Supply Air Filter Media Technical White Paper

In industrial production, clean environment construction, and environmental protection equipment matching, the air cleanliness of supply air systems directly affects product quality, production stability, and workplace safety.

Supply air filter media, as the core basic component of air pretreatment and purification, undertakes the critical role of intercepting dust, particles, fiber impurities and other pollutants, effectively protecting downstream equipment, optimizing supply air quality, and extending system service life. It is widely used in packaged air handling units, painting production lines, cleanrooms, central air conditioning, exhaust treatment systems, and other fields.

With industrial upgrading and stricter environmental standards, the market has higher requirements for supply air filter media in terms of filtration efficiency, dust-holding capacity, low air resistance, and durability. Traditional filter media can no longer meet the demands of high-precision, high-stability, long-cycle industrial scenarios. High-performance, multi-functional, and customized supply air filter media have become the mainstream industry trenad.

This white paper provides comprehensive exposition on the core technologies, product categories, performance parameters, material selection processes, selection logic, installation and maintenance, and typical industry applications of supply air filter media, offering professional, clear, and actionable technical refere.

I. Core Value and Application Scenarios of Supply Air Filter Media

Supply air filter media, as the first line of defense in air purification, derives its core value from removing suspended particles, dust, hair, fibers, and other impurities from the air through physical interception and adsorption. It ensures that the air supplied to target areas or equipment meets cleanliness standards while reducing the load on downstream filtration equipment and extending the service life of the entire supply air system.

In industrial painting scenarios, supply air filter media provides clean air to spray booths, effectively preventing dust and particles from adhering to workpiece surfaces

and avoiding orange peel, pinholes, and impurity protrusions on coatings, significantly improving spray coating quality and product pass rates. It is an essential matching component for high-quality painting production lines. Especially in high-end painting scenarios, the filtration accuracy of filter media directly determines the appearance smoothness and adhesion of coatings.

In packaged air handling units and central air conditioning systems, supply air filter media undertakes the role of fresh air pretreatment and circulating air purification, intercepting large particle dust in outdoor fresh air and suspended impurities in indoor circulating air, protecting core components such as cooling coils, heaters, and fans, avoiding energy consumption increases, equipment damage, and supply air quality decline caused by dust accumulation and blockage, while also improving indoor and workplace air quality.

In cleanrooms, precision manufacturing, electronic processing, and food processing scenarios, supply air filter media serves as the pretreatment component of multi-stage filtration systems, effectively reducing particle concentration in the air, providing protection for subsequent medium and high-efficiency filtration, ensuring workshop cleanliness meets industry standards, and avoiding dust impurities affecting product precision and quality.

Additionally, supply air filter media is widely used in exhaust treatment systems, ventilation ducts, computer room ventilation, and new energy equipment matching scenarios. With features such as high-efficiency filtration, low air resistance, and easy replacement, it has become an indispensable basic component in air purification systems, meeting clean air supply needs for various industrial and civil scenarios.

II. Core Technologies and Product Categories of Supply Air Filter Media

The performance of supply air filter media primarily depends on material selection processes, fiber structure design, and production technology. Different technical routes and product types suit different application scenarios and filtration requirements. Currently, mainstream supply air filter media in the industry can be divided into multiple categories based on filtration accuracy, material, structure, and

application scenarios, with each product category having different focuses on performance and applicable scenarios.

Divided by filtration accuracy, supply air filter media can be classified into coarse and medium-efficiency categories, corresponding to different filtration grades and application scenarios, following the "gradient filtration" principle to provide protection for subsequent filtration stages.

Coarse-efficiency filter media primarily intercepts large particles above 5μm, such as large dust, hair, and flock-like substances. Filtration grades correspond to G1-G4 levels, with low initial resistance, high dust-holding capacity, and economical pricing. It is mainly used in fresh air inlet pretreatment and ventilation duct pre-filtration scenarios, with its core function being to protect downstream medium and high-efficiency filter media and equipment and extend their service life.

Medium-efficiency filter media primarily intercepts medium-sized particles of 1-5μm. Filtration grades correspond to F5-F9 levels, with higher filtration efficiency and more precise air resistance control. It is suitable for packaged air handling units, painting line air supply, and cleanroom pre-filtration scenarios, further improving supply air cleanliness.

Divided by material, supply air filter media is mainly classified into three categories: polyester fiber filter media, polypropylene fiber filter media, and glass fiber filter media. Additionally, special types such as activated carbon composite media, flame-retardant filter media, and high-temperature resistant filter media have been developed to suit special requirements of different scenarios.

