# Automated Coating Production Line System Solutions

In the modern industrial manufacturing system, the coating process directly determines product appearance quality, corrosion resistance, and service life. As the manufacturing industry develops toward scale, standardization, and green development, traditional manual spraying and manual operation modes are gradually being replaced by automated, continuous, and integrated coating production lines. Automated coating production lines integrate pretreatment, coating, leveling, drying, conveying, and exhaust gas purification into an integrated system. Through stable mechanical operation and intelligent control, they achieve efficient, stable, low-consumption, and environmentally friendly continuous production, becoming standard equipment for machinery manufacturing, automotive parts, hardware and home appliances, steel structures, rail transit, construction machinery, and other industries.

This solution provides comprehensive elaboration on the system composition, process logic, equipment configuration, planning and design, environmental safety, installation and commissioning, and operation management of automated coating production lines. It offers complete, clear, and actionable technical references for enterprises in new production lines, technological upgrading, capacity expansion, and environmental transformation, helping enterprises achieve comprehensive improvements in cost reduction, quality improvement, efficiency enhancement, and safety compliance, and promoting production mode transformation toward automation and intelligence.

## 1. Core Value of Automated Coating Production Lines

Automated coating production lines significantly reduce human intervention through full-process continuous operations, maintaining highly stable coating thickness, uniformity, and finish. They significantly reduce defect rates and rework rates. Compared with traditional modes, production lines can achieve 24-hour24 stable operation with controllable production rhythm and clear capacity output, facilitating enterprise production planning and order delivery management.

Production lines achieve refined control of coatings, energy, and labor during operation. Spray gun atomization and flow control are more precise, effectively reducing coating waste. Drying systems use enclosed circulating hot air structures

with high heat utilization rates, significantly reducing comprehensive energy consumption. The full line adopts enclosed operations and centralized purification, with paint mist and exhaust gases uniformly collected and treated, creating a cleaner workshop environment and more stable emissions, meeting current stringent environmental control requirements.

Automated coating production lines can adapt to multi-variety, large-batch, and flexible production with fast workpiece size, material, and process switching, possessing strong scenario adaptability and long-term use value.

## 2. Overall System Composition of Production Lines

Automated coating production lines are a highly integrated systematic equipment, composed of six core modules: pretreatment system, coating system, leveling and drying system, conveying system, electrical control system, and environmental supporting system. All modules operate collaboratively to form a complete closed-loop operation.

The pretreatment system is responsible for removing oil contamination, rust, dust, oxide scale, and other impurities from workpiece surfaces to provide clean and uniform substrates for subsequent coating. It directly affects coating adhesion and corrosion resistance. According to process requirements, spray cleaning, grinding dust removal, hot air drying, and other units can be configured with stable and reliable treatment effects.

The coating system is the core link of the entire production line, integrating manual coating stations, automatic reciprocating machines, robot coating, powder coating systems, and other operation forms. It can be flexibly combined according to workpiece structure, appearance requirements, and production capacity scale. Systems are equipped with high-precision spray guns, stable flow control, and pressure regulation devices to ensure uniform film formation and consistent thickness. Complex workpieces can also achieve no missed spraying, no sagging, and no orange peel, enabling products to simultaneously meet high standards in appearance and performance.

The leveling and drying system provides a stable curing environment for coatings. The leveling section allows coatings to spread naturally and eliminate fine marks, improving surface finish. The drying section uses hot air circulation structures with electric, gas, fuel, and other heat source forms to achieve segmented

temperature control and uniform heating. This ensures rapid and thorough coating curing, improving production efficiency and coating quality.

The conveying system handles continuous transfer of workpieces between processes. Common forms include overhead chains, roller lines, chain plate lines, belt lines, and accumulation conveyor systems. They can be customized according to workpiece weight, dimensions, and production rhythm. Conveying operates smoothly with adjustable speed and precise positioning, ensuring workpiece posture stability during coating and drying without affecting coating quality.

The electrical control system is the control center of the entire production line, using PLCPLC and touch screen centralized management to achieve full line linkage start-stop, automatic temperature adjustment, closed-loop conveying speed control, coating timing matching, fault alarm and recording, and other functions. Systems support formula storage, fast switching, and remote monitoring with simple operation and stable operation, greatly reducing labor dependency.

