



南风股份
NanFeng Corporation

离心式箱体风机 用户手册

Centrifugal Cabinet Fan User Manual



南方风机股份有限公司
Nanfang Ventilator Co., Ltd.

地址：佛山市南海区狮山镇小塘三环西路（狮南段）31号

Address: No.31, Sanhuan West Road (Shinan Section), Xiaotang, Nanhai District,
Foshan, Guangdong, P.R. China

销售热线 (Sales Hotline): +86 757 81006645 86693166 81006113 86693188

传真 (Fax): +86 757 86693184 网站 Web: www.ntfan.com www.nf-fan.com

售后服务热线 (After-sale Service Hotline): +86 757 81006198

E-mail: overseas@ntfan.com info@ntfan.com



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前言 Preface

欢迎您选用本公司生产的通风机系列产品。

Thank you for choosing our ventilation fans.

本手册旨在为您提供通风机在安装、使用、维护及检修全过程的标准技术指导与安全保障指引。为确保设备能够安全、高效、稳定地投入运行，并达到其最佳性能与设计寿命，请务必在操作前，由专业人员仔细阅读并完整理解本手册的全部内容。

This manual is intended to provide you with standard technical guidance and safety assurance guidelines throughout the entire process of installation, operation, maintenance and repair of fans. To ensure that the equipment can be put into operation safely, efficiently and stably, and to achieve its best performance and design life, please be sure to have a professional read and fully understand all the contents of this manual before operation.

通风机作为关键的动力设备，其正确安装、规范操作与定期维护，直接关系到系统运行的可靠性、能耗效率以及所有相关人员与财产的安全。手册中强调的安全警告与注意事项，均基于对潜在风险的严格评估，任何疏忽都可能引发电气事故、机械伤害或设备严重损坏等严重后果。因此，请将安全规范置于一切工作的首位。

As critical power equipment, the correct installation, proper operation and regular maintenance of the ventilator are directly related to the reliability of the system operation, energy efficiency and the safety of all relevant personnel and property. The safety warnings and precautions emphasized in the manual are based on a strict assessment of potential risks, and any oversight could lead to serious consequences such as electrical accidents, mechanical injuries, or severe equipment damage.

Therefore, put safety regulations first in all operation.

我们强烈建议将本手册交由负责设备安装、操作及维护的工程师与技术人员使用和保管，并作为日常培训与工作交接的重要文件。我们深信，严格遵循本手册的指导，是保障设备长效平稳运行、最大化发挥产品价值、并确保作业安全的最坚实基础。

We strongly recommend that this manual be used and kept by the engineers and technicians responsible for the installation, operation and maintenance of the equipment, and that it serve as an important document for daily training and work handover. We are convinced that strictly following the instructions of this manual is the most solid foundation for ensuring the long-term stable operation of the equipment, maximizing the value of the product, and ensuring the safety of the operation.

请注意，本手册为通用性指导文件。对于特定型号或特殊设计的产品，可能存在额外要求，请务必同时参阅随设备提供的专项技术文件与图纸。

Please note that this manual is a general guidance document. For specific models or specially designed products, there may be additional requirements. Please be sure to also refer to the special technical documentation and drawings provided with the equipment.

感谢您的合作。如操作过程中有任何疑问，请及时联系本公司寻求支持。

Thank you for your cooperation. If you have any questions during the operation, please contact us promptly for support.

安全至上，请务必规范操作！

Safety first, please operate in a standardized manner!

1. 产品概述 Product Overview

1.1 应用场合 Applications

离心式箱体风机（以下简称“风机”或“产品”）属于离心通风机的一种派生结构形式，它在典型的离心通风机（以下称“主机”）的外部增加了一个箱体，从而将主机运行时产生的噪声、热量、气流等与外界隔离。该风机具有性能优、噪声低、外形美观、安装方便等特点，尤其在大流量区，其有效容积流量比传统的风机要大 1~2 倍，常用于大型商场、地铁、体育馆、展览中心和宾馆等建筑物的通风换气系统，以及中央空调机组、空气净化机组、风机盘管机组等配套。

The centrifugal cabinet-type fan (hereinafter referred to as "fan" or "product") is a derivative structural form of centrifugal fan. A cabinet is added externally to the typical centrifugal fan (hereinafter referred to as the "main unit"), thereby isolating the noise, heat, and airflow generated during operation from the surrounding environment. The fan offers excellent performance, low noise, attractive appearance, and easy installation. Particularly in the high-flow range, its effective volume flow rate is 1 to 2 times greater than that of conventional fans. It is commonly used in ventilation systems for large shopping malls, subways, gymnasiums, exhibition centers, hotels, and other buildings, as well as in supporting equipment such as central air conditioning units, air purification units, and fan coil units.

1.2 设计制造规范 Design and Manufacturing Standards

1) GB/T 3235-2008 通风机基本型式、尺寸参数及性能曲线 Basic types sizes parameters and performance curve of fans;

2) JB/T 10563-2006 一般用途离心通风机 技术条件 Technical specification for general purposes centrifugal fans;

3) GB 19761-2020 通风机能效限定值及能效等级 Minimum allowable value of energy efficiency and energy efficiency grades for fan;

4) GB/T 1236-2017 (ISO5801:2007, IDT) 工业通风机用标准化风道性能试验 Industrial fan - Performance testing using standardized airways;

5) GB/T 2888-2008 风机和罗茨鼓风机噪声测量方法 Methods for measuring noise for fans blowers compressors and Roots blowers;

6) JB/T 8690-2014 通风机噪声限值 Fans - Noise limited value;

7) JB/T 8689-2014 通风机振动检测及其限值 Fan vibration detection and its limits value;

8) JB/T 6444-2019 风机包装通用技术条件 General specifications for packaging of fans blowers compressors;

9) GB/T 41973-2022 / ISO 14694:2003 工业通风机 平衡品质与振动等级规范 Industrial fans - Specifications for balance quality and vibration levels;

10) 供需双方合同约定的其他要求，包括（以方框内被勾选者为准）：

Other requirements as agreed in the contract between the supplier and the buyer, including (subject to items ticked in boxes):

☐ EN 10204:2004 Metallic products - Types of inspection documents;

☐ EN ISO 5817:2023 Welding - Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) - Quality levels for imperfections;

☐ EN ISO 13920:2023 Welding - General tolerances for welded constructions - Dimensions for lengths and angles - Shape and position;

☐ EN ISO 12944:2018 Paints and varnishes - Corrosion protection of steel structures by protective paint systems;

☐ ISO 21940-11:2016 Mechanical vibration - Rotor balancing - Part 11: Procedures and tolerances for rotors with rigid behaviour.

1.3 使用环境要求 Operating Environment Requirements

具体按订货或见产品铭牌，一般规定如下：

Specific operating environment requirements shall be as ordered or as indicated on the product nameplate. General provisions are as follows:

1) 环境温度 Ambient Temperature

➤ 常规型: $-20^{\circ}\text{C} \sim +50^{\circ}\text{C}$;

Standard model: -20°C to $+50^{\circ}\text{C}$;

➤ 消防排烟型: 可耐受 $280^{\circ}\text{C}/30\text{min}$ 、 $250^{\circ}\text{C}/120\text{min}$ 烟气/热风;

Fire smoke exhaust model: can withstand flue gas/hot air at 280°C for 30 minutes, and at 250°C for 120 minutes;

➤ 低温型: 可耐受 $-30^{\circ}\text{C} \sim -40^{\circ}\text{C}$ 严寒户外。

Low-temperature model: withstands harsh outdoor conditions from -30°C to -40°C .

2) 相对湿度 Relative Humidity

➤ 正常工况: $\leq 85\% \text{RH}$ (无凝露);

Normal conditions: $\leq 85\% \text{RH}$ (non-condensing);

➤ 潮湿 / 地下室工况: 需配防潮电机、绕组加热、防锈涂层。

Humid / basement conditions: moisture-proof motor, winding heaters, and anti-corrosion coating required.

3) 海拔高度 Altitude

➤ 标准适用: 海拔 $\leq 1000\text{m}$;

Standard application: altitude $\leq 1000 \text{ m}$;

➤ 海拔 $> 1000\text{m}$: 空气稀薄, 需加大电机功率、重新选型静压风量。

Altitude $> 1000 \text{ m}$: due to thinner air, motor power must be increased; static pressure and airflow shall be reselected.

4) 介质气体要求 Requirements for Conveyed Gas

➤ 常规输送: 清洁空气、无腐蚀性、无粘性粉尘;

Normal conveying: clean air, non-corrosive, with non-sticky dust;

➤ 含尘条件: 允许轻微粉尘, 含尘浓度 $\leq 150\text{mg}/\text{m}^3$;

Dusty conditions: light dust permitted; dust concentration $\leq 150 \text{ mg}/\text{m}^3$;

➤ 禁止输送: 易燃易爆、可燃挥发性气体; 强腐蚀性酸碱性气体 (需防腐玻璃钢 / 不锈钢风机); 粘稠、纤维絮状物 (易缠绕叶轮)。

Prohibited media: flammable/explosive gases; combustible volatile gases; strongly corrosive acidic/alkaline gases (corrosion-resistant FRP or stainless steel fans required); sticky or fibrous materials (tend to wind around the impeller).

5) 安装场所环境 Installation Site Environment

➤ 通风良好、无烈日暴晒、无雨淋 (户外需加装防雨罩);

Well-ventilated area, not exposed to direct sunlight or rain (outdoor units require a weatherproof cover);

➤ 地基平整坚固, 无剧烈振动源;

Level, solid foundation with no sources of severe vibration;

➤ 远离强腐蚀气体、油烟、蒸汽污染源;

Keep away from strongly corrosive gases, oil fumes, and steam contaminants;

➤ 空气中无爆炸性混合物 (防爆风机除外)。

No explosive mixtures in the air (except for explosion-proof fans).

6) 电气环境 Electrical Environment;

➤ 供电电压波动 $\pm 10\%$ 以内;

Supply voltage fluctuation within $\pm 10\%$;

➤ 无强电磁干扰, 配电空间散热良好。

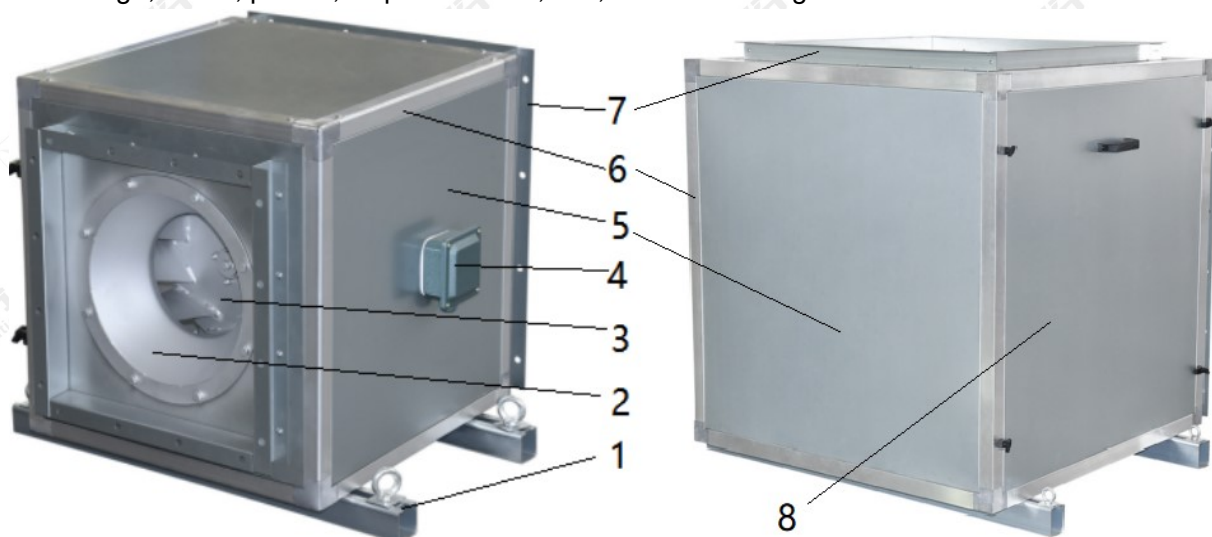
No strong electromagnetic interference; good heat dissipation in the electrical cabinet space.

1.4 传动方式 Drive Type

1.4.1 电机直联传动 Direct drive (motor direct connection)

又称 A 式传动，风机整机主要由箱体、进风口、叶轮、电机和底部槽钢等组成。其中叶轮直接装在电机轴上，箱体部分由出风口法兰、框架、面板、检修门等组成，如图 1 所示。

Also known as Type A drive. The complete fan unit mainly consists of the box, inlet, impeller, motor, and bottom channel steel frame. The impeller is mounted directly on the motor shaft. The box comprises the outlet flange, frame, panels, inspection door, etc., as shown in Figure 1.



1. 底部槽钢；2.进风口；3.叶轮；4.电机（接线盒）；5.面板；6.框架；7.出风口法兰；8.检修门。

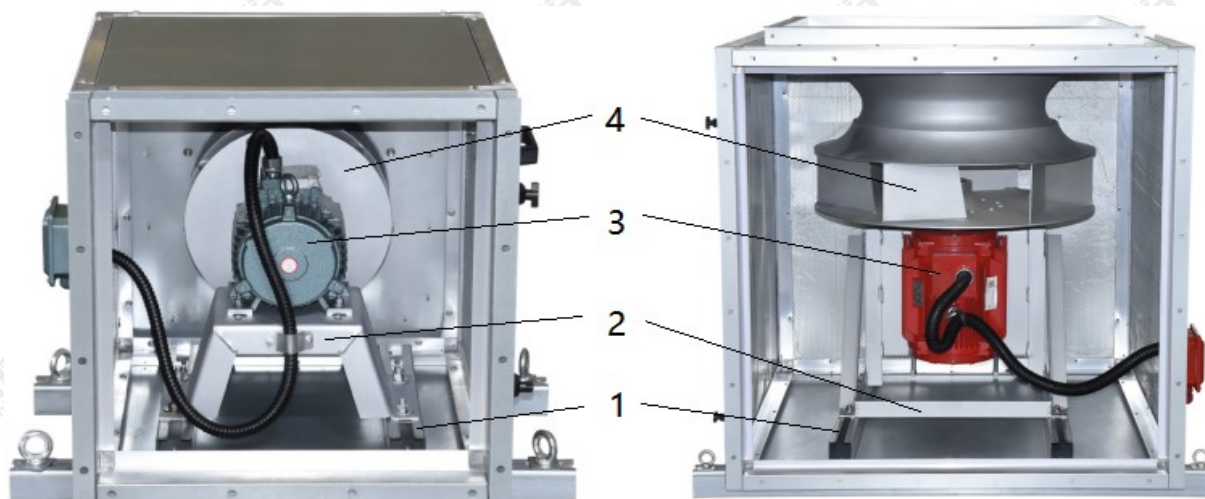
1. Bottom channel steel; 2. Inlet; 3. Impeller; 4. Motor (terminal box); 5. Panel;
6. Frame; 7. Outlet flange; 8. Maintenance door.