Polyester fiber filter media is currently the most widely used type, featuring high toughness, wear resistance, large dust-holding capacity, washable reuse (some models), and eco-friendly non-toxicity. It suits most industrial and civil scenarios and can be customized in thickness and filtration accuracy according to requirements.

Polypropylene fiber filter media is manufactured using melt-blowing technology, featuring delicate fibers, high filtration accuracy, and low air resistance, with waterproof and oil-proof properties. It is suitable for high-humidity, oil-mist-containing supply air scenarios, such as painting line spray booths and oily workshop ventilation.

Glass fiber filter media features high-temperature resistance, corrosion resistance, and stable filtration efficiency, with long-term temperature resistance up to 450-600°C, suitable for high-temperature supply air scenarios such as drying systems and high-temperature exhaust treatment matching.Divided by structure, supply air filter media can be classified into three categories: flat panel, pleated, and pocket types.

Flat panel filter media features a simple structure, easy installation, and low cost, suitable for space-constrained scenarios with simple filtration requirements;

Pleated filter media increases filtration area through pleating design, with larger dust-holding capacity, longer service life, and lower air resistance, suitable for high-air-volume, long-cycle operation scenarios;

Pocket filter media features large filtration area, high filtration efficiency, and good sealing performance, suitable for medium-efficiency filtration stages. It can effectively improve supply air cleanliness and is suitable for packaged air handling units and cleanroom scenarios.

Additionally, with technological upgrades, new products such as electrostatic electret filter media and nanofiber composite filter media are gradually being promoted and applied.

Electrostatic electret filter media enhances Coulomb adsorption force on sub-micron particles by injecting electrostatic charges on fiber surfaces, improving filtration efficiency under low air resistance, with significantly better energy efficiency ratio than traditional products;

Nanofiber composite filter media adopts ultra-fine fiber network structure, with filtration accuracy reaching HEPA level while having high porosity and large dust-holding capacity. It is suitable for high-end scenarios with extremely high cleanliness requirements, such as semiconductor cleanrooms and biological laboratories.

III. Core Performance Parameters and Technica Indicators

The performance of supply air filter media is primarily evaluated through core parameters such as filtration efficiency, dust-holding capacity, initial air resistance, service life, and temperature and humidity resistance, which directly determine the

suitability and effectiveness of filter media and are also the core basis for enterprise selection.

Filtration efficiency is the core indicator, referring to the filter media's ability to intercept particles of different sizes in the air. It is typically classified according to standards such as GB/T 14295, EN779, and ASHRAE52.2. Coarse-efficiency filter media (G1-G4 grades) has a filtration efficiency of 20%-80% for particles above 5μm, with G4 grade reaching 60%-80%, meeting general fresh air pretreatment requirements; medium-efficiency filter media (F5-F9 grades) has a filtration efficiency of 80%-99.9% for particles above 1μm, with F9 grade reaching 99%-99.9%, meeting medium-to-high-end supply air needs for painting lines and cleanrooms. For special scenarios, electrostatic electret filter media can improve filtration efficiency by 15-20% under the same air resistance, and nanofiber composite filter media can achieve filtration efficiency of 99.97% or higher for 0.3μm particles.

Dust-holding capacity refers to the total amount of particles the filter media can intercept before reaching the specified final resistance, measured in g/㎡. Larger dust-holding capacity means longer service life, lower replacement frequency, and effectively reduced maintenance costs. Generally, polyester fiber filter media has a dust-holding capacity of 300-650 g/㎡. Pleated and pocket filter media, due to larger filtration areas, can reach 500-800 g/㎡. Gradient density structured filter media can improve dust-holding capacity by more than 37% compared to traditional homogeneous filter materials.

Initial air resistance refers to the air resistance of filter media under rated air volume when not dust-loaded, measured in Pa. Lower initial air resistance means less impact on supply air system energy consumption, reducing fan operating load. Quality supply air filter media has initial air resistance controlled between 30-120Pa, with coarse-efficiency filter media at 30-80Pa and medium-efficiency filter media at 50-120Pa, meeting the low resistance requirement (≤150Pa@1.0m/s face velocity) in ASHRAE Standard 52.2-2022.

