Technical White Paper on integrated solutions for cleaning systems in industrial cleanrooms

In the fields of environmental protection equipment manufacturing, precision machining, new material production, laboratory testing, waste gas treatment equipment assembly, etc. ,the cleanliness, temperature and humidity, pressure difference and air distribution of the production environment have a direct impact on product quality, equipment operation stability andProduction compliance. There are many problems in traditional workshops, such as unorganized diffusion of dust, accumulation of VOCs, large fluctuation of temperature and humidity, imbalance of pressure difference, etc. Cross-pollution and other issues, not only affect the performance of environmental protection equipment, but also easy to cause secondary pollution, it is difficult to meet the modernization of highStandard production and environmental regulation requirements.

Industrial clean room purification system, with air purification, environmental control, pollution control, intelligent operation and maintenance as the core, throughSystematic design, modular construction, fine operation and maintenance, to build a clean production environment in line with production needs, to achieve dust, Effective control of particulate matter, harmful gases, microorganisms, while protecting the workshop temperature and humidity, differential pressure, air change rate, noiseKey indicators such as stable standards.

This white paper focuses on the technical system, core components, design principles, key equipment, and technical requirements of the purification system in industrial clean roomsConstruction specifications, operation and maintenance management and typical applications are fully expounded, combined with relevant national standards and industry norms, for the enterpriseProvide a complete set of clean room construction, operation and maintenance technical solutions, help enterprises to realize the production environmentUpgrading, product quality improvement and environmental compliance operation.

System definition and application value

The purification system of industrial clean room is a comprehensive environmental control project for industrial production scenariosFiltration, air distribution optimization, temperature and humidity regulation, differential pressure control, fresh air supply, waste gas dust treatment, intelligent monitoring and other technologiesThe environmental parameters such as suspended particulate matter, harmful gases, temperature and humidity, and static pressure difference in the workshop are controlled within the specified range by means of operationTo form a stable, clean and safe production space.

Unlike civil and medical cleanrooms, industrial cleanrooms emphasize productivity, durability, pollution resistance and economyEnvironmental Protection, can be adapted to high dust, high humidity, VOCs emission of industrial conditions, taking into account the production process requirements andRequirements of environmental protection.

Its core application value is reflected in multiple dimensions. One is to improve the quality of products and equipment, especially in the core of environmental protection equipmentParts processing, filter material assembly, sensor assembly, catalytic unit production and other links, clean environment can effectively avoid dust attachedDust and impurity pollution, and improve the reliability and service life of the equipment. The second is to achieve environmental compliance in the production process, through the secretClosed purification, centralized dust removal, waste gas collection and treatment, from the source control of dust and VOCs emissions, meet the unorganized emissions pipeControl requirements, reduce the risk of environmental supervision. Third, improve the working environment, protect occupational health, reduce dust, odor, have.Hazard of harmful gases to operators, reduce the risk of occupational diseases, improve production safety and employee satisfaction. Fourth, optimizationProduction process, to achieve standardization, fine production, clean environment can reduce the frequency of cleaning, reduce rework rate, enhance the materialMaterial turnover efficiency, for automated production lines, intelligent assembly lines to provide a stable basis for operation. Fifth, extend the purification and environmental protection facilitiesEquipment service life, clean

environment can reduce external dust into the fan, filter, catalytic module, activated carbon device such as nuclearCore components to reduce clogging, wear and maintenance costs.

Technical system of total solution

Industrial clean room purification system overall solution using“Design-equipment-construction-commissioning-operation and maintenance” integrationThe technical route covers the whole life cycle from pre-survey to post-operation and maintenance to ensure the stable, efficient and energy-saving operation of the system.

The overall program to environmental parameters as the goal-oriented, according to the production process to determine the level of cleanliness, temperature and humidity range, differential pressureRequirements, fresh air volume, noise limits and other core indicators, based on this air distribution design, purification process configuration, Equipment selection and layout optimization. The system takes efficient filtration as the core purification method, and cooperates with fresh air purification and circulationPurification, local dust removal, waste gas treatment module, the formation of a multi-stage purification system, while through the air conditioning unit to achieve temperature and humidityAccurate control, through the supply and return air system to achieve a reasonable pressure difference, through the intelligent control system to achieve full parameter real-time monitoring and selfAutomatic regulation.