图 1 电机直联传动风机的组成

Figure 1 Components of a direct drive fan

按电机的安装方式又可分为“电机水平安装”和“电机垂直安装”两种，其内部结构如图 2 所示：

Based on the motor installation arrangement, the fan can be classified into two types: "horizontal motor installation" and "vertical motor installation." Their internal box structures are shown in Figure 2:



a)电机水平安装

a)Horizontal motor installation

b)电机垂直安装

b)Vertical motor installation

1.电机导轨；2.电机支架；3.电机；4.叶轮。

1. Motor guide rail; 2. Motor bracket; 3. Motor; 4. Impeller.

图 2 直联传动电机安装方式

Figure 2 Direct-drive Motor installation methods

该传动方式的优点是结构简单、尺寸紧凑，适用于安装空间小的情况；其缺点是叶轮转速与电机转速相同、不能通过机械方式调整。

The advantage of this drive type is its simple, compact design, making it suitable for installations with limited space. Its disadvantage is that the impeller speed equals the motor speed and cannot be adjusted by mechanical means.

1.4.2 皮带传动 Belt drive

风机整机主要由箱体、进风口、叶轮、电机、底部槽钢、主轴、轴承座、皮带轮和皮带等组成，其中主轴与电机轴的端部分别安装有皮带轮，两皮带轮之间通过皮带相连。

The complete fan unit mainly consists of the box, inlet, impeller, motor, bottom channel steel, main shaft, bearing housings, pulleys, and belts. Pulleys are mounted on the ends of the main shaft and the motor shaft respectively, and the two pulleys are connected by belts.

该传动方式的优点是电机通过主轴与叶轮隔离，避免其受到叶轮转动引起的振动等影响，叶轮转速可通过改变两带轮间的直径比进行调节，特别需要调整运行工况的场合；其缺点是外形尺寸较大、成本较电机直联传动高。

The advantage of this drive type is that the motor is isolated from the impeller by the main shaft, protecting it from vibration caused by impeller rotation. Impeller speed can be adjusted by changing the diameter ratio of the two pulleys, making it particularly suitable for applications where operating conditions need to be adjusted. The disadvantages are its larger overall dimensions and higher cost compared to direct drive.

按电机与箱体的相互位置又可细分为电机内置、电机外置共 2 种，其中：

Based on the relative positions of the motor and the box, the fan can be further subdivided into two types: motor built-in and motor external, as follows:

1) 电机内置：电机、皮带轮和皮带均位于箱体内，整机外形见图 3a)。按主机的主轴皮带轮、两轴承座和叶轮间的相互位置，又可细分为 C、E 共 2 种传动方式，其中：

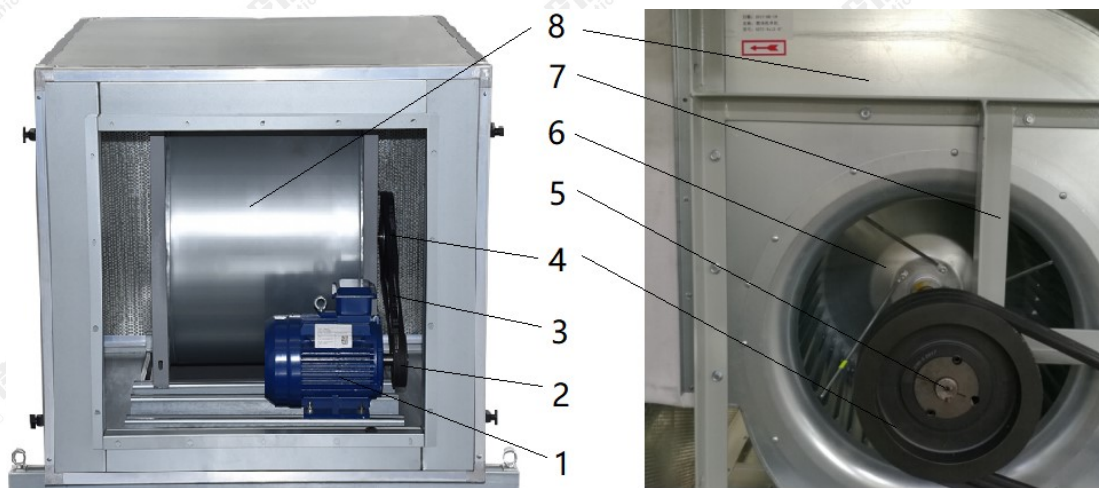
Motor built-in: The motor, pulleys, and belts are all located inside the box. The overall appearance is shown in Figure 3a). Based on the relative positions of the main shaft pulley, the two bearing housings, and the impeller, this type can be further subdivided into two arrangements: Types C and E.

➤ C 式：叶轮位于主轴两个支承的一侧、皮带轮位于主轴两个支承的另一侧，常见于机壳宽度不大的单进风主机，如图 3b)所示；

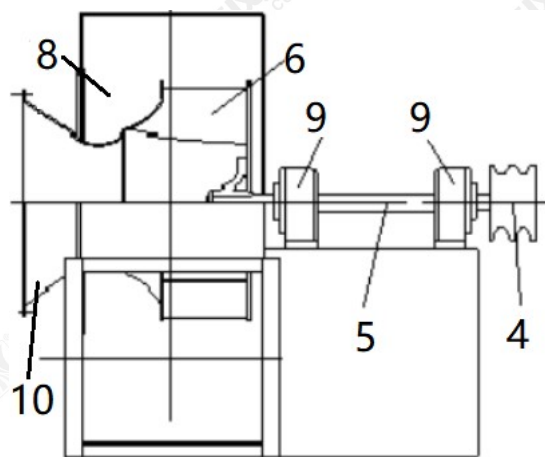
Type C: The impeller is located on one side of the two shaft bearings, and the pulley is located on the opposite side of the bearings, this arrangement is commonly used for single-inlet main unit with a relatively narrow casing, as shown in Figure 3b);

➤ E 式：叶轮位于主轴两个支承中间、皮带轮位于主轴两个支承的一侧，常见于机壳宽度较大的单进风或双进风的主机，如图 3c)所示。

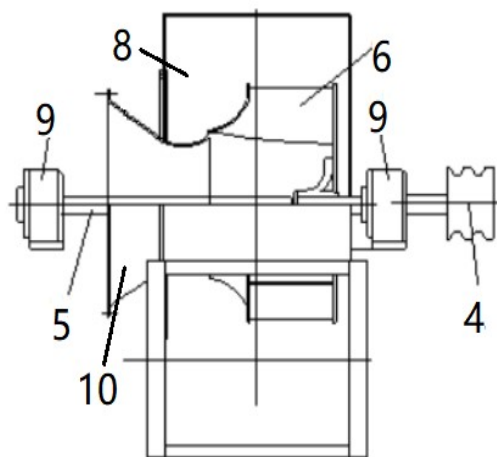
Type E: The impeller is located between the two shaft bearings, and the pulley is located on one side of the bearings, this arrangement is commonly used for single-inlet or double-inlet main unit with a wider casing, as shown in Figure 3c).



a) 整机外形 Overall shape



b) C 式主机 Type C drive (main unit)



c) E 式主机 Type E drive (main unit)

- 1.电机；2.电机带轮；3.皮带；4.主轴带轮；5.主轴；6.叶轮；7.框架；8.蜗壳；9.轴承座；10.进风口。
1. Motor; 2. Motor pulley; 3. Belt; 4. Main shaft pulley; 5. Main shaft; 6. Impeller;
7. Frame; 8. Volute casing; 9. Bearing housing; 10. Inlet.

图 3 电机内置皮带传动风机

Figure 3 Belt-driven cabinet fan with built-in motor

2) 电机外置：电机、皮带轮和皮带均位于箱体外，如图 4 所示。

External motor: The motor, pulley and belt are all located outside the box, as shown in Figure 4.



- 1.电机；2.皮带罩；3.叶轮；4.箱体；5.槽钢底架。

1. Motor; 2. Belt cover; 3. Impeller; 4. Box body; 5. Channel steel base frame.

图 4 电机外置皮带传动风机

Figure 4 Belt-driven cabinet fan with external motor

相比电机内置方式，电机外置通过加长主轴，使电机、皮带轮和皮带置于箱体外、避免受到介质影响，特别适用消防排烟、高温窑炉排风、化工高温废气输送工况。

Compared with the built-in motor arrangement, the external motor type uses an extended main shaft to keep the motor, pulleys, and belts completely outside the box, isolating them from the conveyed medium. It is particularly suitable for fire smoke exhaust, high-temperature kiln exhaust, and chemical high-temperature waste gas conveying applications.

1.5 常见配套附件 Common Accessories

1.5.1 减振器 Vibration isolator:

安装于风机风筒与基础之间，是隔离振动的核心部件。其核心作用为吸收和衰减风机运行时产生的机械振动与结构噪声，阻止其传递至建筑基础，从而保护设备、延长寿命、降低环境干扰并提升运行稳定性。

Installed between the fan casing and the foundation, the vibration isolator is the key component for vibration isolation. Its primary functions are to absorb and attenuate the mechanical vibration and structural noise generated during fan operation, and to prevent them from being transmitted to the building foundation, thereby protecting equipment, extending service life, reducing environmental disturbance, and improving operational stability.

对于电机功率大于 4kW 的风机，建议安装减振器；常用类型见下表。

For fans with motor power exceeding 4 kW, installation of vibration isolators is recommended. Common types are listed in the table below.

序号 No.	类型 Type	外形 Appearance	结构特点 Structural features	核心特点 Core features	适用场合 Applications
1	阻尼弹簧减振器 Damped spring vibration isolator		弹簧 + 阻尼 + 底座 Spring + damper + base	低频隔振强、承载大、寿命长 Strong low-frequency isolation, high load capacity, long service life	中大型风机、消防排烟风机、工业风机 Medium/large fans, fire smoke exhaust fans, industrial fans
2	吊式弹簧减振器 Suspended spring vibration isolator		吊杆 + 弹簧 + 阻尼 Suspension rod + spring + damper	吊式专用；防晃动、隔振隔音 Designed for suspended mounting; anti-sway; vibration and noise isolation	吊顶 / 风管式风机，安装高度有限制场合 Ceiling-mounted or duct fans, installations with height limitations
3	橡胶隔振垫 Rubber vibration isolation pad		橡胶垫 Rubber pad	简易便宜、直接铺垫 Simple, low cost, direct placement	微型 / 小型风机、简易安装场景 Micro/small fans, simple installation scenarios

减振器主要选用原则如下：

The main selection principles for vibration isolators are as follows:

➤ 载荷匹配：单支减振器额定载荷=风机总重/数量×1.3（吊装 1.5-1.6）安全系数，避免过载；一般按弹簧压缩量的 70~90%来选配减振器。所有弹簧皆能容许 50%的额外负荷，弹簧最小高度=未受压高度-1.5 倍额定振幅度。

Load matching: The rated load per isolator=(total fan weight / number of isolators)*1.3 (for suspended mounting:1.5-1.6) safety factor to avoid overload. Isolators are generally selected based on a spring compression of 70% to 90%. All springs shall be capable of withstanding an additional 50% overload. The minimum spring height = uncompressed height – (1.5 * rated deflection).

➤ 频率控制: 减振器固有频率 $f_0 < \text{风机激振频率 } f$ 的 $1/\sqrt{2}$ 倍; 高频风机优先橡胶, 低频优先弹簧+ 阻尼;

Frequency control: f_0 (the natural frequency) $< 1/\sqrt{2}f$ (the fan excitation frequency). Rubber isolators are preferred for high-frequency fans; spring + damper isolators for low-frequency fans.

➤ 工况修正: 高温 ($>80^\circ\text{C}$) 选耐高温橡胶/金属弹簧; 潮湿/腐蚀环境选不锈钢弹簧+氯丁橡胶。

Operating condition adjustments: For high temperatures ($>80^\circ\text{C}$), select high-temperature resistant rubber or metal springs. For humid/corrosive environments, select stainless steel springs with neoprene (or chloroprene rubber).

1.5.2 软接 Flexible connector:

安装于风机进出口与刚性风管之间, 作为柔性密封过渡部件, 其核心作用是补偿安装误差、吸收风机振动与风管热胀冷缩引起的位移, 有效防止振动传递至风管系统, 减少结构噪声, 并保护风机接口免受应力损坏。

Installed between the fan inlet/outlet and the rigid duct, the flexible connector serves as a flexible sealing transition component. Its primary functions are to compensate for installation errors, absorb displacement caused by fan vibration and thermal expansion/contraction of the duct, effectively prevent vibration transmission to the duct system, reduce structural noise, and protect the fan connection from stress damage.

常见材质如下所列, 具体选用时需考虑介质温度、压力、腐蚀性及防火要求:

Common materials are listed below. Selection shall consider medium temperature, pressure, corrosiveness, and fire protection requirements:

➤ 帆布软接: 普通通风, 防微风、减震, 不耐高温, 外形见图 5a);

Canvas flexible connector: For general ventilation, provides slight vibration isolation, not high-temperature resistant. See Figure 5a);

➤ 硅胶布/防火软接: 消防排烟、介质温度 $\leq 150^\circ\text{C}$ 的高温风机, 阻燃、耐高温, 外形见图 5b)。

Silicone-coated fabric / fire-resistant flexible connector: For fire smoke exhaust and high-temperature fans with medium temperatures $\leq 150^\circ\text{C}$. Flame-retardant and high-temperature resistant. See Figure 5b).



a) 帆布软接

Canvas flexible connector



b) 硅胶布/防火软接

Silicone-coated fabric / fire-resistant flexible connector

图 5 常见软接外形

Figure 5 External views of common flexible connectors

1.6 常见安装方式 Common Installation Type

1.6.1 通过框架吊装, 如图 6a)所示 via the framework hoisting, as shown in Figure 6a):

1) 适用场景 Applicable scenarios:

➤ 商业综合体、酒店、大型写字楼排烟机房, 多台风机集中吊顶布置;

Smoke exhaust fan rooms in commercial complexes, hotels, and large office buildings, where multiple fans are arranged in a centralized ceiling layout.

➤ 单台重量 $>500\text{kg}$ 的重型柜式离心风机, 要求分散楼板荷载;

Heavy-duty cabinet centrifugal fans with a single-unit weight exceeding 500 kg, where the design requires the floor load to be distributed.

- 原有楼板承载力不足，不能承受集中荷载的加固改造项目；

Retrofit projects where the existing floor slab has insufficient load-bearing capacity and cannot withstand concentrated loads.

- 对噪音控制严苛，需要降低结构传声、减少墙体振动异响的静音通风系统。

Quiet ventilation system with strict noise control requirements, needing to reduce structure-borne sound transmission and minimize wall vibration and associated noise.