Service life primarily depends on dust-holding capacity, filtration accuracy, and dust concentration in the usage environment. Under normal circumstances, coarse-efficiency filter media has a service life of 1-3 months, and medium-efficiency filter

media has a service life of 3-6 months. In scenarios with lower dust concentration, service life can extend to 6-12 months. Washable filter media can be reused after cleaning, but each cleaning reduces filtration efficiency by approximately 15%, with a maximum of 2-3 cleanings allowed.

Temperature and humidity resistance adapts to usage requirements of different scenarios. The temperature resistance range of conventional polyester and polypropylene filter media is -10°C-120°C, with humidity resistance up to 100%, meeting most normal temperature and humidity scenarios. Glass fiber filter media has a temperature resistance range of 200°C-600°C, suitable for high-temperature scenarios. Flame-retardant filter media must meet UL94 V-0 or EN 13501-1 B-s1,d0 combustion performance requirements, suitable for scenarios with fire prevention requirements.

IV. Material Selection Processes and Production Standards

The performance of supply air filter media fundamentally depends on material selection and production processes. Quality raw materials and refined production processes are key to ensuring stable performance and high durability of filter media.

In terms of raw material screening, polyester fibers use high-toughness, wear-resistant, eco-friendly and non-toxic quality polyester raw materials, with fiber diameter controlled at 10-25μm to ensure breathability and filtration effectiveness of filter media. Polypropylene fibers use food-grade eco-friendly raw materials, processed through melt-blowing technology to produce ultra-fine fibers, improving filtration accuracy and waterproof and oil-proof properties. Glass fibers use high-temperature resistant, corrosion-resistant alkaline-free glass fibers, ensuring stable performance in high-temperature environments. All raw materials comply with RoHS and REACH environmental directives, are odorless and free of harmful volatile substances, suitable for various industrial and civil scenarios.

In terms of production processes, advanced needle-punching, melt-blowing, and composite processes are adopted to ensure uniform fiber distribution and dense structure of filter media, avoiding problems such as fiber shedding and delamination. Needle-punching process enhances the toughness and wear resistance of filter media,

enabling fibers to interweave and form a stable three-dimensional structure, improving dust-holding capacity and service life. Melt-blowing process can produce delicate, high-precision polypropylene filter media, suitable for medium-to-high-end filtration scenarios. Composite process combines fibers of different materials to achieve multi-functional adaptation. For example, activated carbon composite media can simultaneously achieve particle filtration and VOC adsorption, meeting complex scenario requirements.

In terms of quality inspection, each batch of products undergoes strict performance testing, including filtration efficiency, initial air resistance, dust-holding capacity, temperature and humidity resistance, fiber shedding rate, and other indicators. Testing standards follow GB/T 14295-2019 "Air Filters", EN 779:2012, ASHRAE 52.2-2022, and other national and international standards, ensuring product performance meets requirements. Simultaneously, a product traceability system is established to trace the production and testing records of each batch, ensuring stable and reliable product quality.

V. Selection Logic and Adaptation Principles

The selection of supply air filter media requires comprehensive consideration of application scenarios, supply air system parameters, filtration requirements, and environmental conditions. Ensuring precise selection and strong adaptability while considering economy and maintenance convenience, avoiding insufficient or excessive filtration, and reducing production and maintenance costs.

First, determine the filtration grade and accuracy based on filtration requirements. If only used for fresh air pretreatment and protecting downstream equipment, coarse-efficiency filter media (G3-G4 grades) can be selected, prioritizing dust-holding capacity and low air resistance. If used in painting lines, cleanrooms, and other scenarios with higher supply air cleanliness requirements, medium-efficiency filter media (F5-F9 grades) should be selected, focusing on the balance between filtration efficiency and air resistance. For special scenarios such as high temperature, oil content, and VOC content, special filter media such as high-temperature resistant, waterproof and oil-proof, and activated carbon composite types should be selected.

Simultaneously, the "gradient filtration" principle should be followed, with reasonable configuration of coarse and medium-efficiency filter media, such as the G3→F5→F8 configuration, ensuring each level of filter media performs optimally and extending the service life of downstream equipment.

Second, select product structure and dimensions based on supply air system parameters. Fan air volume, duct dimensions, and installation space directly determine the dimensions and structure of filter media. For high-air-volume scenarios, pleated or pocket filter media should be selected to increase filtration area and reduce air resistance. For space-constrained scenarios, flat panel filter media can be selected, with easy installation. Simultaneously, dimensions and shapes of filter media should be customized based on installation methods to ensure good sealing during installation and avoid air leakage leading to filtration effectiveness decline. Additionally, appropriate filter media thickness should be selected based on air velocity. For conventional scenarios, 10-20mm thickness is selected. For heavy pollution or long-term use scenarios, 20-30mm thickened versions are selected to balance filtration effectiveness and service life.