The solution is highly adaptable, according to the workshop area, floor height, production equipment layout, pollution source distribution, cleanFlexible adjustment of grade requirements, support for new clean workshop planning, existing workshop upgrading, local super clean station playingConstruction and other scenarios, taking into account the purification effect, construction cost and operation energy consumption, to achieve optimal comprehensive benefits. Its modular designThe design supports on-demand additions and subtractions of functional units, such as adding VOCs treatment sections to deal with organic waste gases, or embedding sterilization modules to enhance microBiological control; all equipment interface is unified, parameter exchange, easy to expand and system integration.

The structure and function of core system

The purification system of industrial cleaning room is composed of seven core modules. Each module has a clear division of labor and operates in linkageThe complete clean environment control system adapts to the core requirements of industrial scenes related to environmental protection equipment.

Envelope is the basic carrier of clean room, usually using color steel sandwich panel, clean windows and doors, epoxy or PVC cleanFloor, with dust-proof, easy to clean, corrosion resistance, good air tightness and other characteristics, can effectively block the invasion of external dust to preventAccumulation of internal pollutants and cross-contamination, while meeting the fire, sound insulation, load-bearing and other industrial safety requirements, for a clean environmentClean Environment.

Air purification system is the core to achieve cleanliness. It is a multi-stage filtration system composed of primary, medium and high efficiency filters,With FFU fan filter unit, laminar flow cover, clean shed and other equipment, continuous purification of circulating air, effective removalThe suspended particulate matter in the air meets the requirements of different grades of cleanliness. For the production of environmental protection equipment in the scene of more dust,pre-filtration and pulse dust removal devices can be added to extend the service life of high efficiency filters and reduce operation and maintenance costs.

The air conditioning temperature and humidity system is responsible for stabilizing the workshop environment, through the combined air conditioning unit, cold and heat source system, humidification and dehumidificationDevice to achieve precise control of temperature and relative humidity, to avoid fluctuations in temperature and humidity caused by material deformation, condensation, corrosion, corrosionMicrobial breeding and other issues, especially for environmental protection equipment precision components production and testing environment, to ensure product processing accuracy.

The air flow and pressure difference system can form one-way flow or turbulent air flow group by reasonably arranging air supply outlets, return air outlets and exhaust outletsTo quickly discharge pollutants and avoid diffusion. At the same time,

through the ratio of supply and return air volume to form a stable pressure difference, to ensure that the clean areaAir pressure higher than the non-clean area, to prevent the backflow of external dirty air, to achieve zoning control, grading purification, to avoid different processesDifferent processes.

The fresh air exhaust system provides continuous fresh air for the workshop, exhausts dirty air and waste heat and humidity, and the fresh air passes through multiple stagesAfter filtering and temperature and humidity pretreatment, it is sent into the room to ensure the indoor air quality and the respiratory health of the operators. For environmental protectionEquipment production VOCs, Odor, dust in the process link, set up independent exhaust system, realize centralized collection of exhaust gas andFollow-up treatment, taking into account clean control and environmental protection standards.

Pollution Collaborative control system is an important feature of industrial clean room, which is different from ordinary clean roomEquipment linkage, the grinding, spraying, welding, assembly and other processes of dust, organic waste gas local collection, netIn order to avoid the accumulation of pollutants in the clean space, ensure the production ringEnvironmental and emission standards.

Intelligent monitoring system for clean room key parameters of all-weather real-time monitoring and automatic control, including temperature and humidity, pressurePoor, cleanliness, PM value, VOCs concentration, filter resistance, fan running state, etc. , with abnormal alarm, dataRecording, remote monitoring, automatic frequency conversion energy saving and other functions, realize intelligent, visual, unmanned operation and maintenance, reduce manualManagement cost, and improve the stability of system operation.

Design principles and key technical points

Industrial clean room purification system in the design phase to follow the practicality, safety, energy saving, scalability, compliance fiveLarge core principle, to avoid excessive design or lack of function, to ensure that the program fits the actual production conditions of environmental protection equipment, taking into account the effectResults and costs.

Practical requirements to the production process as the core, not blindly pursue high-grade cleanliness, according to the actual working conditions to determine the indicators,Take into account the use of results and investment costs; safety focus on fire, explosion, anti-static, anti-leakage, emergency ventilationDesigned to meet industrial safety standards, especially for VOCs, dust-related environmental protection equipment production conditions, enhanced explosion-proof and ventPressure Design; energy saving by optimizing the air distribution, reducing air leakage, the use of frequency control, heat recovery device, efficient fanMeasures such as reducing energy consumption of air conditioning and purification system operation, expansion reserve equipment replacement, system expansion, process upgradingInterface and space, convenient for post-renovation; compliance with the relevant national norms and industry standards, while meeting localEnvironmental, fire and safety acceptance requirements.