2) 注意点：框架必须做防锈防腐处理，吊装前复核楼板梁位受力点，禁止直接吊在楼板空心板位置；框架四角水平校正后再锁紧吊杆。

Precautions: The framework shall be treated with anti-corrosion and anti-rust protection. Before lifting, verify the load-bearing points on the floor beams. Never attach directly to the hollow-core slab areas of the floor; Level the four corners of the framework before locking the hanger rods.

1.6.2 通过螺杆吊装，如图 6b)所示 Via screw hoisting, as shown in Figure 6b):

1) 适用场景 Applicable scenarios:

- 吊顶内部、风管夹层、管道井内嵌入安装，机房层高低；

Installation within ceiling voids, duct chases, or pipe shafts, where the fan room has a low ceiling height.

- 中小型新风、排风、加压风机，批量标准化快速安装；

Small to medium-sized fresh air, exhaust, or pressurization fans requiring batch standardization and rapid installation.

- 老旧暖通系统改造，现场无法现场焊接钢架，减少动火作业；

Retrofit of existing HVAC systems where on-site steel frame welding is not feasible, reducing the need for hot work.

- 风管直线串联布置，风机居中吊装匹配前后风管走向。

Fans installed centrally in a straight duct run to match the upstream and downstream duct alignment.

2) 注意点：起吊块翻转锁紧螺栓必须满扭矩紧固；吊杆必须配套减振吊架，杜绝振动顺着丝杆传递至楼板；风机箱体壁厚偏薄时需增设加强垫板，防止吊孔撕裂。

Precautions: The locking bolts on the hoisting brackets shall be tightened to full torque; Threaded rods shall be fitted with vibration isolator hangers to prevent vibration transmission through the rods to the floor slab; If the fan box wall thickness is relatively thin, reinforcing backing plates shall be added to prevent tearing at the lifting holes.

1.6.3 座地式安装，如图 6c)所示 Via floor-mounted installation, as shown in Figure 6c):

1) 适用场景 Applicable scenarios:

- 地下车库大型双速排烟风机、工业除尘、废气处理大功率风机；

Large two-speed smoke exhaust fans in underground garages, industrial dust collection, and high-power fans for exhaust gas treatment.

- 潮湿地下机房、容易顶部渗水、吊顶维保难度极大的环境；

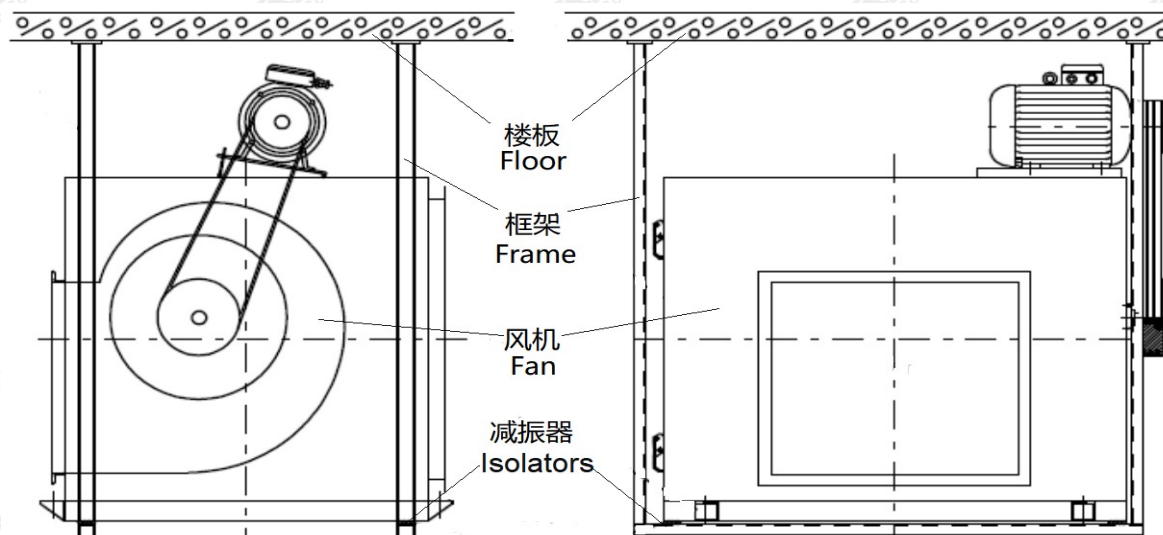
Environments such as damp underground fan rooms, locations prone to water seepage from above, or where ceiling maintenance is extremely difficult.

- 运维频次高，经常需要打开检视门、更换传动皮带、检修电机轴承；

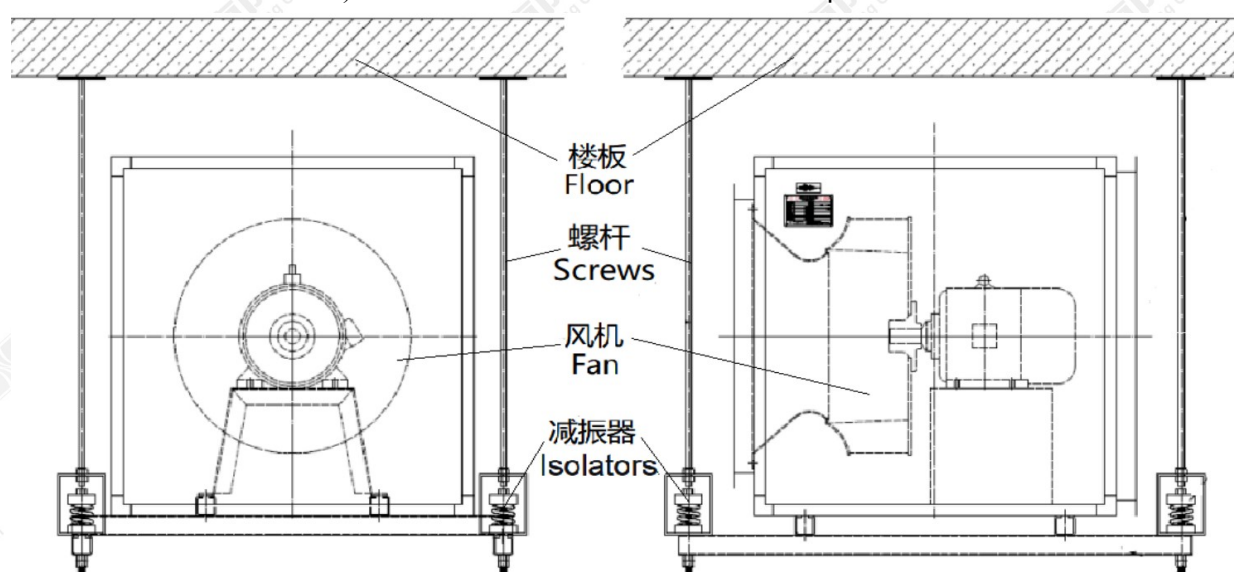
Applications requiring frequent maintenance, such as opening inspection doors, replacing drive belts, or servicing motor bearings.

- 屋面设备机房、地面基础承载力充足，吊顶无安装条件。

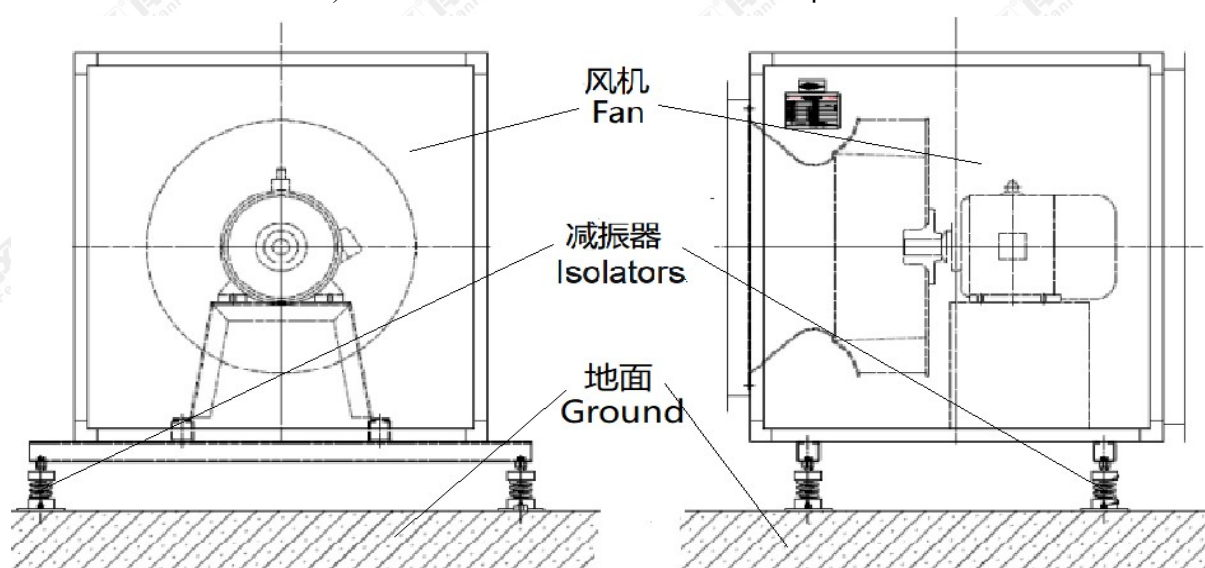
Roof equipment rooms or locations with adequate floor load capacity where ceiling installation is not feasible.



a) 通过框架吊装 Installed via frame suspension



b) 通过螺杆吊装 Installed via screw suspension



c) 座地式安装 Floor-mounted installation

图 6 常见安装方式

Figure 6 Common Installation Type

3) 注意点: 地面必须找平, 重载风机建议浇筑混凝土基础; 风机脚架与基础之间必须强制设置减振垫, 杜绝振动通过地面刚性传递产生共振噪音; 地脚螺栓锁紧后复测整机水平度。

Precautions: The floor shall be leveled. For heavy-duty fans, it is recommended to cast a concrete foundation; Vibration isolation pads shall be installed between the fan support frame and the foundation to prevent vibration transmission through rigid contact with the floor, which could cause resonance noise; After tightening the anchor bolts, recheck the levelness of the complete fan unit.

2. 搬运与吊装 Handling & Hoisting

2.1 优先遵循规范 Priority Specifications

1) GB 50275-2010 风机、压缩机、泵安装工程施工及验收规范 Code for construction and acceptance of fan, compressor and pump installation;

2) ISO 13003:2015 Cranes - Safe use - Part 1: General;

3) GB/T 13384-2008 机电产品包装通用技术条件 General specifications for packing of mechanical and electrical product;

4) ISO 12100:2010 Safety of machinery - Priority Specifications for design - Risk assessment and risk reduction;

5) IEC 60529:2013 Degrees of protection provided by enclosures (IP Code)。

2.2 总体原则 General Principles

1) 产品包装箱: 应使用箱体上指定的叉车位置或吊装点, 按箱体上的指示标识进行操作, 确保受力方向尽量与重心一致、防止箱体侧翻, 如图 7 所示:

Product shipping crate: Use the forklift position or lifting point specified on the crate and operate according to the markings on the crate to ensure that the force direction is as consistent as possible with the center of gravity and to prevent the box from overturning, as shown in Figure 7:

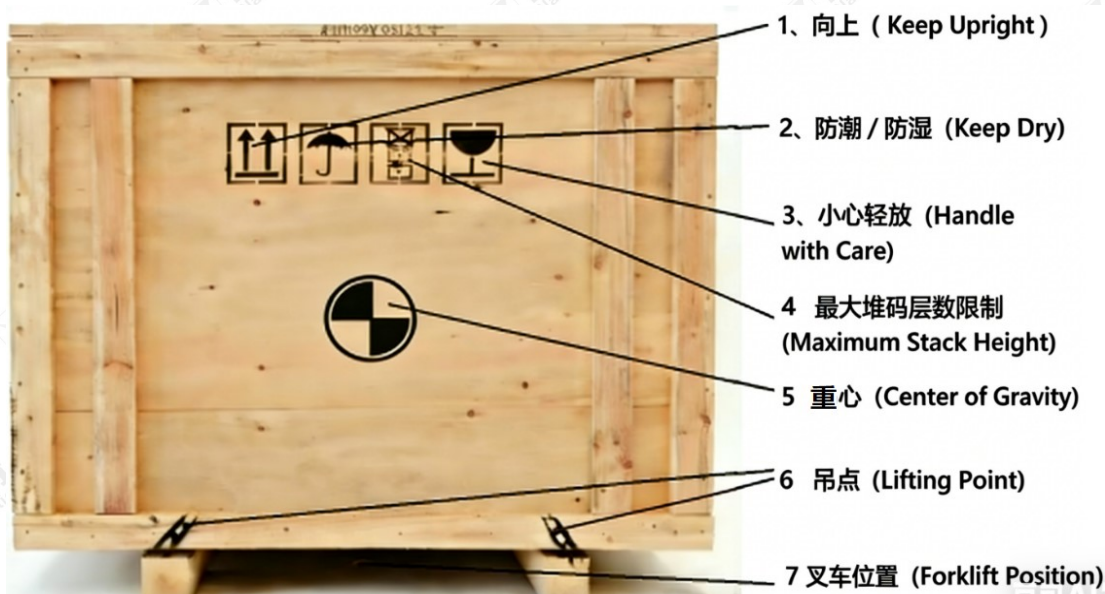
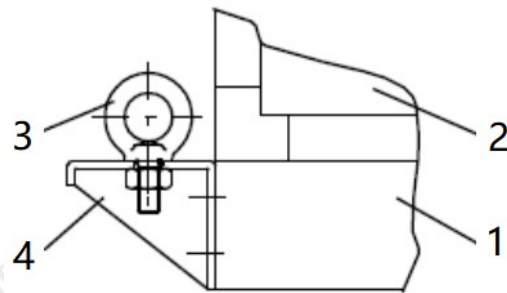
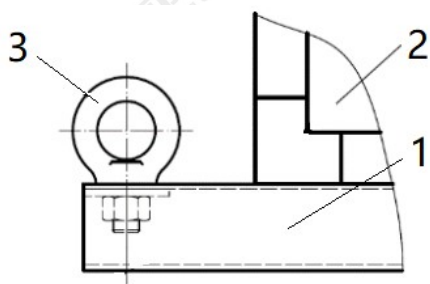


图 7 包装箱的外形

Figure 7 Shape of the shipping crate

2) 如箱体已开拆或无包装箱时, 应通过底部槽钢或与之相连起吊块上的吊耳 (如图 8 所示) 等指定的吊装点进行起吊, 优先选用位于底部、结构粗壮、分布面广的多个吊点; 严禁在风机外壳、叶片、轴承箱或电机等非承重部位直接吊挂。

If the crate has been opened or no crate is available, the fan shall be lifted using designated lifting points such as the bottom channel steel or the lifting lugs on the hoisting brackets attached to it (as shown in Figure 8). Priority shall be given to multiple lifting points that are located at the bottom, structurally robust, and widely distributed. Direct attachment of slings to non-load-bearing parts such as the fan casing, blades, bearing housing, or motor is strictly prohibited.



a) 吊环在槽钢上 The lifting rings on the channel steel

b) 通过起吊块 Via hoisting bracket

1. 底部槽钢; 2. 箱体; 3. 吊环; 4. 起吊块。

1. Bottom channel steel; 2. Box body; 3. Lifting ring; 4. Hoisting bracket

图 8 风机底部起吊部位

Figure 8 Lifting points at the fan base

3) 平稳缓慢: 动作应平稳、缓慢, 避免急停、急起、碰撞或猛烈摆动。

Smooth and slow: Movements should be smooth and slow, avoiding sudden stops, sudden starts, collisions, or violent swings.

