Centrifugal Fan Series Technical White Paper

As a core power equipment in industrial ventilation, environmental purification, HVAC, coating production lines, exhaust gas treatment, metallurgy, and chemical industries,centrifugal fans use centrifugal force generated by impeller rotation to pressurize and convey gases, serving as key equipment for stable operation of air circulation,exhaust gas emission, process air supply, and environmental purification.

With the advancement of the "dual carbon" goal, the upgrading of industrial energy efficiency standards, and stricter environmental policies, traditional low-efficiency fans have struggled tomeet the modern industrial demands of high pressure, high flow, low energy consumption, low noise, and long service life. High-efficiency energy-saving, intelligent variable-frequency, low-noise stable, and customized centrifugal fans have gradually become the industry mainstream.

This white paper systematically covers the working principles, core structure, performance parameters, product classification, production process,selection logic, installation and maintenance, industry applications, and technology trends of centrifugal fans. Combined with GB 19761-2023 "Energy Efficiency Limits andEnergy Efficiency Grades for Ventilation Fans", JB/T 10563-2006, and other national and industry standards, it provides professional, precise, and actionable technical references for enterprises in equipment selection,system integration, energy-saving retrofits, and operation and maintenance management, helping enterprisesimprove ventilation system efficiency, reduce energy consumption costs, and achieve environmental compliance and high-quality development.

I. Working Principles and Core Value of Centrifugal Fans

Centrifugal fans operate based on the principle of centrifugal force pressurization. Gas enters the fan axially from the inlet, and is uniformly guidedinto the center of the impeller by the collector. When the impeller rotates at high speed, the blades drive the gas in circular motion to generate centrifugal force, throwing the gas radiallyinto the volute casing. The volute casing converts the kinetic energy of the airflow into pressure energy through a gradually expanding structure, and finally discharges it from the tangential outlet,achieving continuous gas transport and pressure increase.

The entire process follows the laws of energy conservation and fluid mechanics. Through optimizationof impeller structure, rotational speed, and blade form, precise matching of flow rate, pressure, and efficiency is achieved.

Its core value is reflected in four dimensions: First, efficient airflow delivery — providing stable air pressure and flow rate, suitable for long-distance, high-resistance pipe systems, addressing industrial airflow needs that natural ventilation cannot meet. Second, energy saving and cost reduction — high-efficiencyfan energy efficiency reaches 80%–87%, saving 20%–40% energy compared to traditional products, significantly reducing long-term operating electricity costs. Third, environmentaladaptability — working with purification equipment to effectively collect and discharge exhaust gas, dust, and paint mist, meeting atmospheric pollutant emission standards.Fourth, process assurance — providing stable supply air, exhaust air, and heat exchange airflow for coating, smelting, chemical, and other processes, ensuring productquality and production safety.

Compared with axial fans (high flow, low pressure) and Roots blowers (constant flow, high noise), centrifugal fans offercomprehensive advantages of wide pressure range (100 Pa–10,000 Pa+), strong flow adaptability, high operating efficiency, controllable noise, and good stability,covering low-pressure ventilation, medium-pressure air supply, and high-pressure forced delivery scenarios, making them the preferred power equipment for industrial ventilation and environmental systems.

II. Core Structure and Key Components

Centrifugal fans use a modular structural design, with the core consisting of the impeller, volute casing, air inlet, transmission system, motor, base,and noise reduction and sealing components. Each component works in coordination to ensure stable fan performance and reliable operation.

As the core working component, the impeller is welded or riveted from blades, front disk, rear disk, and hub, directly determining the fan'sflow rate, pressure, efficiency, and noise. Blades are divided into three categories: backward-curved blades, forward-curved blades, and radial blades. Backward-curvedblades curve opposite to the direction of rotation, with an exit angle <90°, offering the highest efficiency (80%–87%),

lowest noise,smooth operation, and strong energy-saving advantages, making them the mainstream choice for high-efficiency energy-saving fans. Forward-curved blades with exit angle >90° offer high pressure,low flow rate, suitable for small-volume, high-pressure scenarios, but with lower efficiency and higher noise. Radial blades are simple in structure and wear-resistant,suitable for dust-laden gas and high-temperature flue gas transport scenarios. High-end impellers use airfoil-shaped hollow blades, optimized through CFDfluid simulation, with lower airflow resistance and efficiency improvement of 5%–8%.

