Packaged Air Handling Unit and Automatic Control System Technical White Paper

In industrial painting, cleanrooms, environmental protection equipment matching, spray drying production lines, precision manufacturing, and other scenarios, air temperature, humidity, cleanliness, wind speed, and supply air uniformity directly determine product quality, working environment, and production stability. As the core equipment for centralized air supply and air conditioning, packaged air handling units can achieve integrated functions including fresh air filtration, temperature and humidity regulation, cooling and heating exchange, dehumidification and humidification, air pressure delivery, and sealed circulation. With intelligent automatic control systems, fully automatic operation, precise regulation, and energy-saving operation can be achieved. It has become an indispensable key supporting equipment for modern industrial environmental control.

This solution provides comprehensive explanation on the structural composition, working principles, core functions, system configuration, automatic control logic, engineering design, installation and commissioning, and operation and maintenance of packaged air handling units. It offers clear, professional, and directly actionable technical references for enterprises in painting line matching, workshop purification, constant temperature and humidity environment construction, and environmental protection equipment upgrade projects, helping enterprises achieve the comprehensive goals of stable production, environmental improvement, energy reduction, and long-term reliable operation.

I. Application Value and Applicable Scenarios of Packaged Air Handling Units

Packaged air handling units take modular structure as their core advantage, flexibly combining functional sections according to on-site requirements to achieve centralized air treatment and stable delivery. In industrial painting production lines, the treated clean air at constant temperature and humidity is supplied to spray booths, effectively avoiding flow marks, orange peel, pinholes, and other coating defects caused by abnormal temperature and humidity, significantly improving spray appearance and film-forming quality.

In environmental protection equipment matching scenarios, units can provide stable fresh air and air volume support for exhaust treatment, catalytic combustion, drying and curing, and other systems, ensuring stable operating conditions and reliable purification efficiency of main equipment. In precision manufacturing, assembly workshops, cleanrooms, and other environments, units maintain stable indoor environment through multi-stage filtration and temperature and humidity control, reducing the impact of dust, humidity, and temperature fluctuations on product precision and production processes.

These units feature high air volume, high wind pressure, low noise, stable operation, and convenient maintenance. They can adapt to continuous 24-hour operation conditions and are widely applied in mechanical manufacturing, automotive painting, hardware spraying, aerospace, rail transit, electronic processing, food processing, environmental engineering, and other fields. They are ideal equipment for achieving high-quality production and standardized environmental control.

II. Overall Unit Structure and Functional Section Composition

Packaged air handling units adopt a modular frame structure with freely combinable standard functional sections. The overall sealing is strong, structural strength is high, and heat loss is small. Installation and expansion are flexible and convenient. Unit housings adopt double-layer insulated panels with high-efficiency insulation materials filled in between, effectively preventing cold and heat loss, reducing operating energy consumption, and avoiding external wall condensation.

The fresh air and return air mixing section is responsible for mixing outdoor fresh air and indoor circulating air in proportion to ensure supply air oxygen content and air circulation efficiency while reducing cooling and heating loads. Primary and medium-efficiency filtration sections can effectively intercept dust, particles, fiber impurities in the air, ensuring clean air is supplied to workshops or spray rooms, avoiding quality issues caused by impurities adhering to workpiece surfaces.

Cooling and heating sections achieve air temperature regulation through refrigerant, hot water, steam, or electric heating. They can quickly cool or heat according to requirements, ensuring supply air temperature remains stable within the

set range. Humidification and dehumidification sections regulate air humidity, avoiding condensation caused by excessive humidity, poor coating drying, or static electricity and dust caused by excessively low humidity. This is particularly critical in spray environments.

Supply air sections are equipped with efficient and low-noise fans. With variable frequency operation design, they can provide stable wind pressure and air volume, meeting requirements for long-distance delivery and uniform air supply to multiple areas. Some units are also equipped with silencing sections, flow equalization sections, sealed maintenance sections, etc., further improving operational stability, noise reduction effectiveness, and maintenance convenience.

