTFE fiber impregnated, its strength retention never deal with 40% to 91. 4%.

By comparing the performance of PPS surface coated filter media and permeable membrane filter media, analyzes the advantage of PPS osmosis coated relative PPS filter material coated on the surface of filter material. Resistance of PPS coated on the surface filter material filtration is big; filtration wind speed cannot too much, commonly under 0. 8 m/min, at the same time there also exist problems such as ash which is not easily precoat, because ontology rising costs, energy consumption is large, this filter film is easy to fall off and hole, congestion at the same time, the filter material cannot use; PPS saturation effect of filter material using PTFE emulsion infiltration for filter material as a whole, the fiber surface coated PTFE membrane, can well protect the fiber, the filter material, acid-proof alkaline, hydrolysis resistance and wear resistance are better and more suitable acid and alkali in adverse environments. After processing the penetration effect of filter material type ventilation quantity still can reach 166. 7 ~ 200 mm/s, it is lower 30% resistance than coated on the surface of filter material early.

Using several high temperature resistant polyester mixtures combing with different proportion and glass fiber net, the two-layer fiber mesh and glass fiber cloth needle into the material, and then use PTFE additives made after the use of a variety of characteristics of a series of filtration products.





Conditioning soaking by PTFE impregnated liquid processed fiberglass base cloth draping on PTFE microporous membrane filter material, focus on many advantages of the glass fiber, such as high strength low stretch, high temperature resistance, corrosion resistance and PTFE microporous membrane surface more smooth, hydrophobic, breathable, chemical stability is good wait for a characteristic, reduce the possibility of owing to fiberglass sharp prick membrane. The effect of filter material is almost can intercept all dust, dust in the air and can run without any increase in resistance to guarantee air flux, it has high strength, long use period, large amount of high temperature resistant, breathable and ash removal , etc.

Conclusion and prospect

100% PTFE fiber filter material relative to other fiber filter material has better heat resistance and chemical corrosion resistance, but it is expensive and filtration efficiency advantage; In PTFE fiber adding suitable amount of super fine glass fiber, does not affect its heat resistance performance, and can improve the efficiency of filter material of filtering and to lower the price of filter material. With PTFE impregnation liquid after processing, can improve other fiber filter material performance of resistant to chemical corrosion and ash removal, expanding the scope of the filter material used and prolong service life. In addition, in order to reach the goal of highly efficient, can cover PTFE microporous membrane on surface coated of needled felt to improve its filtration efficiency, makes it not only has good mechanical properties, but also has better filtering performance. At present, the pure PTFE filter material and the mixing PTFE filter material have been praised by users.