2.3 搬运要求 Handling Requirements

1) 整体搬运: 对于组装好的风机, 近距离可使用叉车, 叉托风机底部、缓慢行驶; 较远距离应使用托架、平板车或货车, 并可靠固定;

1) Transportation of complete fan: For assembled fans, a forklift may be used for short-distance transport. Lift the fan from the bottom with the forks and drive slowly. For longer distances, use a skid, flatbed cart, or truck, and securely fasten the fan.

2) 部件搬运: 散件运输时, 叶轮、机壳等大件需单独支撑固定, 防止相互挤压、摩擦;

Component handling: When transporting loose parts, large parts such as impellers and casings should be supported and fixed separately to prevent mutual squeezing and friction;

3) 保护措施: 对精密加工面、轴端等采取保护 (如使用护套), 防止碰伤。

Protective measures: Protect the precision machined surfaces, shaft ends, etc. (such as using sleeves) to prevent damage.

2.4 吊装要求 Hoisting Requirements

1) 吊具使用: 吊装前检查吊索、卸扣的额定载荷及完好性, 确保其安全系数足够 (通常要求安全系数 ≥ 4); 无包装吊运时, 吊索优先使用吊带。如采用钢丝绳或链条等金属索, 风机表面有可能与吊索接触的部位应用纸皮、木块、草垫或胶垫等软物隔开, 或在钢丝绳表面套上橡皮管, 以免被吊索划伤; 吊索应足够长, 吊索夹角应不大于 60° , 若吊索太短, 则上方用角钢或木架支撑, 以防止风机受压而变形或损坏;

Use of lifting gear: Check the rated load and integrity of the lifting slings and shackles before lifting to ensure sufficient safety factor (safety factor ≥ 4 is usually required); When lifting without packaging, soft slings are preferred. If metal slings such as wire ropes or chains are used, any fan surfaces that may come into contact with the slings shall be protected by placing soft materials such as cardboard, wooden blocks, straw mats, or rubber pads between them, or by covering the wire ropes with rubber sleeves to prevent scratches; The sling should be long enough and the sling angle should not exceed 60° . If the sling is too short, it should be supported by an angle steel or wooden frame above to prevent the fan from being deformed or damaged under pressure;

2) 平衡吊装: 对于重心不对称风机, 应采用平衡梁或调节吊索长度, 确保设备水平起吊, 防止倾翻;

Balanced lifting: For fans with an asymmetrical center of gravity, use a spreader beam or adjust the length of the sling to ensure that the equipment is lifted horizontally to prevent overturning;

3) 试吊确认: 起吊至离地约 100-200mm 后, 暂停并检查设备平衡性、吊具受力及捆绑情况, 确认无误后再继续;

Trial lift confirmation: After lifting to about 100-200mm off the ground, pause and check the balance

of the equipment, the force on the lifting gear and the binding. Resume only after confirming that there are no errors;

4) 人员安全: 吊装区域设置警戒, 人员严禁在吊物下方站立或通行; 由专业指挥员统一指挥。

Personnel safety: Set up a cordon in the lifting zone and prohibit personnel from standing or passing under the lifted object; All lifting operations shall be directed by a qualified commander.

2.5 特别注意事项 Special notes

1) 在吊运之前,应检查各部位的联接螺栓是否拧紧、焊接部位是否牢固, 风机上有无不该放置的物品; 当出现吊物变形时应立即停止起吊, 并采取措施避免该现象发生后方可继续;

Before hoisting, check that all connecting bolts are tightened, welded joints are sound, and no foreign objects are placed on the fan; When the lifted object is deformed, the lifting should be stopped immediately and measures should be taken to prevent the phenomenon before continuing;

2) 叶轮吊装时, 严禁用钢丝绳直接套在叶片上, 应使用专用夹具或从轮毂吊耳起吊;

When hoisting the impeller, it is strictly forbidden to directly loop the wire rope over the blade. Use special clamps or lift from the lifting lugs on the hub;

3) 电机与轴承: 避免承受不当的横向力或冲击载荷;

Motors and bearings: Avoid improper lateral forces or impact loads;

4) 气象条件: 大风、大雨、大雾等恶劣天气应停止露天吊装作业。

Weather conditions: Do not perform outdoor hoisting operations in adverse weather, such as strong winds, heavy rain, or dense fog.

3. 仓储存放 Warehouse Storage

3.1 优先遵循规范 Priority Specifications

1) GB 50275-2010 风机、压缩机、泵安装工程施工及验收规范 Code for construction and acceptance of fan, compressor and pump installation;

2) ISO 12499:1999 Industrial fans - Mechanical safety of fans - Guarding;

3) ISO 9001:2015 Quality management systems - Requirements;

4) GB/T 13384-2008 机电产品包装通用技术条件 General specifications for packing of mechanical and electrical product;

5) ISO 12100:2010 Safety of machinery - Priority Specifications for design - Risk assessment and risk reduction;

6) GB 50150-2016 电气装置安装工程 电气设备交接试验标准 Electric equipment installation engineering - standard for hand-over test of electric equipment;

7) ISO 2372:2007 Mechanical vibration - Evaluation of machine vibration by measurements on rotating parts.

3.2 环境要求 Environmental Requirements

1) 应存放于干燥、通风良好的室内仓库, 避免露天放置;

It should be stored in a dry, well-ventilated indoor warehouse, avoiding outdoor storage;

2) 温度宜保持在 -10°C 至 $+40^{\circ}\text{C}$ 以内, 并避免剧烈温度波动。若环境温度可能低于 -10°C , 需特别注意电机内润滑油脂的凝固问题, 以及部分橡胶密封件等可能因低温而硬化脆裂; 若环境温度长期高于 40°C , 会加速电机绝缘老化、电子元件性能劣化, 并可能导致精密部件润滑油脂流失或变质;

The temperature should be kept with -10°C to $+40^{\circ}\text{C}$ and sharp temperature fluctuations should be avoided. If the ambient temperature may be below -10°C , pay special attention to the solidification of the lubricating grease inside the motor, as well as the risks that some rubber seals, etc. may harden and crack due to the low temperature; If the ambient temperature remains above 40°C for a long time, it will accelerate the aging of motor insulation, and the deterioration of electronic component performance, and may cause the loss or deterioration of lubricating grease in precision parts;

3) 环境应无腐蚀性气体、粉尘;

The environment should be free of corrosive gases and dust;

4) 若需室外临时存放, 应做足够防护, 包括垫高、防雨布严密覆盖, 避免阳光直射、雨淋、水浸等。
If it needs to be temporarily stored outdoors, adequate protection measures should be taken, including raising the position, covering with a rainproof fabric, and avoiding direct sunlight, rain, and water immersion, etc.

3.3 风机主体保护 Fan Main Unit Protection

- 1) 电机、轴承等精密部件必须严格防潮, 并定期检查电气绝缘;
Precision components such as motors and bearings must be strictly moisture-proof and electrical insulation must be checked regularly;
- 2) 所有加工表面、法兰接口应涂防锈油(脂)并用防护材料包扎;
All machined surfaces and flange joints should be coated with anti-rust oil (grease) and wrapped with protective materials;
- 3) 叶轮必须平稳放置, 防止变形, 并防止杂物进入叶片间;
The impeller must be placed steadily to prevent deformation and to prevent foreign objects from entering between the blades;
- 4) 叶轮等活动部件应处于自由状态, 避免受力;
The moving parts such as the impeller should be in a free state and avoid being subjected to force.
- 5) 长期存放时, 每月至少盘车 1 次, 每次盘车不少于 10 转, 并形成盘车记录备查。
During long-term storage, perform shaft barring at least once a month with no fewer than 10 revolutions each time, and maintain barring records for future inspection.

3.4 附件与包装 Accessories & Packaging

- 1) 随机的电气仪表、控制系统应存放于专用干燥环境;
Random electrical instruments and control systems should be stored in a dedicated dry environment;
- 2) 减振器、软接等橡胶制品应避免阳光直射、高温及油污;
Rubber products such as vibration isolators and flexible connectors should be kept away from direct sunlight, high temperatures and oil stains;
- 3) 包装箱应保持完整, 标识清晰, 按包装图示要求堆放。
The shipping crate should be kept intact, clearly marked, and stacked as required by the packaging diagram.

3.5 管理要求 Management Requirements

- 1) 建立存放台账, 先到先装, 避免超期长期存放;
Establish a storage log and follow the first-in, first-out (FIFO) principle to avoid excessive storage time;
- 2) 每月定期检查产品状态, 特别是防锈、包装完好性和电机等电气件的绝缘;
Carry out regular inspections at monthly intervals on product condition, especially anti-rust status, packaging integrity and insulation performance of electrical parts including motors;
- 3) 重型部件存放地面应坚实平整, 确保稳定, 防止倾倒。
Heavy parts should be stored on solid and flat ground to ensure stability and prevent toppling.

4. 装配/安装 Assembly/Installation

4.1 优先遵循规范 Priority Specifications

- 1) JB/T 10563-2006 一般用途离心通风机 技术条件 Technical specification for general purposes centrifugal fans;
- 2) GB 50275-2010 风机、压缩机、泵安装工程施工及验收规范 Code for construction and acceptance of fan, compressor and pump installation;
- 3) GB 50040-2020 动力机器基础设计规范 Code for design of dynamic machine foundation;
- 4) ISO 13702:2009 Petroleum and natural gas industries - Rotating machinery - Foundations;
- 5) ISO 14694:2003 Petroleum and natural gas industries - Pipeline transportation systems;

- 6) ISO 1940-1:2003 Mechanical vibration - Balance quality requirements for rotors in a constant (rigid) state;
- 7) GB 50243-2016 通风与空调工程施工质量验收规范 Code of acceptance for construction quality of ventilation and air conditioning works;
- 8) ASHRAE 62.1-2022 Ventilation for Acceptable Indoor Air Quality;
- 9) JGJ255-2012 采光顶与金属屋面技术规程 Technical specification for skylights and metal roof;
- 10) ISO 16228:2007 Building construction - Sealants - Test method for sealant adhesion/cohesion;
- 11) GB/T 3098.1-2010 紧固件机械性能 螺栓、螺钉和螺柱 Mechanical properties of fasteners - Bolts, screws and studs;
- 12) ISO 898-1:2013 Mechanical properties of fasteners made of carbon steel and alloy steel - Part 1: Bolts, screws and studs;
- 13) ASHRAE 90.1-2019 Energy Standard for Buildings Except Low-Rise Residential Buildings;
- 14) GB 50254-2014 电气装置安装工程 低压电器施工及验收规范 Code for construction and acceptance of low-voltage apparatus Electric equipment installation engineering;
- 15) IEC 60364-5-52:2009 Low-voltage electrical installations - Part 5-52: Selection and erection of electrical equipment - Wiring systems;
- 16) JBT 5994-1992 装配通用技术要求 General technical requirements for assembly;
- 17) GB 50231-2009 机械设备安装工程施工及验收通用规范 General code for construction and acceptance of mechanical equipment installation engineering.

4.2 安装前的检查 Pre-installation Inspection

1) 安装基础 Installation foundation

➤ 频率特性: 安装基础必须具有足够的强度、稳定性和耐久性, 能承受风机静、动载荷; 自振频率不得大于电机和通风机转速的 0.3 倍, 以免产生共振;

Frequency characteristics: The installation foundation must have sufficient strength, stability and durability to withstand the static and dynamic loads of the fan; The natural frequency should not exceed 0.3 times the rotational speed of the motor and the fan to avoid resonance;

➤ 结构形式: 对于刚性支承, 安装基础宜为整体混凝土块; 当采用吊架(支架)安装风机时, 应保证风机中心线与支撑平面的位移允许偏差不得超过 10mm, 在屋顶安装时还应考虑当地的大风、地震等极端气候条件造成的额外负载影响, 让该架与建筑物的主体结构连接牢固;

Structural form: For rigid support, the installation foundation should be an integral concrete block; When installing the fan using hangers (brackets), ensure that the allowable deviation of the fan center line from the support plane does not exceed 10mm. When installing on the roof, also take into account the additional load effects caused by local extreme weather conditions such as strong winds and earthquakes, and ensure that the frame is firmly connected to the main structure of the building;

➤ 尺寸要求: 安装基础外形尺寸(长、宽、高)、标高、螺栓预留孔/预埋件的位置、尺寸及深度, 必须严格符合设备基础图。

Size requirements: The external dimensions of the installation foundation (length, width, height), elevation, position, size and depth of the bolt reserved holes/embedded parts for bolts must strictly conform to the equipment foundation drawing.

一般要求混凝土基础四周比风机底座或减振器底板单边预留 $\geq 100\text{mm}$; 安装平面露出地面以防积水, 标高允许偏差 0 至 -20mm ; 刚性支承时安装平面整体水平度要求 $\leq 1/1000$ (允许通过二次灌浆和垫铁来找平), 挠性支撑时各处减振器支撑面间标高差 $\leq 2\text{mm}$ 。

Generally, a minimum clearance of 100 mm on each side shall be provided between the concrete foundation and the fan base or vibration isolator base plate. The installation surface shall be elevated above the ground to prevent water accumulation, with allowable elevation deviation of 0 to -20 mm . For rigid support, the overall levelness of the installation surface shall be $\leq 1/1000$ (leveling by secondary grouting and shim plates is permitted). For flexible support, the elevation difference between the supporting surfaces of each vibration isolator shall not exceed 2 mm.

➤ 表面质量：与风机支撑底座或减振器接触的位置平整、无蜂窝麻面；预留孔内部清洁度，确保无杂物、油污；

Surface quality: There should be flat and no honeycomb or pitted surface at the contact areas of the fan support base or vibration isolator. The interior of reserved holes should be clean and free of debris and oil stains;

➤ 预留空间：以便于风机日常的检查、维护以及风机的拆卸、零部件的更换等。

Reserved space: To facilitate daily inspection and maintenance of the fan, as well as disassembly and replacement of components.