The volute casing adopts a snail-shaped spiral structure, welded from high-quality steel plates. Its core function is to collect the gas thrown out by the impeller,convert kinetic energy into static pressure, and guide the airflow to discharge smoothly. High-quality volute casings are streamlined in design with no internal vortex andlow airflow resistance, reducing energy loss and noise. High-pressure fan volute casings use thickened steel plates to enhance rigidity and prevent resonancedeformation.

The air inlet (collector) has a trumpet-shaped streamlined structure. Its function is to uniformly guide airflow into the impeller, reducing inletvortex losses and improving fan intake efficiency. Standard fans use conical air inlets,

while high-efficiency fans use curved streamlinedcollectors, resulting in smoother airflow and over 30% reduction in pressure loss.

The transmission system is divided into direct drive and belt drive. Direct drive connects the motor and impeller coaxially, with transmission efficiency above 98%,no slipping, and simple maintenance, suitable for high-efficiency, high-speed scenarios. Belt drive uses pulley speed change, with flexible speedadjustment and lower cost, suitable for medium-to-low pressure and low-speed scenarios, but with slightly lower transmission efficiency (90%–95%), requiring periodicbelt maintenance.

The motor is the power core, paired with high-efficiency three-phase asynchronous motors, variable-frequency motors, or explosion-proof motors. Energy efficiency grade reaching IE4,IE5, meeting GB 19761-2023 energy efficiency grade 2 and above standards. Protection grade IP54/IP55, insulation gradeClass F, suitable for humid, dusty, explosion-proof, and other special environments.

Base and noise reduction components: The base is made of high-strength cast iron or structural steel welded and tempered to eliminate internal stress, ensuringsmooth fan operation with minimal vibration. Noise reduction components include sound insulation enclosures, silencers, and vibration-damping pads, which can reduce fan noise to 75–85 dB(A), meeting industrial noise emission standards.

III. Performance Parameters and Technical Specifications

Centrifugal fan performance must comply with national mandatory standards and industry specifications. Core parameters are the key basis for selection and application,mainly including the following indicators:

Flow Rate (Q): Volume of gas transported per unit time, unit m^3/h, range 100–100,000 m^3/h, reflecting the fan'sdelivery capacity. Selection must match the actual system ventilation volume with a 10%–15% margin.

Pressure (P): Total pressure difference between fan outlet and inlet, unit Pa, divided into total pressure, static pressure, and dynamic pressure (total pressure =static pressure + dynamic pressure), reflecting the fan's ability to overcome pipe resistance. Classified by pressure into low pressure (≤1000 Pa), medium pressure(1000–3000 Pa), and high pressure (>3000 Pa), suitable for different pipe resistance scenarios.

Efficiency (η): Ratio of effective power to shaft power, the core energy-saving indicator. High-efficiency backward-blade fan efficiency80%–87%, medium-efficiency forward-blade fan 65%–75%, energy efficiency Grade 1 fan efficiency ≥85%.

Power: Includes shaft power (actual power consumed by the fan) and motor power (shaft power × 1.05–1.15 safetyfactor), unit kW. Motor power matching should avoid "oversized motor" or overload operation to reduce energy consumption.

Speed (n): Number of impeller revolutions per minute, unit rpm. Standard: 2900 rpm (2-pole), 1450 rpm (4-pole),960 rpm (6-pole). Speed is proportional to flow rate and pressure ($Q \propto n$, $P \propto n^2$). Variable-frequency fans can adjust speed to preciselymatch operating conditions.

Noise and Vibration: Noise ≤85 dB(A) (at 1 m distance), vibration value ≤2.8 mm/s (ISO 10816-3 standard);high-quality fan vibration value ≤1.7 mm/s.