The key technical points in the design process, focusing on air distribution design, differential pressure control, filter configuration, fresh airRatio, noise control and energy saving optimization. Reasonable air distribution can avoid dead space and eddy current, quickly carry away pollutants, and protect the environmentThe overall cleanliness of the barrier clean area is uniform, and the pressure difference control ensures that no cross contamination occurs between different clean areas to ensure cleanlinessThe multi-stage filtration configuration takes into account the purification efficiency and operation cost, and is reasonably matched according to the dust concentration and the cleaning requirementsFilter grade; adequate fresh air volume to ensure air quality and safe operation, while avoiding energy waste; noise control to avoidImpact on the production and operating environment, to ensure compliance with industrial noise emission standards; overall system through frequency conversion, heat recovery,by means of frequency conversion, heat recovery, air duct layout optimization, etc. , the long-term energy-saving operation is realized, and the operation cost of the enterprise is reduced.

Requirements for selection and configuration of main equipment

The selection of the core equipment of the system directly determines the performance and stability of the clean room, which needs to be combined with the production conditions of environmental protection equipment, cleaningNet level, pollution source type and other indicators to accurately match, taking into account the practicality and economy.

In the air filtration equipment, the primary effect filter is used for fresh air pretreatment, blocking large particle dust, protecting the back-end equipment;Medium efficiency filter further filters fine particulate matter, extending the service life of high efficiency filter, high efficiency filter is used for end fineFiltration is the core of ensuring cleanliness. According to the cleanliness level, the corresponding efficiency filter is selected. FFU laminar flow unit is applicableIn local high cleanliness area, flexible layout, easy maintenance, adapt to environmental protection equipment precision component production station.

Air conditioning and temperature and humidity equipment selection of industrial-grade air conditioning units, with refrigeration, heating, humidification, dehumidification, throughFilter and other full-function, equipped with frequency conversion control system, according to the workshop load changes automatically adjust, reduce energy consumption. Humidification and removalWet equipment according to regional climate and production needs matching, to ensure that the annual temperature and humidity stability in the design range, to avoid environmental factorsAffect product quality.

Fan and air valve equipment selection of low noise, high efficiency, energy-saving centrifugal fan or axial flow fan, with electric air valve, Check valve to achieve air volume regulation and anti-backflow, the key parts of the use of closed air valve to enhance air tightness, reduce air leakage, ensure that the departmentSystem operating efficiency. euipment can be configured according to the source of pollution workshop mobile dust collector, welding fume purifier, activated carbon adsorptionDevice, photocatalytic device, etc. , and cleaning system linkage operation, to achieve side purification and governance, to ensure that no dust in the clean room, VOCs

accumulation in the clean room, while meeting environmental protection emission requirements.

Intelligent monitoring equipment includes all kinds of sensors, touch screen, PLC controller, background management software, support data storageStorage, remote view, history tracing, automatic adjustment, real-time monitoring of the key parameters of the clean room, abnormal situation timelyAlarm, to meet the needs of modern plant digital management, improve the efficiency of operation and maintenance.

Code for acceptance of construction, installation and commissioning

The construction of clean room project should follow the standardized process, focusing on the control of airtightness, cleanliness and safety to ensure the projectThe quality meets the design requirements and adapts to the harsh requirements of environmental protection equipment production. The site should be thoroughly cleaned and removed before constructionDust, moisture-proof treatment, to avoid impurity residue affect the cleaning effect; enclosure structure installation pay attention to splicing seal, eliminate gap leakageWind, to ensure air tightness; floor construction to ensure smooth, wear-resistant, easy to clean, to avoid dust and damage; air duct production and safetyPay attention to airtightness and smooth inner wall, reduce dust and airflow resistance, avoid secondary pollution.

Purification equipment, air conditioning units, FFU, filters, monitoring systems, such as the installation of accurate positioning, wiring specifications, pipelinesReasonable layout to avoid affecting the production line and equipment operation. After installation, complete system commissioning, including air volume levelingBalance, pressure difference adjustment, temperature and humidity calibration, air flow uniformity test, filter leak detection, noise test, automatic control system debuggingTo ensure that the operation of each module is coordinated, and the parameters meet the design standards.

During the acceptance phase, check each item according to the design index, including cleanliness, temperature and humidity, pressure difference, air change rate,

fresh air volume, etc. Noise and other key parameters, at the same time check the effect of environmental protection, to ensure that the system meets the design requirements and use standards, in line with the countryDomestic Environmental Protection and fire protection standards, the system can be delivered for operation to ensure production compliance of the enterprise.