The environmental supporting system includes paint mist filtration, exhaust gas purification, fresh air supply, waste heat recovery, and other units, ensuring no odor, no dust, and no exceeding-standard emissions during production, meeting environmental inspection and safe production requirements.

# 3. Coating System Process and Configuration Key Points

According to processes, coating systems can be divided into two main categories: liquid coating and powder coating. Liquid coating production lines are suitable for products with high appearance requirements, rich colors, and strong corrosion resistance. Powder coating production lines have advantages of solvent-free environmental protection, wear-resistant coatings, strong adhesion, and low comprehensive cost, being increasingly applied in industrial fields.

Automatic coating uses reciprocating machines or multi-axis robots for execution with stable motion trajectories, uniform coating speed, and high film thickness consistency. Robot coating has stronger flexibility and can handle special-shaped parts, complex structural parts, and deep cavity internal parts. Through offline programming, it can quickly adapt to new products, meeting high-end manufacturing requirements.

Spray rooms adopt enclosed structures. According to processes, they are configured with water curtain, water swirl, pump-free water curtain, or dry filtration

devices to efficiently capture and treat paint mist, avoiding paint mist dispersion and polluting the workshop environment. Indoor supply air passes through multi-stage filtration to ensure a clean coating environment and reduce the impact of particles and impurities on coating appearance.

Intelligent coating systems support parameter memory, multi-variety fast line switching, and closed-loop flow control, which can significantly improve coating utilization and reduce production costs. Systems have multiple safety protections that automatically stop or alarm in abnormal conditions, ensuring equipment and personnel safety.

## 4. Drying and Heat Circulation System Design

Drying and curing is a key link determining coating performance. Automated production lines use enclosed drying ovens with optimized internal air duct design, uniform temperature field, and small temperature difference. They ensure synchronized curing of coatings on all parts of workpieces. Oven bodies use high-density insulation materials to reduce heat loss, improve thermal efficiency, and lower energy consumption.

Heat sources can be flexibly selected according to enterprise site conditions, including electric heating, gas heating, fuel heating, steam heat exchange, and other forms to adapt to different energy supply scenarios. Systems are equipped with high-precision temperature control modules that support segmented temperature control according to process curves, achieving automatic heating, insulation, and cooling to ensure coatings do not yellow, crack, or become brittle.

To further improve energy-saving effects, some production lines are configured with waste heat recovery devices to recover and reuse heat from drying exhaust gas, significantly reducing overall energy consumption. Air curtains are installed at drying oven entrances and exits to reduce heat leakage and improve operational economy.

## 5. Conveying System Types and Scenario Adaptation

The conveying system directly affects production line layout, operational efficiency, and product quality, requiring customized design based on workpiece characteristics, weight, and output.

Overhead conveyor lines are the most widely used form in the coating industry, suitable for hanging-type workpieces with small footprint, smooth operation, and multi-layer arrangement, suitable for large-batch continuous production. Roller-type and

chain-plate-type conveyor lines have strong carrying capacity, suitable for heavy workpieces such as boxes, plates, and large structural parts. Belt-type and mesh-belt-type conveyor lines operate gently, suitable for small precision workpieces to avoid bumps and scratches.

Intelligent conveying systems have functions of variable frequency speed regulation, positioning stops, accumulation storage, and safety interlocks. They can automatically adjust speed according to coating, leveling, and drying rhythms to achieve precise matching of process rhythms. The entire line operates smoothly with low noise and small maintenance requirements, suitable for long-term continuous operation.

## 6. Production Line Planning, Design, and Selection Principles

Planning of automated coating production lines requires comprehensive consideration of workpiece characteristics, capacity requirements, process standards, site conditions, environmental safety, and other factors to ensure reasonable, economical, and practical solutions.

Workpiece size, weight, and material determine coating methods, room dimensions, conveying forms, and drying parameters. Daily output and production rhythm determine line length, station quantity, drying time, and conveying speed. Process routes follow the logical sequence of pretreatment, coating, leveling, drying, and cooling to reduce detours and cross-contamination.

Workshop layout needs to reserve loading and unloading spaces, logistics passages, equipment maintenance spaces, and environmental equipment installation positions to ensure smooth logistics, convenient operation, and easy maintenance. Environmental protection and safety must be incorporated into preliminary design, including paint mist collection efficiency, exhaust gas treatment methods, explosion-proof electrical configuration, ventilation, firefighting emergency measures, etc., ensuring production lines comply with national regulations and policy requirements.