Materials and Adaptability: Standard Q235 carbon steel; corrosion-resistant scenarios use 304/316 stainless steel; high-temperaturescenarios (≤250°C) use heat-resistant steel; explosion-proof scenarios use explosion-proof materials and spark-free design.

IV. Product Series Classification and Application Scenarios

By structure, pressure, application, and blade form, centrifugal fans are divided into multiple series to meet the needsof different industries and operating conditions:

1. General Low-Pressure Centrifugal Fan (Series 4-72, 4-79)

Low pressure, medium efficiency, highly versatile. Pressure 100–1000 Pa, flow rate 100–100,000 m³/h, backward-curved blades,efficiency 78%–82%, low noise, stable operation. Suitable for general factory ventilation, workshop exhaust, HVAC air supply， civil building ventilation, and other standard scenarios. This is the most widely used general-purpose fan.

2. Medium-Pressure Centrifugal Fan (Series 9-26, 11-62)

Medium pressure, high efficiency. Pressure 1000–3000 Pa, suitable for medium-resistance pipe systems. Uses airfoil-type backward blades,efficiency 82%–85%. Suitable for coating line air supply, exhaust gas collection and transport, pre-stage air supply for bag-type dust collectors, shopping mall and hotel centralair conditioning, and other scenarios, balancing pressure and efficiency.

3. High-Pressure Centrifugal Fan (Series 9-19, 8-09)

High pressure. Pressure 3000–10,000 Pa+, moderate flow rate, using radial or backward blades, robust structure,impact-resistant. Suitable for industrial kiln air supply, pneumatic material conveying, high-pressure exhaust treatment, metallurgical blast furnace air supply, forcedventilation, and other high-resistance scenarios.

4. Special-Purpose Centrifugal Fans

Corrosion-Resistant Centrifugal Fan: Stainless steel/FRP material, acid and alkali resistant, suitable for chemical, electroplating, and acidic exhaustgas transport scenarios.

Explosion-Proof Centrifugal Fan: Explosion-proof motor, spark-free design, suitable for coal mines, petroleum, chemical industry, and other flammable and explosive gastransport scenarios.

High-Temperature Centrifugal Fan: Heat-resistant steel material, temperature resistance 150–250°C, suitable for boiler induced draft, high-temperature exhaust dischargescenarios.

Low-Noise Centrifugal Fan: Equipped with sound insulation enclosure and silencer, noise ≤75 dB(A), suitable for hospitals, office buildings, and precisionworkshops and other quiet environments.

V. Production Process and Quality Control

High-quality centrifugal fans adopt precision design, refined manufacturing, and full-process inspection processes to ensure performance standards and stablequality.

Design Phase: SolidWorks 3D modeling and CFD fluid simulation optimization are used to simulate the internal airflow field,optimize blade angles, volute casing profiles, and collector structures, eliminate vortices, improve efficiency, and reduce noise.

Manufacturing Phase: Impellers are made with CNC cutting and automatic welding, followed by dynamic balance correction (G2.5 accuracy grade) to avoidoperational vibration. Volute casings are made with laser cutting and die forming, achieving high dimensional accuracy and good sealing. Core components undergo heat treatmentto improve hardness and wear resistance. Complete machine assembly follows a standardized process to ensure coaxiality and clearance meet process requirements.

Quality Inspection: Each fan undergoes factory performance testing, checking flow rate, pressure, efficiency, power, noise, vibration,

and other indicators, complying with GB/T 1236-2017 test standards. Key components (bearings, motors) use reputable brands (SKF,

NSK) to ensure service life. A product traceability system is established to record production and inspection data throughout the entire process, ensuring batch-to-batch stability.

VI. Selection Logic and Adaptation Principles

Centrifugal fan selection must follow the principles of "matching operating conditions, prioritizing energy efficiency, system compatibility, and economic rationality" to avoid

selection errors that lead to high energy consumption, insufficient performance, and short service life.

1. Determine Core Operating Parameters

Clarify actual flow rate, system resistance (calculate air pressure), account for pipeline air leakage and resistance losses, reserve a 10%–15%

margin.