III. Core Working Principles and Operating Modes

Packaged air handling units take centralized air treatment as the core logic. Outdoor fresh air and indoor return air enter the unit in set proportions, sequentially completing mixing, filtration, cooling or heating, humidification or dehumidification, flow equalization, pressurization and delivery, and other processes. The treated clean air is uniformly supplied to target areas through air ducts, maintaining the environment within the set temperature, humidity, and cleanliness ranges.

In summer high-temperature and high-humidity environments, units cool and dehumidify the air through cooling sections, removing excess moisture while lowering temperature to ensure dry and stable supply air. In winter low-temperature environments, units raise air temperature through heating sections and cooperate with appropriate humidification, avoiding static electricity and dust problems caused by overly dry air. During spring and autumn transition seasons, 100% fresh air operation can be used, fully utilizing natural air conditions and significantly reducing energy consumption.

In closed-loop circulation mode, units can achieve indoor air circulation treatment, reducing fresh air loads and improving temperature and humidity stability. This is suitable for painting rooms and clean spaces with strict environmental requirements and strong sealing. The overall unit operates smoothly, air distribution

is reasonable, supply air is uniform, and no vortices or dust raising occur, providing a stable and reliable air environment for production.

IV. Core Functions of Intelligent Automatic Control System

The automatic control system is the control core of packaged air handling units, achieving full-process automated operation, precise regulation, and safety protection without frequent manual intervention. The system takes PLC controllers as the core, paired with touch screen human-machine interfaces, to intuitively display key parameters such as temperature, humidity, wind speed, operating status, and fault information, with simple and easy-to-understand operation.

Automatic temperature and humidity control is the core function of the system. Through high-precision sensors, real-time collection of supply air and environmental data, automatic adjustment of cooling and heating, humidification and dehumidification quantities keeps temperature and humidity control accuracy within a stable range, meeting stringent production requirements. Variable frequency fan automatic speed regulation can automatically adjust rotation speed based on duct pressure or actual air volume requirements, significantly reducing energy consumption while ensuring supply air effectiveness.

The system has complete safety protection logic, including fan overload protection, motor overheating protection, anti-freezing protection, fault alarms, and automatic shutdown functions, avoiding equipment damage caused by operation under abnormal conditions. The automatic control system supports multi-segment mode switching and can set different operating parameters for different time periods based on production processes, achieving automatic startup during work and automatic shutdown after work, improving management efficiency.

Advanced configurations can also support remote monitoring, data recording, historical queries, and linkage control functions. They can achieve linkage operation with painting production lines, drying equipment, and environmental purification systems, truly achieving intelligent, integrated, and unmanned management.

V. System Design and Selection Key Points

The design of packaged air handling units and automatic control systems requires comprehensive determination based on application scenarios, air volume requirements, temperature and humidity control ranges, filtration grades, installation space, and energy consumption requirements, ensuring high system matching, stable operation, and strong economy.

Air volume and wind pressure are key for selection. Comprehensive calculation based on supply air distance, number of outlets, duct resistance, space volume, and air change rates ensures sufficient air supply, uniform air flow, and no blind spots. Temperature and humidity set ranges must strictly match production processes. Especially for painting workshops, temperature and humidity must be controlled within the optimal range to ensure stable spray coating quality.

Filtration grades are determined based on environmental cleanliness requirements. Ordinary workshops can adopt primary + medium-efficiency combinations. Scenarios with higher cleanliness requirements can upgrade to HEPA filtration configurations. Unit functional section combinations follow the actual needs principle, avoiding redundant configurations while reserving space for inspection, maintenance, and consumable replacement.

Automatic control system configurations are selected based on management requirements. Basic types meet local automatic control, while advanced types support remote monitoring, data upload, and multi-equipment linkage, adapting to intelligent factory upgrade requirements. The overall design considers the entire lifecycle usage scenarios including installation, operation, maintenance, and expansion, ensuring long-term reliability and convenient usability.

VI. Installation, Commissioning, and Operation Management

Unit installation must be conducted on flat and solid foundations, ensuring levelness and structural stability. Duct connections must be sealed tightly,avoiding energy consumption increases and insufficient air supply caused by air leakage. Flexible connections are set between units and ducts to reduce vibration and noise transmission, improving workshop environment comfort.