Operation Maintenance and long-term management

The long-term stable operation of clean room depends on standardized operation and maintenance management. Scientific maintenance can not only ensure the cleaning effect, but alsoCan extend the service life of equipment, reduce operating costs, adapt to environmental protection equipment long-term stable production needs. Heavy daily maintenancePoints include filter replacement, equipment maintenance, cleaning management, parameter monitoring and energy consumption management.

Regularly check the filter resistance and cleanliness, timely replacement of the initial effect, medium effect, high efficiency filter, to avoid clogging guideAir volume decline, purification failure, affect the production environment and product quality; air conditioning units, fans, pumps, humidification and dehumidificationEquipment should be maintained regularly, check running status, add lubricating oil, clean up sundries to ensure stable operationStandard cleaning system, the use of special cleaning tools and detergents, to avoid secondary pollution, to maintain a clean environment.

Through the intelligent monitoring system to continuously track the key parameters, timely find and deal with anomalies, establish a sound operation and maintenance ledger,record maintenance content, replacement cycle, energy consumption data, to achieve preventive maintenance, reduce downtime failure. At the same time according toThe production load and seasonal variation optimize the operation mode, reduce energy consumption on the premise of ensuring cleanliness, and realize energy saving and environmental protectionWin-win situation.

Typical application scenarios

The overall solution is widely applicable to environmental protection equipment and related industrial fields, close to the actual production of enterprises, provide fineQuasi-adaptive clean environment solution. In the environmental protection equipment manufacturing workshop, it can be used for filter material, filter cylinder, catalyst and activityCarbon modules, sensors, control units and other high-precision components production and assembly, effectively avoid dust pollution, improve product consistencyAnd reliability to ensure the performance of environmental protection equipment.

In the waste gas treatment supporting clean station, can build local clean environment, used for catalytic combustion equipment, zeolite runner, Activated carbon adsorption equipment core component assembly, to prevent impurity adhesion affect the treatment effect, to ensure that environmental protection equipment up to standard operation.In the new material and filter material production workshop, control dust and fly fiber, improve product quality and production environment safety, reduce powderHarm of dust to operators.

In the laboratory and Testing Center, build clean testing environment, ensure environmental protection equipment performance testing, filter material efficiency test, Catalytic performance analysis and other data are accurate and reliable, which provides guarantee for product development and quality control. In precision machining and sheet metalAssembly workshop, control dust and oil, improve the surface quality of environmental protection equipment shell and structural parts, reduce the follow-up polishing and cleaningCleaning pressure, improve production efficiency.

Ix. Trends in technological development

In the future, the purification system of industrial clean room will continue to upgrade in the direction of energy saving, integration, intelligence and low carbon,it fits the trend of green development and intelligent upgrading of environmental protection equipment industry. High-efficiency low-resistance filtration, heat pipe heat recovery, photovoltaic power supply,frequency adaptive control technology will continue to be applied to further reduce the system operation energy consumption, help enterprises to achieve“Double carbon”Goals.

The purification system is deeply integrated with dust removal, waste gas treatment and intelligent production line to realize environmental control, production process and environmental protectionGovernance integration, improve production efficiency and environmental protection management effect. Internet of things, Big Data and digital twin technology will be widely usedUse, realize the whole life cycle management of clean room, remote operation and maintenance, intelligent early warning, automatic optimization become standard, reduce manualManagement cost, improve the stability of the syst operation.

Low-carbon building materials, recyclable materials, modular rapid disassembly and assembly technology will promote the construction of a cleaner workshop more environmentally friendly, more efficient,More flexible, adapt to environmental protection equipment enterprise process upgrading and capacity expansion needs, to provide enterprises with more economy and adaptabilityClean Solutions.

Conclusion

Industrial clean room purification system overall solution, is a modern industrial enterprises to achieve high-quality production, green systemIt is an important basic project for manufacturing and compliance operation. It can not only significantly improve the quality of products, improve the working environment, guaranteeOccupational health can be deeply integrated with the environmental management system of the enterprise to realize the synergy of production process and pollution control, and help the enterprises to realize the sustainable development of the industryEnhance the core competitiveness of environmental equipment enterprises.

This white paper systematically combs the technical system, composition module, design points, construction specification and operation of industrial clean roomManagement, to provide enterprises with a complete, scientific, can be landing the overall solution.