2) 连接风管 Connected air ducts

➤ 接口尺寸：连接风管的法兰内径、螺栓孔中心距、孔径及数量必须与风机机壳进出口法兰或两者之间的软接法兰完全匹配。一般要求配对法兰平行度偏差 $\leq$ 管道外径的 0.15%或 2mm；将两法兰进行预对接，螺栓应能穿入；

Interface dimensions : The inner diameter, center distance of bolt holes, hole diameter and quantity of the connecting air duct flange must be exactly the same as those of the fan casing inlet or outlet flange or the flexible joint flange between them. Generally, the parallelism deviation of mating flanges shall not exceed 0.15% of the pipe outer diameter or 2 mm. Perform pre-assembly of the two flanges, and bolts shall be able to be inserted;

➤ 支撑形式：风机进出口处的风管（及其相连的弯头、风阀等）需有独立、牢固的支架，严禁将其重量直接承压在风机接口上；确认风管支架已安装到位，能有效防止风管下垂或位移；

Support form: The ducts at the fan inlet and outlet (together with attached elbows, dampers, etc.) shall have independent and rigid supports. The weight of these components shall not be directly imposed on the fan connections. Ensure that the duct supports are properly installed and capable of effectively preventing sagging or displacement of the ducts;

➤ 长度要求：当风机采用软接与风管连接时，预留长度应保证软接安装后应处于自然舒展状态，无扭曲、拉伸或压缩变形；直管段长度通常 ≥ 1.5 倍管径，以形成均匀流场；

Length requirement: When the fan is connected to the air duct with a flexible joint, the reserved length should ensure that the flexible joint is in a naturally extended state after installation, without twisting, stretching or compression deformation; The length of the straight duct section should be at least 1.5 times the duct diameter to ensure a uniform flow field;

➤ 洁净要求：风管内部必须清洁无异物，如安装工具、焊渣、保温材料等杂物。

Cleanliness requirements: The inside of the air duct must be clean and free of foreign objects such as installation tools, welding slag, insulation materials, etc.

3) 风机部分 Fan section

➤ 对照通风系统工程图纸、设备清单等技术文件，检查确认将被安装的风机型号规格、安装方式、安装位置等是否正确；

Check and confirm that the model, specification, installation method and installation position of the fan to be installed are correct by referring to the ventilation system engineering drawings, equipment list and other technical documents;

➤ 仔细检查风机各个部件、配套附件是否齐全、完好；叶轮和机壳是否因运输而损坏变形；各零部件联接是否紧固；如发现问题应及时修复、调整方可安装使用；

Carefully inspect all fan components and associated accessories to ensure they are complete and undamaged. Check whether the impeller and casing have been damaged or deformed during transportation. Verify that all parts are securely fastened. If any problems are found, they shall be repaired or adjusted before operation.

➤ 如果风机距离出厂或存放在于湿度较大环境中的时间较长，应用 500 伏兆欧表测量电机的相对地绝缘电阻（允许值一般要求 $\geq 0.5M\Omega$ ，潮湿环境要求 $\geq 1M\Omega$ ，具体按电机安装与维护手册规定）。否则应对电机的定子绕组进行干燥处理，干燥处理的温度不允许超过 120℃。

If the fan has been out of the factory or stored in a humid environment for a long time, the relative

ground insulation resistance of the motor should be measured with a 500-volt megohmmeter (the allowable value is generally required to be $\geq 0.5M\Omega$, and $\geq 1M\Omega$ in a humid environment, as specified in the motor installation and maintenance manual). Otherwise, the stator windings of the motor should be dried out, and the drying temperature should not exceed 120°C .

4.3 整机安装 Unit Installation

1) 风机必须依照铭牌所示的气流方向和叶轮旋转方向正确安装, 同时风机的气流方向应与系统要求的送风或排气方向一致;

The fan must be installed correctly in accordance with the airflow direction and impeller rotation direction indicated on the nameplate, and the fan airflow direction should be consistent with the supply or exhaust direction required by the system;

2) 找正找平: 风机主轴中心线应尽量与风管中心线保持同心或符合安装图纸要求, 平面位移偏差 $\leq 10\text{mm}$ 、标高 $\leq \pm 10\text{mm}$; 在风机底座、电机或轴承座安装面上检测, 纵、横向水平度偏差均不应大于 $1/1000$;

Alignment and leveling: The fan main shaft center line shall be as concentric as possible with the center line of the air duct or in accordance with the requirements of the installation drawing. The planar displacement deviation shall not exceed 10 mm , and the elevation deviation shall not exceed $\pm 10\text{ mm}$; Check on the mounting surfaces of the fan base, motor or bearing pedestal, and the longitudinal and transverse levelness deviations shall each not exceed $1/1000$.

3) 刚性安装时风机与基础结合面, 以及进出口有风管联接时应通过垫铁、接头等调整使之自然吻合, 不得强行联接。

When rigidly mounted, the interface between the fan and the base, as well as the duct connections at the inlet and outlet, shall be adjusted to fit naturally using shim plates, joints, etc. Do not force the connection.

4) 法兰密封: 开边机壳组合成完整机壳或进出风口外接法兰时, 需要在法兰端面做好密封。输送高温介质的风机常采用缠绕耐高温的石棉绳或其他耐高温柔性材料进行密封, 具体应参考图 9 的图案进行交叉缠绕, 经多圈 (一般 3-6 圈) 缠绕后, 再用螺栓将两侧法兰锁紧。

Flange sealing: When assembling a split casing into a complete casing or connecting external flanges at the inlet/outlet, the flange faces shall be properly sealed. For fans conveying high-temperature media, high-temperature resistant asbestos rope or other flexible high-temperature resistant materials are commonly used for sealing. The rope shall be wound in a cross pattern as shown in Figure 9. After multiple turns (typically 3-6 turns), the two flanges shall be tightened together with bolts.

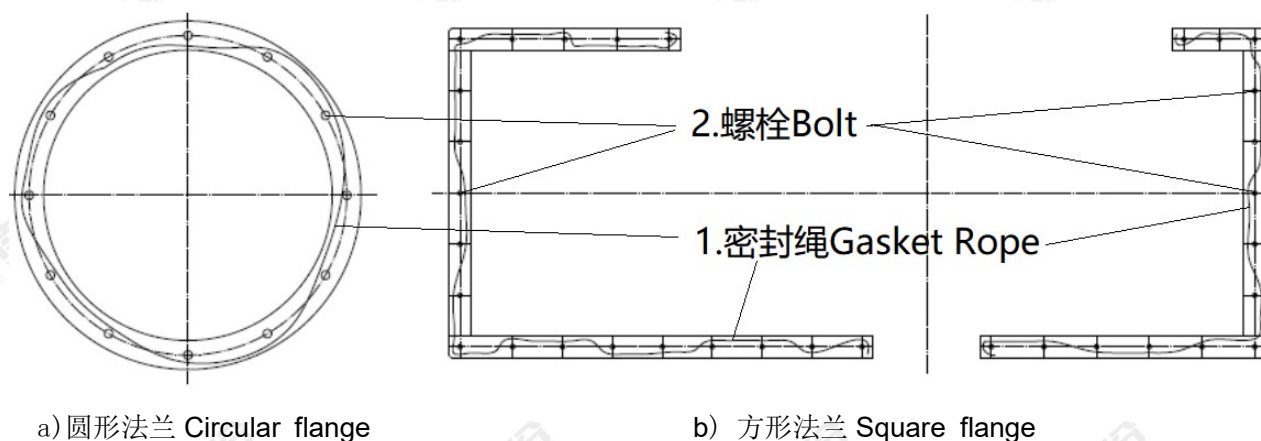


图 9 法兰缠绕密封图案

Figure 9 Flange wrapping pattern for sealing

5) 对于分体供货的皮带传动风机, 主轴与电机轴必须保持平行, 两根轴上的三角皮带轮相对应的轮槽对称面应该重合、不得错位, 不许带轮有倾斜和摆动; 套上三角皮带后, 然后调整电机的位置, 改变两根轴的中心距, 并将各条皮带张紧度调整至基本一致; 然后安装皮带罩以利安全。

For belt-driven fans supplied as separate components (split shipment), the shaft and the motor

shaft must be kept parallel. The corresponding groove centerlines of the V-belt pulleys on the two shafts shall align without offset. The pulleys shall have no tilt or wobble. After installing the V-belts, adjust the motor position to change the center distance between the two shafts, and adjust the tension of each belt to be basically uniform. Then install the belt guard for safety.

4.4 附件安装 Attachments Installation

1) 总体原则 General principles

➤ 较重的附件应有单独的支承，并应与基础或其他建筑物连接牢固、避免共振，与风机机壳相连时不得将外力施加在风机机壳上；

Heavy accessories should have separate supports and be firmly connected to the foundation or other buildings to avoid resonance. When connected to the fan casing, no external force should be applied to the fan casing;

➤ 附件与风机机壳间连接应有可靠密封，以保证风机附件与机壳间无明显漏气。

There should be a reliable seal between the accessories and the fan casing to ensure there is no obvious air leakage between the accessories and the casing.

2) 减振器安装 Vibration isolators Installation

➤ 当风机为卧式安装时：未装减振器前，先在就位后的风机安装孔附近位置各用一个千斤顶（或其它垫块），将风机顶起（或垫高）并调整水平后，测量风机底座与地面的距离，垫平差值，装上减振器，落地，在减振器地脚孔打上膨胀螺栓并固定；

When the fan is installed horizontally: Before installing the vibration isolators, use a jack (or other lifting device) near each mounting hole to raise the fan slightly. Level the fan, then measure the distance between the fan base and the foundation., pad the leveling value, install the vibration isolators, place them on the ground, and drill expansion bolts into the vibration isolator anchor holes and fix them;

➤ 当风机为吊式安装时：利用顶面安装槽钢调整水平，并测量安装点水平差值，垫平差值，装上吊式减振器，托上风机，紧固螺栓；

When the fan is suspended: Use the top-mounted channel steel to adjust the level, measure the level difference at the installation point, pad the leveling value, install the suspended vibration isolator, support the fan, and tighten the bolts;

➤ 各减振器的基础应在同一水平面上；弹簧减振器在安装过程中没有弹簧径向不垂直和倾斜的现象；保证风机底座上的各个减振器受力均匀。

The bases of the vibration isolators should be on the same level; For spring vibration isolators, there should be no radial non-perpendicularity or tilting of the springs during installation; Ensure that all the vibration isolators on the fan base are evenly stressed.

3) 软接安装 Flexible connector installation

➤ 长度与状态：安装后自然下垂/伸展，长度控制在 100-400mm，严禁拉伸、压缩、打折，软接内壁平整，无内凹、无褶皱（避免气流受阻、产生噪音）；

Length and condition: After installation, the flexible connector shall hang or extend naturally. Length must be controlled at 100-400mm. Stretching, compression, and folding are strictly prohibited. The inner wall of the flexible connector should be flat without inward bulges or wrinkles (to avoid airflow obstruction and noise generation);

➤ 方向要求：与风机风向一致（风机出风口标注箭头，软接布料/波纹方向与箭头同向，不阻碍气流），无反装；

Direction requirements: Consistent with the airflow direction of the fan (the fan outlet is marked with an arrow, the fabric or corrugation direction of the flexible connector shall be the same as the arrow to avoid obstructing airflow.), Reverse installation is not permitted;

➤ 固定方式：软接两端分别套在风机法兰、风管法兰外侧（或内侧，需与法兰贴合紧密），用卡箍环绕固定，或用螺栓对角均匀拧紧（螺栓间距 $\leq 80\text{mm}$ ，每侧螺栓数量 ≥ 4 个，确保受力均匀）；软接边缘包边需贴合法兰，无松动、无脱边；

Fixing method: The two ends of the flexible connector should be respectively fitted on the outside (or inside) of the fan flange and the air duct flange, with a tight fit to the flange, and fastened with clamps or evenly tightened diagonally with bolts (bolt spacing $\leq 80\text{mm}$, number of bolts on each side ≥ 4 to ensure even force distribution); The edge trim of the flexible connector should fit the flange without looseness or detachment;

➤ **表面处理:** 当安装结束需要进行补漆美化外观时, 对于基材为非金属材料的软接必须选用专门针对该材质的柔性涂料 (如柔性聚氨酯漆、专用橡胶漆), 并在隐蔽处做小范围附着力测试; 切勿使用普通硬质油漆, 且需控制漆层不要过厚, 否则容易导致表面涂层开裂或剥落。

Surface treatment: When touch-up painting is required to enhance the appearance after installation, for flexible connector with a non-metallic base material, a specific flexible coating for that material (such as flexible polyurethane paint, special rubber paint) must be used, and a small area adhesion test should be conducted in concealed areas; Do not use ordinary hard paint, do not apply the paint too thickly, otherwise it may cause the surface coating to crack or peel off.

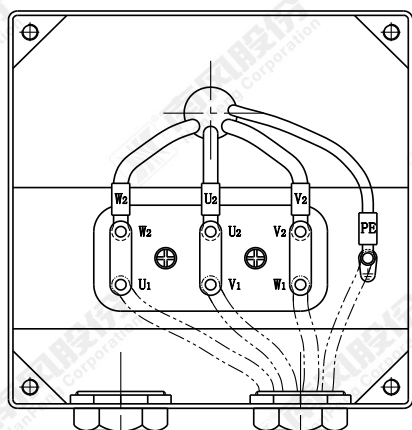
4) 风阀 (调节门) 安装: 注意不要装反, 其中进口风阀预旋方向应与叶轮旋转方向一致。

Damper installation: Do not install the damper in reverse. The pre-rotation direction of the inlet damper should be consistent with the rotation direction of the impeller .

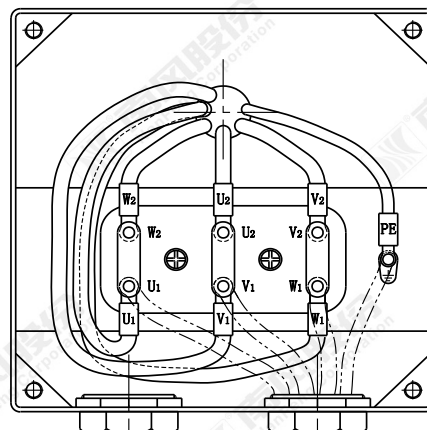
4.5 电气连接 Electrical connection

4.5.1 动力电源线路连接 Power supply cable connection:

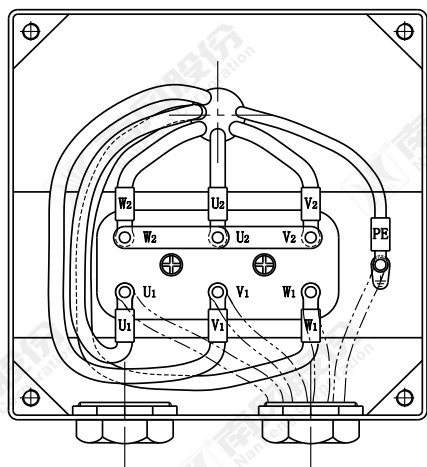
1) 动力电源线选择、连接及接地必须与设计要求的技术规范一致, 并按电机安装与维护手册或接线盒盖上所附的接线图连接; 电机接线盒内动力线常见接法见图10。



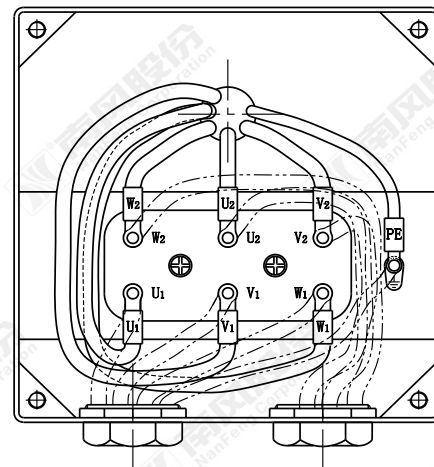
a) 三相单速电机 (3引线)
3-phase single-speed motor (3 leads)



b) 三相单速电机 (6引线) Δ 接 ($\geq 4\text{kW}$)
3-phase single-speed motor (6 leads) Δ ($\geq 4\text{kW}$)



c) 三相单速电机 (6引线) Y 接 ($\leq 3\text{kW}$)
3-phase single-speed motor (6 leads) Y ($\leq 3\text{kW}$)



d) 双速电机 (6引线)
Two-speed motor (6 leads)

图10 电机接线盒内动力线常见接法

Figure 10 Common power cable wiring in motor terminal box

Power cable connection: The selection, connection and grounding of the power cable must be in accordance with the technical specifications of the design requirements and be connected according to the wiring diagram attached to the motor installation and maintenance manual or the junction box cover; Typical wiring of the power cable inside the motor terminal box is shown in Figure 10.