Third, select materials based on usage environmental conditions. For normal temperature and humidity scenarios without special requirements, polyester fiber filter media is preferred, offering high cost-effectiveness and strong adaptability. For high-humidity, oil-mist-containing scenarios, polypropylene fiber filter media is selected, featuring waterproof and oil-proof properties. For high-temperature scenarios, glass fiber filter media is selected, with stable temperature resistance. For scenarios containing VOCs and odors,scenarios containing VOCs and odors, activated carbon composite filter media is selected to achieve integrated particle filtration and odor adsorption. Simultaneously, products with appropriate dust-holding capacity should be selected based on ambient dust concentration. For high-dust-concentration scenarios, pleated or pocket filter media with large dust-holding capacity should be selected to reduce replacement frequency.

Finally, consider economy and maintenance convenience. Under the premise of meeting filtration requirements, prioritize products with long service life and easy replacement, reducing maintenance costs. Washable or disposable filter media can be

selected based on usage frequency. Washable filter media is suitable for low-dust-concentration, inconvenient-replacement scenarios. Disposable filter media is suitable for high-dust-concentration, convenient-replacement scenarios.

VI. Installation, Replacement, and Maintenance Key Points

Correct installation, standardized replacement, and scientific maintenance are key to ensuring supply air filter media performs at its best, extends service life, and reduces operating costs. Whether flat panel, pleated, or pocket filter media, installation and maintenance must follow corresponding specifications to avoid filtration effectiveness decline and equipment damage caused by improper operation.

During installation, ensure filter media fits tightly against the installation frame without gaps or air leakage, avoiding unfiltered air from directly entering the supply air system and affecting filtration effectiveness. Before installation, clean dust and debris from the installation frame and check if the frame is flat and secure. During installation, the windward side of filter media must face the air flow direction, ensuring particles can be effectively intercepted. For pocket filter media, ensure filter bags are installed flat without wrinkles, avoiding excessive air resistance caused by filter bag blockage.

Simultaneously, avoid damaging filter media during installation to prevent fiber shedding, affecting filtration effectiveness and equipment operation.

During replacement, replace filter media timely based on service life, final resistance, and usage environment to avoid increased air resistance, rising energy consumption, and declining filtration efficiency caused by filter media blockage. Under normal circumstances, when the final resistance of filter media reaches 2-3 times the initial resistance (normally 200-250Pa), or when the filter media surface is visibly dust-loaded or blackened, timely replacement is required. For washable filter media, if filtration efficiency significantly decreases after 2-3 cleanings, timely replacement is also required. During replacement, turn off the supply air system power to avoid dust flying, and properly dispose of replaced waste filter media to avoid secondary pollution.

For daily maintenance, regularly check the operating status of filter media, observe dust accumulation on the filter media surface, record air resistance changes, and establish maintenance records for timely replacement. For washable filter media, use

clean water or neutral detergent for cleaning, avoid corrosive detergents, and ensure thorough drying before reinstallation and use, avoiding mold growth caused by moisture. Simultaneously, regularly clean ducts, fans, and other components of the supply air system to reduce dust accumulation, providing a good operating environment for filter media and extending its service life.

VII. Typical Industry Application Solutions

Supply air filter media, with its diverse product types and stable performance, is widely used in various industrial and civil scenarios. Customized adaptation solutions can be provided based on the characteristics of different industries, ensuring filtration effectiveness matches production requirements.

The industrial painting industry is one of the core application scenarios for supply air filter media. Spray booths and flash-off rooms on painting production lines require clean and uniform air supply, avoiding dust impurities affecting coating quality. A two-stage filtration configuration of "coarse-efficiency + medium-efficiency" is normally adopted. Coarse-efficiency filter media (G4 grade) is used for fresh air pretreatment, intercepting large particle dust and hair, protecting downstream medium-efficiency filter media. Medium-efficiency filter media (F6-F8 grade) adopts pleated or pocket structure, with high filtration accuracy and low air resistance, ensuring the air supplied to spray booths meets cleanliness standards and effectively avoiding orange peel, pinholes, and impurity defects on coatings. For oil-mist-containing painting scenarios, waterproof and oil-proof polypropylene filter media can be selected to improve filtration effectiveness and service life.