Automation level can be flexibly configured according to enterprise needs, from semi-automatic simple lines to fully automatic intelligent production lines, balancing practicality and investment rationality and meeting upgrading needs of enterprises of different scales.

# 7. Key Points in Environmental and Safety Design

Coating production involves organic solvents, paint mist, and VOCVOCs exhaust gases. Environmental protection and safety are core contents of production line design. Spray rooms adopt fully enclosed structures, equipped with efficient paint mist purification devices to ensure no odor and no paint mist dispersion in workshops. Exhaust gas treatment systems are configured according to airflow and concentration, using activated carbon adsorption, catalytic combustion, zeolite rotors, RTORTO and other technologies to achieve stable compliant emissions.

Production line electrical systems are designed according to explosion-proof grades. Motors, control cabinets, lighting, and switches all use explosion-proof configurations to eliminate electrical spark risks. Emergency stop buttons, safety door interlocks, and alarm devices are installed throughout the line to ensure rapid response to abnormal situations. Ventilation systems ensure air circulation in workshops and reduce solvent concentrations. Firefighting, leak collection, emergency exhaust, and other configurations are complete, comprehensively improving production safety levels.

# 8. Installation, Commissioning, and Operation Maintenance

Production line installation must be strictly executed according to standard processes of foundation construction, equipment positioning, structural assembly, pipeline connection, electrical wiring, and thermal insulation sealing to ensure structural stability, good sealing, and vibration-free operation. During commissioning, empty load operation, conveying linkage, temperature debugging, coating debugging, and environmental equipment linkage are completed in sequence to gradually optimize parameters and bring the entire line to optimal operational status.

Daily maintenance focuses on key components such as spray guns, nozzles, filters, conveyor chains, temperature control sensors, fans, and burners. Regular cleaning, lubrication, and calibration ensure equipment accuracy and operational stability. Environmental equipment should be regularly inspected for ash removal and filter material replacement to ensure purification effectiveness does not degrade.

Establish equipment operation records to document temperature, speed, energy consumption, faults, and maintenance content for data analysis and predictive maintenance, extending equipment service life and reducing unplanned downtime risks.

# 9. Typical Industry Application Solutions

In the construction machinery and steel structure industries, large overhead automated coating production lines can achieve continuous coating and drying of workpieces with strong coating corrosion resistance and uniform appearance, meeting outdoor long-term corrosion resistance requirements.

The automotive and parts industry uses robot coating ++ accumulation conveyor lines to achieve high-precision, high-appearance, high-efficiency production with strong consistency and low rework rate.

The hardware and home appliance industries use small automated coating lines with small footprint, fast rhythm, and flexible line switching, suitable for multi-variety small-batch production.

Powder coating production lines are widely used in furniture, building materials, and chassis cabinet industries with advantages of solvent-free environmental protection, wear-resistant and corrosion-resistant coatings, and lower comprehensive costs, becoming increasingly favored by enterprises.

# 10. Technology Development Trends

In the future, automated coating production lines will upgrade toward higher levels of intelligence, flexibility, green development, and energy saving. Robot coating, visual positioning, online film thickness detection, and AIAI parameter optimization will gradually become widespread, achieving unmanned, high-precision production.

Production line modularization and standardization levels will continuously improve with faster delivery, simpler installation, and stronger scalability.

Energy consumption will continue to be optimized, and waste heat recovery, intelligent variable frequency, and low-resistance high-efficiency structures will further reduce operating costs.

Environmental technology will continue to upgrade. Low-VOCVOCs processes, efficient exhaust gas purification, waste heat recovery, and zero-emission solutions will become mainstream directions, promoting comprehensive green transformation of the coating industry.

# 11. Conclusion

Automated coating production lines are core equipment for modern manufacturing enterprises to achieve quality improvement, efficiency enhancement, cost reduction, environmental protection, and safety. Through systematic design, modular configuration, intelligent control, and standardized maintenance, enterprises can significantly improve coating quality, stabilize production efficiency, reduce comprehensive costs, and meet both environmental and safety requirements.

This solution provides comprehensive, professional, and actionable technical guidance for enterprises. Enterprises can customize the most suitable automated coating production lines based on their product characteristics, production needs, site conditions, and policy standards to achieve coordinated development of efficient, green, and intelligent production.