另外，在潮湿环境下使用的7.5kW或以上电机，一般配备有电加热器，在风机停机时电加热器工作，让电机内部比环境高 5-10℃，从而维持电机绝缘电阻达标。该电加热器的电源常见为220VAC/1P。

In addition, motors of 7.5 kW or above used in humid environments are generally equipped with an electric heater. When the fan is shut down, the electric heater operates to maintain the motor interior 5-10℃ above the ambient temperature, thereby keeping the motor insulation resistance within acceptable limits. The power supply for this electric heater is typically 220 VAC / 1 P.

4.5.2 在线监测系统（如有）安装 Installation of online monitoring system (if equipped):

该系统典型组成见图 11。A typical system configuration is shown in Figure 11.

它由传感器、二次显示仪表、就地控制箱等部分组成，可对电机绕组温度、风机前后轴承温度和振动等进行动态监测，并将信号上传至集中控制系统。值得注意的是，用户如要搭建此系统须在风机订货时说明，以便在产品出厂前预置传感器或预留其接口。

It consists of sensors, secondary display instruments, a local control box, etc. It provides dynamic monitoring of motor winding temperature, and bearing temperature and vibration at the front and rear fan bearings, and transmits signals to a centralized control system. It should be noted that if users wish to install such a system, they must specify this requirement when ordering the fan, so that sensors can be pre-installed or their interfaces reserved before the fan leaves the factory.

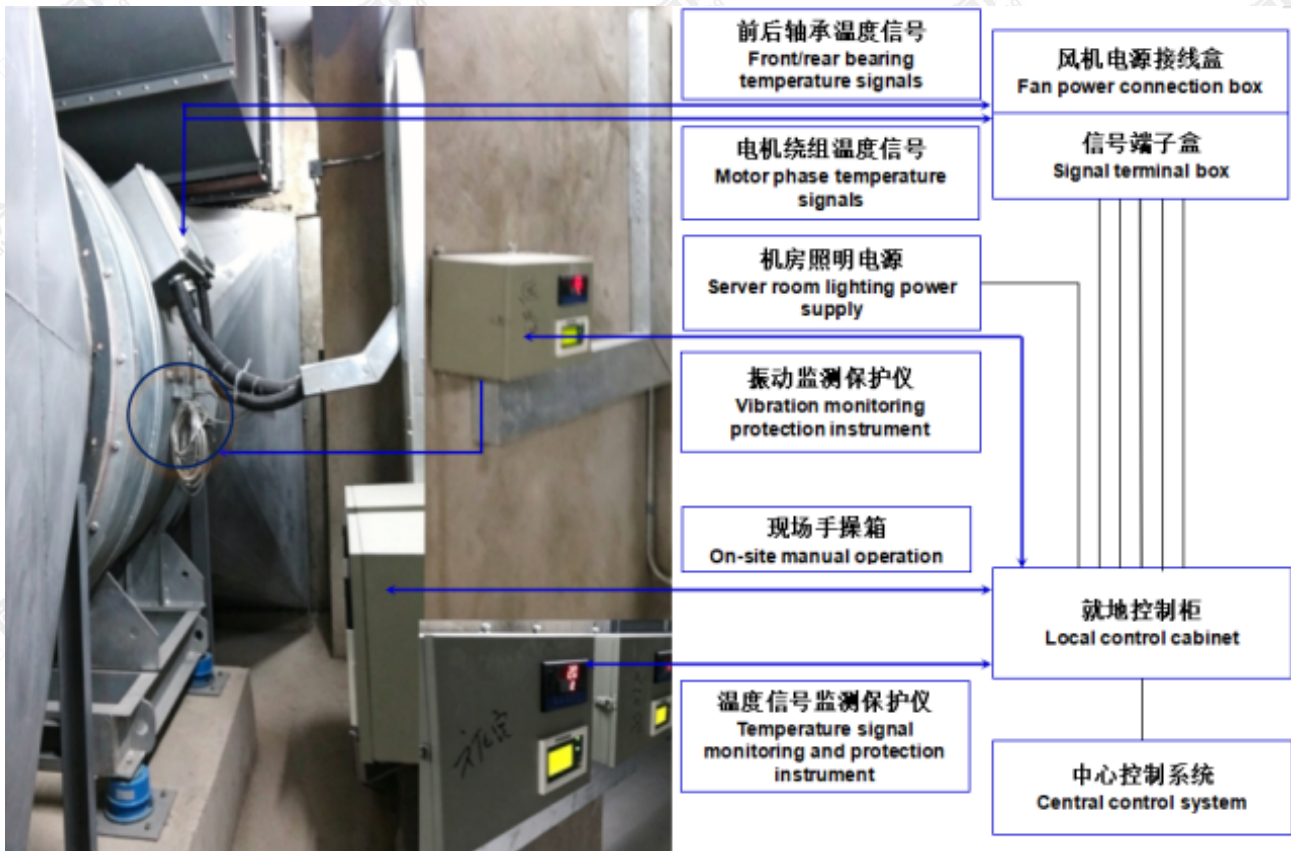


图 11 典型在线监测系统的组成

Figure 11 Components of a typical online monitoring system

在潮湿环境下使用的风机各监测参数对应的传感器类型、输出信号和设置参见下表：

For fans used in humid environments, the sensor type, output signal, and settings corresponding to each monitored parameter are shown in the table below.

序号 No.	参数名称 Parameter	传感器类型 Sensor type	输出信号 Output signal	建议报警点 Alarm setpoint	建议停机点 Shutdown setpoint
1	前轴承温度 Front bearing temperature	PT100	4-20mA	80℃	95℃
2	后轴承温度 Rear bearing temperature	PT100	4-20mA	80℃	95℃
3	电机 A 相温度 Motor phase A temperature	PT100	4-20mA	135℃(H 级绝缘 Class H insulation)	140℃(H 级绝缘 Class H insulation)
4	电机 B 相温度 Motor phase B temperature	PT100	4-20mA	135℃(H 级绝缘 Class H insulation)	140℃(H 级绝缘 Class H insulation)
5	电机 C 相温度 Motor phase C temperature	PT100	4-20mA	135℃(H 级绝缘 Class H insulation)	140℃(H 级绝缘 Class H insulation)
6	前轴承(或垂直方向) 振动 Front bearing vibration (or vertical direction)	压电式加速度 传感器 Piezoelectric accelerometer	4-20mA	7.1mm/s	11mm/s
7	后轴承(或水平方向) 振动 Rear bearing vibration (or horizontal direction)	压电式加速度 传感器 Piezoelectric accelerometer	4-20mA	7.1mm/s	11mm/s

注：1) “前轴承”指电机（A式风机）或主轴（非A式风机）上靠近叶轮的轴承，“后轴承”则为同一轴上远离叶轮的轴承。每个轴承的通常监测前、后轴承在垂直方向的振动，或前轴承的垂直、水平两个方向的振动，如果成本允许也可监测前后轴承的垂直、水平、轴向振动；2) “电机相温度”的报警点与停机点设置与其绝缘等级相关，其他环境下使用的见其电机手册。

Note: 1) "Front bearing" refers to the bearing closest to the impeller on the motor (for Type A fans) or on the shaft (for non-Type A fans), while "rear bearing" refers to the bearing farthest from the impeller on the same shaft. Typically, vibration is monitored in the vertical direction for both front and rear bearings, or in both vertical and horizontal directions for the front bearing. If cost permits, vibration in the vertical, horizontal, and axial directions may also be monitored for both front and rear bearings. 2) The alarm and shutdown setpoints for "motor phase temperature" depend on its insulation class. For other environmental conditions, refer to the motor manual.

4.5.3 线路防护：强弱电分离敷设，避免电磁干扰，必要时加装金属隔板；采用金属槽管安装时全程必须可靠接地，连接处不得有尖锐突出；各处密封处理，防止老鼠、蟑螂等小动物进入进行破坏。

Cable protection: Power and control cables shall be routed separately to prevent electromagnetic interference (EMI). Install metal partitions if necessary. When installing with metal conduits, the entire line must be reliably grounded and there must be no sharp protrusions at the connection points; Seal all areas to prevent small animals such as rats and cockroaches from entering and causing damage.

4.6 冷却水接通 Cooling water connection

对于采用水冷的轴承座，接入的冷却水一般为自来水，进水温度 $\leq 32^{\circ}\text{C}$ ，进水压力 0.2-0.3MPa，管径应不小于轴承座的进出口尺寸。

For bearing housing equipped with water cooling, the cooling water supplied shall be ordinary tap water. The inlet water temperature shall be $\leq 32^{\circ}\text{C}$, and the inlet water pressure shall be 0.2-0.3 MPa. The pipe diameter shall not be smaller than the inlet/outlet connection size of the bearing housing.

4.7 户外工作风机防护 Protection For Outdoor Operating Fan

对于户外工作的风机应该采取必要的防雨和防晒措施。如果用户没有向供应商定制防雨和防晒设备，用户应该自行解决风机的防雨和防晒问题。否则，雨水进入润滑油会造成乳化（白色的乳状液），导致轴承锈蚀和磨损，从而加速轴承的损坏；太阳暴晒会导致电机和风机的轴承温升过高，降低轴承的寿命。

Necessary rain and sun protection measures should be taken for outdoor operating fans. If the user does not order rain and sun protection equipment from the supplier, the user should provide the rain and sun protection for the fan on their own. Otherwise, rainwater entering the lubricating oil may cause emulsification (a milky, white emulsion), leading to bearing corrosion and wear, thereby accelerating bearing damage; Sun exposure can cause excessive temperature rise in the bearings of motors and fans, reducing bearing lifespan.

4.8 装后整备 Post-assembly Finishing

包括但不限于以下工作：

Including but not limited to the following:

1) 润滑油脂加注：润滑点包括电机、轴承座等处的轴承，具体按“7.润滑指引”进行；

Grease/oil filling: Lubrication points include bearings of the motor, bearing housing, etc. Refer to Section 7 "Lubrication Guide" for details;

2) 清洁被污染风机表面；

Clean any contaminated surfaces of the fan;

3) 清走风机内部的杂物和安装工具。

Remove debris and installation tools from inside the fan.

4.9 常用螺栓联接预紧力 Preload for Common Bolted Connections

1) 主轴轴端紧固螺栓扭矩表 Torque table for fastening bolts at the shaft end:

规格 Specification	扭矩 Torque (N · m)	规格 Specification	扭矩 Torque (N · m)
M5	6	M12	50
M6	6	M16	120
M8	15	M20	180
M10	30		

2) 碳钢 8.8 级螺栓扭矩表 Torque table for Grade 8.8 carbon steel bolts:

规格 Specification	扭矩 Torque (N · m)	规格 Specification	扭矩 Torque (N · m)
M3	1-1.3	M16	189-252
M4	2.4-3.2	M18	260-347
M5	5-6.8	M20	369-492
M6	9-12	M22	502-669
M8	22-29	M24	638-850
M10	44-58	M27	933-1244
M12	76-102	M30	1267-1689
M14	121-162	M36	2214-2952

3) 不锈钢 (A2-70) 常用螺栓扭矩表 Torque table for common stainless steel bolts (A2-70)

规格 Specification	扭矩 Torque (N · m)	规格 Specification	扭矩 Torque (N · m)
M3	1.0-1.4	M8	21.1-28.8
M4	2.5-3.4	M10	42.9-58.5
M5	5.1-7	M12	72.6-99
M6	8.5-11.7	M16	191.4-261

注明：1) 如表中的扭矩未能把螺栓拧紧，可适当把扭矩加大；2) 叶轮轮毂锁紧、主轴端盖安装、轴承座紧固、进出口法兰连接、机壳上下中分面组合、电机底座固定、传动护罩固定和减振支座固定等处的

受力关键螺栓，在安装后应沿螺栓头与贴合面涂刷连贯防松对位标线记号，以便日后巡检时能直观查验松动情况。

Note: 1) If the bolt cannot be properly tightened using the torque value listed in the table, the torque may be increased appropriately. 2) For critical load-bearing bolts used in the following applications: impeller hub locking, shaft end cover installation, bearing housing fastening, inlet/outlet flange connections, assembly of split casing along the horizontal centerline, motor base fixing, drive guard fixing, and vibration isolator support fixing — a continuous anti-loosening alignment mark shall be painted across the bolt head and the mating surface after installation. This will allow any loosening to be visually detected during future inspections.

5. 试运转 Trial Operation

5.1 优先遵循规范 Priority Specifications

1) GB 50275-2010 风机、压缩机、泵安装工程施工及验收规范 Code for construction and acceptance of fan, compressor and pump installation;

2) ISO 12499:1999 Industrial fans - Mechanical safety of fans - Guarding;

3) JB/T 10563-2006 一般用途离心通风机 技术条件 Technical specification for general purposes centrifugal fans;

4) ISO 10816-1:2018 Mechanical vibration - Evaluation of machine vibration by measurements on non-rotating parts;

5) GB/T 2888-2008 风机和罗茨鼓风机噪声测量方法 Methods for measuring noise for fans blowers compressors and Roots blowers;

6) JB/T 8689-2014 通风机振动检测及其限值 Fan vibration detection and its limits value;

7) GB/T 10178-2006(ISO5802:2001,IDT) 工业通风机 现场性能试验 Industrial fans-Performance testing in situ.