Clarify the gas medium: normal temperature air / high-temperature flue gas / corrosive gas / flammable and explosive gas, to determine material

and explosion-proof grade.

Clarify the installation environment: indoor/outdoor, space size, noise requirements, temperature and humidity conditions, to determine protection grade

and noise reduction configuration.

2. Select by Pressure and Efficiency

Low pressure, large-space ventilation: Choose 4-72 low-pressure series, high cost-effectiveness, high flow rate, low noise.

Medium pressure, medium-resistance pipelines: Choose 9-26 medium-pressure high-efficiency series, balancing pressure and energy saving.

High pressure, high-resistance scenarios: Choose 9-19 high-pressure series, sufficient pressure, stable and reliable.

Energy saving priority: Must choose backward-blade high-efficiency fan with energy efficiency Grade 1–2, significantly reducing long-term operating electricity costs.

3. Transmission and Motor Selection

High-efficiency, high-speed, low-maintenance scenarios: Choose direct drive, high efficiency, long service life.

Speed adjustment required, space-constrained scenarios: Choose belt drive, flexible adjustment, low cost.

Motors should preferably be IE4/IE5 high-efficiency variable-frequency motors, compatible with inverters to achieve on-demand flow adjustment, saving energy by 30% or more.

4. Special Scenario Selection

Corrosive environments: Stainless steel/FRP corrosion-resistant fans;

Explosion-proof environments: ExdIIBT4 explosion-proof grade fans;

High-temperature environments: Heat-resistant steel high-temperature fans (temperature resistance ≤250°C);

Quiet environments: Low-noise sound-insulated fans (noise ≤75 dB(A)).

VII. Installation, Commissioning, and Operation & Maintenance Standards

Correct installation and standardized maintenance are key to ensuring efficient, stable, long-life, and low-failure operation of centrifugal fans.

1. Installation Standards

Install on a flat and solid foundation, equipped with vibration-damping pads (rubber/spring) to reduce vibration transmission;

Flexible connection between fan and pipeline to prevent pipeline stress from transmitting to the fan and causing resonance deformation;

Install filter screens at the air inlet to prevent foreign objects from entering the impeller; ensure smooth outlet pipelines to reduce bends and resistance;

Standardize electrical wiring with reliable grounding; variable-frequency fans equipped with dedicated inverters and filtering devices.

2. Commissioning Process

No-load trial run: Check rotation direction, vibration, and noise; confirm no abnormalities before running for 2 hours;

Load commissioning: Gradually load to rated operating conditions; check flow rate, pressure, current, and temperature to ensure the working point is in the high-

efficiency zone;

Bearing temperature ≤75°C, motor temperature ≤80°C, vibration and noise complying with standards.

3. Routine Maintenance

Daily inspection: Check vibration, noise, temperature, and belt tension; stop immediately for troubleshooting upon any abnormality;

Regular maintenance: Replenish bearing grease every 3 months, replace with lithium grease once a year; inspect impeller every 6 months for

dust accumulation and wear, clean promptly; replace aged or loose belts in time;

Variable-frequency fans: Regularly check inverter parameters to ensure stable operation; for long-term unused fans, run idle once a month

to prevent component corrosion.

4. Common Fault Handling

Excessive vibration: Impeller dust accumulation causing imbalance → Clean impeller; bearing wear → Replace bearings; loose installation → Tighten bolts;

Insufficient flow rate: Air inlet blocked → Clean filter screen; belt slipping → Tension belt; impeller worn → Repair impeller;

Abnormal noise: Bearing damage → Replace bearings; impeller scraping → Adjust clearance; resonance → Adjust vibration damping or reinforce base.

VIII. Typical Industry Application Solutions

Environmental Coating Production Lines: Paired with 4-72 low-pressure fan + 9-26 medium-pressure fan combination: low-pressure fans for spray boothair supply to ensure uniform airflow; medium-pressure fans for paint mist exhaust gas collection and transport, pressure 1500–2500 Pa, efficiency ≥82%,combined with paint mist filter

cotton and activated carbon adsorption equipment to achieve compliant exhaust emission. High-efficiency fans save 25% energy compared to traditional products,reducing maintenance costs by 30%.