In packaged air handling unit matching scenarios, supply air filter media serves as the core pretreatment component of the unit. Based on unit air volume and filtration requirements, appropriate filtration grades and structures are selected. Large units typically adopt pocket medium-efficiency filter media, with large filtration area and high dust-holding capacity, suitable for long-term continuous operation. Small units can select flat panel or pleated filter media, with easy installation and lower cost. Simultaneously, polyester or polypropylene materials are selected based on the unit's usage environment, ensuring filter media adapts to the unit's operating conditions,

protecting core components such as cooling coils, heaters, and fans inside the unit, and reducing energy consumption.

Cleanroom and precision manufacturing scenarios have higher requirements for supply air cleanliness. A multi-stage filtration system is normally adopted, with supply air filter media serving as the pretreatment component, selecting medium-efficiency filter media (F7-F9 grade) to intercept 1-5μm particles, providing protection for subsequent high-efficiency filtration and ensuring workshop cleanliness meets ISO standards. For high-end cleanroom scenarios such as semiconductor and biological laboratories, nanofiber composite filter media can be selected to further improve filtration accuracy and meet stringent cleanliness requirements.

In high-temperature and environmental protection equipment matching scenarios, such as drying systems and high-temperature exhaust treatment equipment, high-temperature resistant glass fiber filter media must be selected, with temperature resistance above 200°C, ensuring stable performance in high-temperature environments and intercepting dust impurities in high-temperature air streams to protect downstream equipment. For exhaust treatment systems containing VOCs and odors, activated carbon composite filter media can be selected to simultaneously achieve particle filtration and odor adsorption, improving exhaust treatment effectiveness.

VIII. Technology Development Trends

With industrial upgrading, stricter environmental standards, and intelligent development, the technological development of supply air filter media will advance toward high performance, multi-functionality, energy saving and environmental protection, and intelligence, gradually meeting high-end requirements of different scenarios.

In terms of high-performance development, filtration efficiency and dust-holding capacity are further improved,air resistance is reduced, and the core goal of "high efficiency with low resistance" is achieved. For example, gradient density structured filter media will be widely applied, intercepting large particles with outer coarse fibers and capturing sub-micron particles with inner fine fibers, improving dust-holding

capacity and delaying pressure drop increase rate. Electrostatic electret technology will be continuously upgraded, extending charge half-life through material modification to improve filtration efficiency stability. Nanofiber technology will gradually break through mass production bottlenecks, with costs continuously decreasing and penetrating more high-end scenarios.

In terms of multi-functionality, demand for special filter media will continue to increase, such as high-temperature resistant, waterproof and oil-proof, flame-retardant, activated carbon composite, and antibacterial multi-functional integrated filter media, which will suit more complex scenario requirements, achieving "one media, multiple uses" and simplifying filtration system configuration while reducing costs. Simultaneously, degradable and recyclable eco-friendly filter media will become an industry trend, reducing environmental pollution and conforming to green production concepts.

In terms of energy saving and environmental protection, production energy consumption and pollutant emissions of filter media are reduced by optimizing production processes and selecting eco-friendly raw materials. Simultaneously, by improving dust-holding capacity and extending service life, filter media replacement frequency is reduced, lowering maintenance costs and resource waste. Additionally, linkage with intelligent supply air systems enables real-time monitoring of filter media operating status, fault warnings, and replacement reminders, improving maintenance efficiency and reducing energy consumption.

In terms of combining standardization with customization, industry standards for supply air filter media will be further improved to standardize product performance indicators and testing methods, ensuring stable and reliable product quality. Simultaneously, based on personalized requirements of different industries and scenarios, customized products and solutions are provided, including customization in dimensions, filtration accuracy, materials, and structures, improving adaptability and effectiveness.

IX. Conclusion

Supply air filter media, as the basic core component of air purification systems, directly affects supply air cleanliness, equipment service life, production quality, and operating costs. It plays an irreplaceable role in industrial production, clean environment construction, and environmental protection equipment matching. With the continuous upgrading of industrial technology and the continuous improvement of environmental requirements, high-performance, multi-functional, and customized supply air filter media will become the industry mainstream, providing powerful support for enterprises to achieve clean production, energy saving and environmental protection, and quality and efficiency improvement.

This white paper comprehensively expounds on the core technologies, product characteristics, selection logic, maintenance key points, and industry applications of supply air filter media, providing enterprises with professional, systematic, and actionable technical references.