5.2 开机前检查 Pre-startup Inspection

1) 复查确认前述安装工作已经完成并符合规定要求，包括但不限于：

Recheck to confirm that the aforementioned installation work has been completed and meets the specified requirements, including but not limited to:

➤ 手动盘车：打开检修门，用手或工具扳动叶轮、电机尾部或带轮 2-3 转，确认叶轮转动灵活、叶片与机壳间的间隙均匀。操作时注意人身安全，不可让衣袖、头发及其它异物卷入旋转部件中；完成盘车后应及时关闭检修门；

Manual barring: Open the inspection door, and manually rotate the impeller, motor rear end, or pulley by hand or with a tool for 2-3 revolutions. Confirm that the impeller rotates smoothly and that the clearance between the blades and casing is uniform. During operation, ensure that sleeves, hair, or other foreign objects do not get caught in rotating parts. Close the inspection door promptly after barring;

➤ 各风机整机、安全保护附件以及减振器固定件等紧固件安装可靠、没有松动现象；

The fasteners on the Fan unit, safety protection accessories and vibration isolator fasteners are securely installed without any looseness;

➤ 电机及轴承座处的轴承已经进行了充足的润滑，轴承座采用水冷时已接通冷却水；

The bearings of the motor and bearing housing have been adequately lubricated. If the bearing housing uses water cooling, the cooling water supply has been connected;

➤ 风机和风管系统联接处已密封好；

The connection between the fan and the duct system has been sealed;

➤ 电气线路连接正确、仪器仪表完好。

The electrical wiring is properly connected and the instruments are in good condition.

2) 检查确认风机内部及前后风管内没有杂物、人员已到达风机和风管外的安全位置；

Check and confirm that there is no debris inside the fan and in the upstream and downstream ducts, and that personnel are in a safe location away from the fan and ducts;

3) 复测确认电机的绝缘电阻达标;

Retest to confirm that the insulation resistance of the motor meets the standard;

4) 确认风机进、出口风阀 (如有) 动作正常, 且进口风阀关闭、出口风阀全开; 进口带盘式消声器时, 应先使消声器间隙调整最小 (待启动后才调整该间隙至用户负荷为止)。

Confirm that the inlet and outlet dampers of the fan (if any) operate properly, and the inlet damper shall generally be fully closed and the outlet damper fully open. If a disc-type silencer is installed at the inlet, first adjust the silencer gap to the minimum setting (the gap shall be readjusted to the user's load requirement only after the fan has started).

5.3 电控箱柜通电 Electrical Cabinet Power-On

1) 检查确认电源电压和频率值、信号显示、仪表参数设置和上下游通讯等正常;

Check and confirm that the power supply voltage and frequency values, signal display, instrument parameter settings, and upstream and downstream communication are normal;

2) 控制和保护参数设置 Control and protection parameter settings :

➤ 过载电流一般设为风机铭牌电流的 1.05 倍, 防止电机在启动时电流过大或在意外情况下超载烧坏电机;

Overload current shall normally be set at 1.05 times the rated current on the fan nameplate to prevent the motor from burning out due to excessive current at startup or overload in an unexpected situation;

➤ 11kW 及以下可采用直接启动;

Direct start is available for 11kW and below;

➤ 采用软起动器控制时, 一般启动电流 $3.0 \sim 4.0 I_n$ (I_n 为电机额定电流), 风机的功率越大、压力系数越大, 该值越大, 具体参考软启动器的操作手册;

When a soft starter is used, the starting current is typically $3.0 \sim 4.0 I_n$ (I_n = motor rated current). The larger the fan power and pressure coefficient, the higher the starting current. Refer to the soft starter operation manual for details.

➤ 采用变频器控制时, 一般启动加速斜坡时间 $10 \sim 40s$ (频率从 $0 \sim 50Hz$), 风机的功率越大、压力系数越大, 该值越大, 具体参考变频器的操作手册。

When a variable frequency drive (VFD) is used, the acceleration ramp time is typically $10 \sim 40 s$ (frequency from $0 \sim 50 Hz$). The larger the fan power and pressure coefficient, the longer the ramp time. Refer to the VFD operation manual for details.

3) 在线监测系统的设置见 4.5.2。

For online monitoring system settings, refer to Section 4.5.2.

5.4 运转及监测 Operation & Monitoring

1) 点动风机: 查看风机的气流方向和叶轮的旋转方向是否与风机铭牌上的箭头标记一致(如图 12 所示的叶轮旋向为: 人站在进风口朝叶轮看去, 叶轮逆时针旋转), 否则须任意交换进入电机的两相电源线的位置, 然后重试机;

Jog the fan: Check if the airflow direction and impeller rotation direction match the arrows on the fan nameplate (for the impeller rotation shown in Figure 12: when viewed from the inlet toward the impeller, the impeller rotates counterclockwise). If not, swap any two of the three-phase power leads to the motor, then restart the fan;

2) 启动风机, 各部分应无异常现象和摩擦声响;

Start the fan; all parts shall be free from abnormal conditions and friction noise;

3) 风机达到正常转速后, 应在进口风阀开度为 $0^\circ - 5^\circ$ 时进行小负荷运转;

After the fan starts and reaches the normal speed, it shall run under small load with the inlet damper opening at $0^\circ - 5^\circ$;

4) 小负荷运转正常后, 应逐渐开大进口风阀, 但电机电流不得超过额定值, 直至规定的负荷, 连续运转时间不应少于 120min;

After the small-load operation is normal, the inlet damper shall be gradually opened, but the motor

current shall not exceed the rated value until the specified load is reached, the continuous operation time shall not be less than 120 minutes;

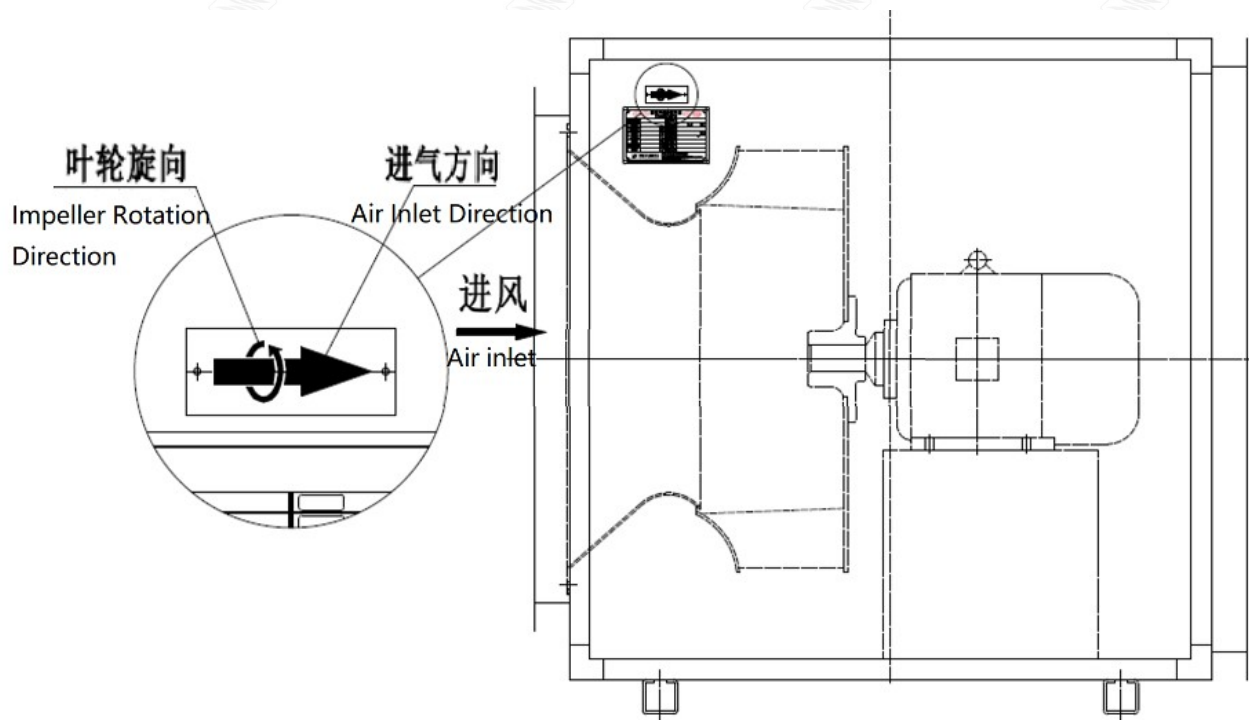


图 12 风机方向指示

Figure 12 Fan direction indicator

5) 高温风机进行高温试运转时, 其升温速率不应大于 $50^{\circ}\text{C}/\text{h}$; 进行冷态试运转时, 其电机不得超负荷运转;

For high-temperature fans during high-temperature trial operation, the heating rate shall not exceed $50^{\circ}\text{C}/\text{h}$; during cold trial operation, the motor shall not operate under overload;

6) 试运转中应执行以下监测并记录实测的数值备查:

During trial operation, the following monitoring shall be performed, and the measured values shall be recorded for future reference:

➤ 检查轴承温度: 轴承温升不得大于 40°C , 表温不得大于 80°C (耐高温或进口轴承除外);

Check if the bearing temperature: the temperature rise of the bearing should not exceed 40°C , and the surface temperature should not exceed 80°C (except for high-temperature resistant or imported bearings);

➤ 检查轴承处的振动速度有效值: 一般刚性支承 $\leq 4.6\text{mm/s}$ 、挠性支撑 $\leq 7.1\text{mm/s}$, 或按订货要求;

Check if RMS vibration velocity at the bearing: generally, for rigid support, it should be $\leq 4.6\text{mm/s}$, and for flexible support, it should be $\leq 7.1\text{mm/s}$, or as per the order requirements;

➤ 检测风机转速和电机电流: 转速应达到正常, 电机电流不得超过其额定值;

Check fan speed and motor current: the speed shall reach the normal, and the motor current shall not exceed its rated value;

➤ 如发现风机有剧烈的振动 (轴承处振动速度有效值超过 11mm/s)、撞击、轴承温度迅速上升等反常现象时, 必须紧急停机, 予以排除。

If the fan shows severe vibration (RMS vibration velocity at the bearing exceeds 11mm/s), impact, or a rapid increase in bearing temperature and other abnormal phenomena, it must be shut down immediately to eliminate the problem. There should be no abnormal shaking.

7) 轴承座采用水冷时, 应检查冷却部分是否正常, 冷却出水温度是否过高。

For water-cooled bearing housing, check that the cooling system is functioning properly and that the cooling water outlet temperature is not excessively high.

8) 带变频器调节的风机, 用户在变频调速的过程中应注意不要超过风机配用电机的额定功率值, 应在

给定的变频性能参数范围内的进行调频使用。

For fans with variable frequency drive(VFD), users shall not exceed the rated power value of the motor used with the fan during variable frequency speed regulation and should operate within the specified VFD performance range.

5.5 特别提醒 Special Reminders

由于风机在本环节最容易发生问题，对于海外等距离较远或重要项目，用户或调试单位如可能应邀请本公司或授权人员在现场或远程视频见证，否则应进行开机前检查至调试结束的全程录像，并将录像保存到项目验收后以备查证。

Since the fan is most prone to problems at this stage, for overseas or other distant or critical projects, the user or commissioning unit should, if possible, invite our company or authorized personnel to witness on-site or remotely via video; otherwise, the entire process from pre-startup inspection to commissioning completion should be video-recorded and saved for verification after project acceptance.

6. 使用和维护 Operation and Maintenance

6.1 优先遵循规范 Priority Specifications

- 1) GB/T 13470-2008 通风机系统经济运行 Economic operation for the fan system;
- 2) ISO 5802:2001 Industrial fans - Performance testing in situ;
- 3) GB/T 41973-2022 工业通风机 平衡品质与振动等级规范 Industrial fans - Specifications for balance quality and vibration levels;
- 4) ISO 14694:2003 Industrial fans - Specifications for balance quality and vibration levels;
- 5) GB 50275-2010 风机、压缩机、泵安装工程施工及验收规范 Code for construction and acceptance of fan, compressor and pump installation;
- 6) JB/T 10563-2006 一般用途离心通风机 技术条件 Technical specification for general purposes centrifugal fans;
- 7) GB 50254-2014 电气装置安装工程 低压电器施工及验收规范 Code for construction and acceptance of low-voltage apparatus Electric equipment installation engineering;
- 8) IEC 60335-1:2021 Household and similar electrical appliances - Safety - Part 1: General requirements;
- 9) JB/T 6886-2010 通风机 涂装技术条件 Technical specification for draught fan application;
- 10) ISO 12499:1999 Industrial fans - Mechanical safety of fans - Guarding;
- 11) ISO 9001:2015 Quality management systems - Requirements.

6.2 总体原则 General Principles

1) 通电运转前应按执行前述的“5.2 开机前检查”，只有风机及辅助设备完全正常的情况下才能投入自动运行。

The "5.2 Pre-startup Inspection" mentioned above should be carried out before power-on operation. Automatic operation shall only be initiated when the fan and auxiliary equipment are in full normal condition.

2) 运转中应定期监测，当出现振动剧烈、轴承温升过高、电机电流过大、较大异响时应立即停机检查，禁止带病运行。

During operation, regular monitoring shall be carried out. When severe vibration, excessive temperature rise of the bearing, excessive motor current or significant abnormal noise occur, the machine shall be stopped immediately for inspection. It is strictly prohibited to operate with defects.

3) 电机部分优先按其出厂随机手册的规定执行。

The motor section shall follow its provisions in factory supplied manual first.

4) 在风机开机、停机或运转过程中，如发现不正常现象时应立即检查，对检查发现的小故障应查明原因并设法消除，如发现大故障应立即停机全面检查（如果无法解决，可以联系供应商指导解决）。

During the start-up, shutdown or operation of the fan, if any abnormality is found, an immediate inspection shall be carried out. For minor faults found during the inspection, the cause shall be identified

and eliminated. If a major fault is found, the fan shall be stopped immediately for a comprehensive inspection (if it cannot be resolved, contact the supplier for guidance).

5) 当环境温度 $\leq 0^{\circ}\text{C}$ 需较长时间停机时, 水冷轴承座(如有)须排尽其中的循环水以免发生冻裂。

When shutting down for a long time at an ambient temperature $\leq 0^{\circ}\text{C}$, drain all circulating water from the water-cooled bearing housing (if any) to prevent freezing and cracking.

6) 定期维保必不可少, 包括加注润滑油脂、清理叶轮表面杂物、定期张紧或更换皮带(如有)等。

Regular maintenance is essential, including filling lubricating grease, removing debris on the impeller surface, and regularly tensioning or replacing the belt (if any).

7) 严禁长期静置不运转, 否则会造成轴承卡死、轴弯叶轮变形、电机受潮烧损、机构卡涩等。

It is strictly prohibited to keep the fan idle for a long time without rotation, as this may cause the bearings to seize up, the shaft to bend, the impeller to deform, the motor to become damp and burn out, and the mechanism to become stuck.