Automatic control system wiring is standardized, and sensor installation positions are reasonable, ensuring collected data is authentic and accurate, avoiding control deviations caused by improper installation. During commissioning, no-load operation, air volume testing, temperature and humidity adjustment, variable frequency adjustment, and interlock protection testing are conducted sequentially to gradually optimize parameters and achieve the optimal operating state.

Daily operation management focuses on filter cleaning, fan status, belt tension, temperature and humidity stability, etc. Regular inspection and maintenance can ensure long-term efficient unit operation and extend service life. After general automatic control system parameters are set, frequent adjustment is unnecessary. Stable operation can be maintained by regularly calibrating sensors and checking alarm records.

Units operate with low noise, low failure rate, and simple maintenance. They are suitable for long-term continuous operation, can significantly reduce manual management costs, and improve overall production guarantee capability.

VII. Typical Industry Matching Solutions

In industrial painting production lines, packaged air handling units provide uniform air supply at constant temperature, humidity, and cleanliness to spray booths, effectively improving coating appearance quality and reducing defect rates. They are standard matching equipment for high-quality painting lines.

In environmental protection equipment matching projects, units can provide stable fresh air and air volume support for catalytic combustion, exhaust purification, and activated carbon adsorption-desorption systems, ensuring stable exhaust treatment system operating conditions and continuous compliance of purification efficiency.

In precision assembly workshops, electronic manufacturing, food processing, and other clean environments, units maintain indoor cleanliness and environmental stability through multi-stage filtration and precise temperature and humidity control, meeting high-standard production requirements.

In large workshops, storage spaces, and factory ventilation and air exchange scenarios, units can achieve centralized fresh air supply, cooling and heating, and air circulation, improving overall working environments and enhancing employee comfort and work efficiency.

VIII. Energy Saving and Environmental Protection Design Advantages

Packaged air handling units adopt modular insulated structures with small cold and heat loss and high energy utilization rates. Cooperating with variable frequency automatic control systems, fan rotation speed and cooling and heating output can be automatically adjusted according to actual loads. Energy consumption is significantly reduced compared to traditional fixed-frequency equipment.

Multiple modes including 100% fresh air, mixed air, and circulating air can be flexibly switched. Natural air conditions are fully utilized in suitable weather to further reduce energy consumption. Units adopt efficient and low-noise fans and optimized air duct design with small operating resistance, low energy consumption, and low noise, conforming to green production and environmental protection requirements.

Filtration sections can effectively intercept particles in the air and improve indoor and outdoor air quality. Cooperating with the overall workshop environmental protection system, environment-friendly production is achieved. The overall unit structure is durable, has a long service life, low maintenance costs, and possesses excellent long-term economic performance.

IX. Technology Development Trends

Future packaged air handling units will develop toward higher energy efficiency, more intelligent control, greater modularization, and lighter weight. Variable frequency technology, heat pump technology, and heat recovery technology will further popularize, and energy consumption will continue to decrease.

Automatic control systems will deeply integrate with IoT and cloud platforms to achieve remote monitoring, fault early warning, intelligent regulation, and data visualization management, better adapting to intelligent factory and digital production

requirements. Unit modularization will continue to improve, making installation faster, transportation more convenient, and adaptability stronger.

Integrated air treatment and purification, VOC treatment, and constant temperature and humidity control will become mainstream, providing enterprises with simpler, more efficient, and more integrated one-stop environmental control solutions.

X. Conclusion

Packaged air handling units and automatic control systems are core equipment for achieving stable air supply, temperature and humidity control, clean environment, and energy-efficient operation in modern industrial production. They play an irreplaceable role, especially in painting production lines, environmental protection equipment matching, and precision manufacturing scenarios. Scientific selection, reasonable design, standardized installation, and intelligent operation and maintenance can significantly improve product quality, improve working environments, reduce energy costs, and ensure continuous stable production.

This technical white paper provides enterprises with full-process, systematic, and actionable technical guidance. Enterprises can customize the most suitable packaged air handling units and automatic control systems based on their own process requirements, on-site conditions, and control standards to achieve stable, efficient, energy-saving, and environmentally friendly production environment construction goals.