Industrial Exhaust Gas Treatment Systems: Using corrosion-resistant medium-pressure centrifugal fans (304 stainless steel material), pressure 2000–3500 Pa,suitable for acid-base exhaust gas and organic exhaust gas transport scenarios, with strong corrosion resistance and good sealing to prevent exhaust gas leakage. Variable-frequency regulationadapts to exhaust gas concentration changes, stabilizes flow rate, and ensures purification efficiency, meeting environmental emission requirements.

Metallurgical and Building Materials Industry: Using 9-19 high-pressure centrifugal fans, pressure 5000–8000 Pa, for kiln air supply, materialtransport, and dust removal systems. Robust structure, dust wear-resistant, stable operation, suitable for 24-hour continuous high-load operation,ensuring stable production processes.

HVAC and Building Ventilation: Using low-noise high-efficiency 4-72 fans, noise ≤75 dB(A), efficiency ≥80%, suitablefor shopping malls, office buildings, and hospital central air conditioning air supply and exhaust. High flow, low noise, smooth operation, improving indoorenvironmental comfort.

Dust Removal and Purification Systems: Paired with medium-pressure centrifugal fans, pressure 2000–3000 Pa, as the primary power for bag-type dust collectors and electrostatic precipitators,stably transporting dust-laden gas and ensuring efficient operation of dust removal systems. High-efficiency design reduces system energy consumption.

IX. Technology Development Trends

High Efficiency and Energy Saving: Energy efficiency continues to improve; full-pressure efficiency exceeds 90%. IE5 ultra-high-efficiency motors, mixed-flow impellers,and CFD simulation optimization technology are popularized, saving 40% or more energy compared to traditional products. GB 19761-2023 mandatory

standards drive low-efficiency fans out of the market, making high-efficiency products the mainstream.

Intelligence and Digitalization: Variable-frequency speed control, intelligent monitoring, and remote operation and maintenance have become standard features; National Standard Information Public ServicePlatform. Fans are equipped with sensors to collect temperature, vibration, and current data in real time, uploaded to the cloud platform via IoT, achievingfault warning, predictive maintenance, and automatic speed adjustment, completely changing the "fix when broken" model. AI algorithm optimizes operating parameters, adapting to dynamic changes in operating conditions, improving system energy efficiency by more than 15%.

Low Noise and Environmental Friendliness: Through airfoil blades, streamlined volute casings, vibration-damping and sound insulation, and active noise reduction technology, fan noise isreduced to below 70 dB(A), meeting stricter noise emission standards. Eco-friendly materials, oil-free lubrication, and upgraded sealing reducedust leakage and environmental pollution.

Specialization and Customization: Demand for customized special fans for extreme operating conditions such as high temperature, high pressure, strong corrosion, explosion-proof, and ultra-quiet is growing. Composite materials (carbonfiber, FRP), wear-resistant coatings, and high-temperature-resistant alloys are applied to expand fan application scenarios,achieving precise "one fan, one operating condition" matching.

System Integration: Transitioning from single fan supply to ventilation system integration, energy-saving retrofits, and EPC general contracting. Providingfan + pipeline + purification equipment + intelligent control integrated solutions, optimizing system matching, achieving overall maximum energy efficiencyand minimal maintenance.

X. Conclusion

As the core power equipment for industrial ventilation and environmental governance, the performance of centrifugal fans directly affects production efficiency, energyconsumption costs, environmental compliance, and operational safety. With

the accelerating transformation toward industrial greening and intelligent development, high-efficiency energy-saving, low-noise stable,and intelligent customized centrifugal fans have become the inevitable choice of the industry, and are key support for achieving the "dual carbon" goal and promoting high-qualityindustrial development.

This white paper systematically covers the technical principles, performance parameters, selection logic, operation and maintenance standards, and industry applications of centrifugal fans.Combined with the latest national standards and industry trends, it provides enterprises with a comprehensive technical reference throughout the entire process.