6.3 监测维保建议表 Monitoring & Maintenance Recommendation Table

序号 No.	项目 Item	周期 Frequency	使用工具 Tools Used	操作方法 Operation Method	合格判定标准 Acceptance Standard	异常处置要求 Abnormal Disposal Requirement
1	风机运行核心状态监测 Fan Operation Core Status Monitoring	每日不少于 1 次 No less than once a day	钳形电流表、便携式测振仪、红外测温枪、耳听 / 手感 Clamp ammeter, portable vibration meter, infrared thermometer, , and sensory inspection (hearing and touch)	1. 风机额定工况运行时, 实时监测电机三相运行电流 2. 检测轴承位垂直 / 水平方向振动速度 3. 测量电机轴承端盖温升, 监听运转异响 4. 目视检查各部件有无松动、移位 1. Monitor the three-phase operating current of the motor in real time when the fan is running under rated conditions 2. Measure the vibration velocity at bearing positions in vertical/horizontal directions 3. Measure the temperature rise of the motor bearing end cover and listen for abnormal noise 4. Visually check for looseness and displacement of all parts	1. 电机运行电流不超额定值, 三相电流平衡 2. 轴承位振动速度有效值合格(刚性支撑 $\leq 4.6\text{mm/s}$ 、挠性支撑 $\leq 7.1\text{mm/s}$, 或按订货要求), 无异常抖动 3. 轴承温升 $\leq 40^{\circ}\text{C}$, 无金属摩擦声、周期性异响 4. 各部件无松动、无移位 1. Motor operating current does not exceed the rated value, three-phase current is balanced 2. The RMS vibration velocity at bearing positions must be qualified (rigid support $\leq 4.6\text{mm/s}$, flexible support $\leq 7.1\text{mm/s}$, or as per the order requirements), and there should be no abnormal shaking. 3. Bearing temperature rise $\leq 40^{\circ}\text{C}$, no metal friction sound or periodic abnormal noise	1. 电流持续超标、振动超阈值、温升超上限、出现较大异响时, 立即执行紧急停机 2. 部件松动立即停机紧固, 确认无异常后方可重启 1. Execute emergency stop immediately when current continues to exceed limit, vibration exceeds threshold, temperature rise exceeds upper limit, or loud abnormal noise occurs 2. Stop the machine immediately to tighten loose parts, and restart only after confirming no abnormality

序号 No.	项目 Item	周期 Frequency	使用工具 Tools Used	操作方法 Operation Method	合格判定标准 Acceptance Standard	异常处置要求 Abnormal Disposal Requirement
					4. All parts are free from looseness or displacement	
2	运行环境与电气巡检 Operating Environment & Electrical System Inspection	每日不少于 1 次 No less than once a day	万用表、目视巡检工具 Multimeter, visual inspection tools	1. 检测供电电源电压、频率是否符合额定要求 2. 检查电控柜有无故障报警、异常指示灯亮 3. 监听风管内部有无杂物撞击、气流异响 4. 查风机周边有无水浸、淋雨、杂物堆积、安全遮挡 1. Verify that the power supply voltage and frequency meet the rated requirements 2. Check for any fault alarm or illuminated abnormal indicator on the electric control cabinet. 3. Listen for foreign objects impacting or abnormal airflow noise inside the duct. 4. Check for water ingress, rain, debris accumulation and safety obstructions around the fan	1. 电源电压、频率在额定允许波动范围内 2. 电控柜无故障报警、无异常发热、无异味 3. 风管内部无杂物撞击声、无气流紊流异响 4. 风机周边无积水、无直淋雨、无杂物堆积、无安全隐患 1. Power supply voltage and frequency are within the rated allowable fluctuation range 2. No fault alarm, abnormal heating or peculiar smell in the electric control cabinet 3. No foreign object impact sound or abnormal noise caused by airflow turbulence inside the air duct. 4. No ponding, direct rain, debris accumulation or safety hazards around the fan	1. 电源异常、电控柜故障报警时,立即停机排查电气隐患 2. 风管内杂物异响时,停机清理风道 3. 周边有积水、淋雨隐患时,立即采取防水遮挡措施 1. Stop the machine immediately to check for electrical faults when power supply is abnormal or control cabinet has fault alarm. 2. Stop the machine to clean the air duct when there is abnormal noise from foreign objects inside 3. Take waterproof shielding measures immediately when there is ponding or rain hazard around the fan.
3	叶轮与机壳内部月度检查 Monthly Inspection of Impeller & Casing Interior	每月至少 1 次 No less than once a month	手电、高压气枪、毛刷、目视工具 Flashlight, high-pressure air gun, brush, visual tools	1. 停机断电后,打开检修门或观察窗检查叶轮表面状态 2. 清理叶轮表面积尘、油污、杂物附着物 3. 检查机壳内部有无积水、杂物堆积 4. 目视检查叶轮有无变形、叶片缺损 1. After the fan is shutdown and power off,	1. 叶轮表面洁净,无积尘、无油污、无杂物附着 2. 机壳内部无积水、无杂物堆积、无锈蚀 3. 叶轮无明显变形、叶片完好无缺损、无裂纹 1. The impeller surface is clean, free of dust, oil and adhered foreign matter 2. No water	1. 叶轮有明显变形、叶片缺损时,立即停机更换叶轮 2. 机壳内有积水、杂物时,彻底清理并排查进水原因 3. 叶轮结垢严重时,拆解彻底清洗 1. Stop the fan immediately to replace the impeller

序号 No.	项目 Item	周期 Frequency	使用工具 Tools Used	操作方法 Operation Method	合格判定标准 Acceptance Standard	异常处置要求 Abnormal Disposal Requirement
				check the impeller surface condition through the inspection door or sight window 2. Clean dust, oil and adhered debris on the impeller surface 3. Check for water accumulation and debris accumulation inside the casing 4. Visually check for impeller deformation and blade damage	accumulation, debris accumulation or corrosion inside the casing 3. No obvious deformation of the impeller, the blades are intact without damage and cracks	when there is obvious deformation or blade damage 2. Thoroughly clean out water and debris in the casing and check the cause of water inflow 3. Disassemble and thoroughly clean the impeller when the scaling is serious
4	控制与保护装置月度校验 Monthly Verification of Control & Protection Devices	每月至少 1 次 No less than once a month	万用表、绝缘摇表、目视工具 Multimeter, megohm meter, visual tools	1. 测试启停按钮、操作按钮是否灵活、动作正常 2. 检查电源、运行、故障指示灯是否工作正常、显示准确 3. 校验过载保护、短路保护、漏电保护装置是否齐全、动作灵敏可靠 4. 检查监控仪表设置是否正确、显示数值是否准确 1. Test whether the start-stop button and operation button are flexible and operate normally 2. Check whether the power supply, operation and fault indicator lights work normally and display accurately 3. Verify whether the overload protection, short circuit protection and leakage protection devices are complete and operate sensitively and reliably 4. Check whether the	1. 所有按钮操作灵活、动作正常，无卡涩、无失灵 2. 指示灯工作正常，与实际运行状态一致 3. 所有保护装置齐全、参数设置正确，动作灵敏可靠 4. 监控仪表显示准确，与实测数值偏差在允许范围内 1. All buttons are flexible in operation and normal in action, no jamming or no failure 2. The indicator lights work normally and are consistent with the actual operating state 3. All protection devices are complete, parameter settings are correct, and the action is sensitive and reliable 4. The monitoring instrument display is accurate, and the deviation from the	1. 按钮失灵、指示灯异常时，立即停机更换损坏元件 2. 保护装置动作失灵、参数错误时，立即停机整改，校验合格后方可重启 3. 仪表显示异常时，立即校准或更换仪表 1. Stop the fan immediately to replace damaged components when the button fails or the indicator light is abnormal 2. Stop the machine immediately for rectification when the protection device fails to operate or the parameter setting is incorrect, and restart only after passing the verification test 3. Calibrate or replace the instrument

序号 No.	项目 Item	周期 Frequency	使用工具 Tools Used	操作方法 Operation Method	合格判定标准 Acceptance Standard	异常处置要求 Abnormal Disposal Requirement
				monitoring instrument settings are correct and the displayed values are accurate	measured value is within the allowable range	immediately when the display is abnormal
5	整机紧固件 季度紧固检查 Quarterly Fastening Inspection of Whole Machine Fasteners	每季度至少 1 次 No less than once a quarter	套筒扳手、 扭矩扳手、 十字螺丝刀 Socket wrench, torque wrench, Phillips screwdriver	1. 停机断电后, 逐一检查地脚螺栓、机壳连接螺栓、风机与电机连接螺栓、密封盖固定螺栓 2. 按标准扭矩逐一复紧所有连接螺栓 3. 检查螺栓、垫圈有无锈蚀、变形、滑牙 1. After the fan is shut down and power is disconnected, check the anchor bolts, casing connecting bolts, fan-motor connecting bolts and seal cover bolts one by one 2. Retighten all connecting bolts one by one according to the standard torque 3. Check for corrosion, deformation or stripped threads of bolts or washers	1. 所有螺栓紧固无松动, 扭矩符合设备标准要求 2. 螺栓、垫圈无锈蚀、无变形、无滑牙、无缺损 3. 各连接部位贴合紧密, 无移位、无松动异响 1. All bolts are fastened without looseness, and the torque meets the equipment standard requirements 2. No corrosion, deformation, stripped threads or damage of bolts and washers 3. All connecting parts are closely fitted, no displacement and no loose abnormal noise	1. 螺栓松动、扭矩不达标时, 立即按标准复紧 2. 螺栓锈蚀、变形、滑牙时, 立即更换同规格全新螺栓 3. 连接部位移位时, 立即停机校正复位 1. Retighten immediately according to the standard when the bolts are loose or the torque is not up to standard 2. Replace with new bolts of the same specification immediately when the bolts are corroded, deformed or stripped 3. Stop the fan immediately to correct and reset when the connecting part is displaced
6	叶轮季度深度停机检查 Quarterly In-depth Shutdown Inspection of Impeller	每季度至少 1 次 No less than once a quarter	手电、直尺、手动盘车工具、目视工具 Flashlight, straight ruler, manual barring tool,	1. 停机断电后, 拆解风口, 全面检查叶轮叶片、轮盘、焊缝 / 铆钉 2. 检查叶片有无磨损、裂纹、变形、点蚀 3. 重点检查焊缝、铆钉有无开焊、松动、脱落 4. 手动盘车 360°, 感受叶轮转动是否平稳、有无卡涩、擦壳 1. After the fan is shut down and power is disconnected, disassemble the air outlet and comprehensively check the impeller blades, wheel disc, welds / rivets 2. Check the blades for wear, cracks, deformation, pitting 3. Focus on checking the welds, rivets for open welds, looseness, and falling off 4. Manually rotate the fan 360°, feel whether the impeller rotation is smooth, whether there is sticking or rubbing 1. No wear, cracks, deformation, pitting or damage on the blades	1. 叶片无磨损、无裂纹、无变形、无点蚀、无缺损 2. 焊缝、铆钉无开焊、无松动、无脱落, 连接牢固 3. 手动盘车转动平稳, 无卡涩、无擦壳、无偏摆 1. No wear, cracks, deformation, pitting or damage on the blades 2. Welds, rivets are not open, no looseness, no falling off, connection is firm 3. Manually rotate the fan smoothly, no sticking, no rubbing, no deviation	1. 叶片有裂纹、变形、严重磨损时, 立即停机更换叶轮 2. 焊缝开焊、铆钉松动时, 立即停机整改, 修复后做动平衡校验 3. 盘车有卡涩、擦壳时, 立即停机排查原因, 校正间隙 1. Stop the fan immediately when the blades have cracks, deformation, or serious wear and replace the impeller 2. When the welds are open or rivets are loose, stop the fan immediately for rectification, and perform dynamic balance calibration after repair 3. When there is sticking or rubbing during rotation, stop the fan immediately to check the cause and adjust the clearance

序号 No.	项目 Item	周期 Frequency	使用工具 Tools Used	操作方法 Operation Method	合格判定标准 Acceptance Standard	异常处置要求 Abnormal Disposal Requirement
			visual tools	1. After the fan is shut down and power is disconnected, disassemble the air outlet and fully inspect the impeller blades, discs, welds/rivets 2. Check for wear, cracks, deformation and pitting of the blades 3. Pay special attention to welds and rivets. Check for weld cracks, as well as looseness or detachment of both welds and rivets. 4. Manually bar the impeller 360° (rotate by hand) to check for smooth rotation and to detect any jamming or rubbing against the casing.	2. No weld cracking, looseness or detachment, the connection is firm 3. Manual barring rotates smoothly, no jamming, no casing rub and no deflection	immediately to replace the impeller when the blades have cracks, deformation or severe wear 2. Stop the fan immediately for rectification when the weld is cracked or the rivet is loose, and perform dynamic balance verification after repair 3. Stop the machine immediately to check the cause and correct the clearance when there is jamming or casing rub during barring
7	轴承季度状态检查 Quarterly Status Inspection of Bearing	每季度至少 1 次 No less than once a quarter	手动盘车工具、耳听棒、测温枪 Manual barring tool, stethoscope, infrared thermometer	1. 停机断电后，手动盘车 360°，感受轴承转动是否灵活、有无卡涩、异响 2. 用耳听棒贴紧轴承端盖，监听轴承内部有无金属摩擦声、沙沙异响 3. 测量轴承端盖静态温度，检查有无异常发热 1. After the fan is shut down and power is disconnected, manually bar the shaft 360° to check whether the bearing rotates smoothly and to detect any jamming or abnormal noise. 2. Press the stethoscope to the bearing end cover and listen for metal friction sound or rustling abnormal noise inside the	1. 手动盘车轴承转动灵活，无卡涩、无卡顿、无异常阻力 2. 轴承内部无金属摩擦声、无周期性异响、无沙沙杂音 3. 轴承端盖无异常发热，温度与环境温度偏差在正常范围内 1. The bearing rotates smoothly during manual barring, no jamming, no sticking or no abnormal resistance 2. No metal friction sound, periodic abnormal noise or rustling noise inside the bearing 3. No abnormal heating of the bearing end	1. 轴承转动卡涩、有异响时，立即停机更换电机免维护轴承 2. 轴承有异常发热时，立即停机排查原因，必要时更换轴承 3. 严禁拆解免维护轴承加注润滑脂，故障直接整体更换 1. Stop the fan immediately to replace the motor maintenance-free bearing when the bearing rotates with jamming or abnormal noise 2. Stop the machine immediately to check the cause when the bearing shows

序号 No.	项目 Item	周期 Frequency	使用工具 Tools Used	操作方法 Operation Method	合格判定标准 Acceptance Standard	异常处置要求 Abnormal Disposal Requirement
				bearing 3. Measure the static temperature of the bearing end cover and check for abnormal heating	cover, the temperature deviation from the ambient temperature is within the normal range	abnormal heating, and replace the bearing if necessary 3. It is strictly prohibited to disassemble the maintenance-free bearing for greasing, and replace the whole assembly directly in case of failure
8	电机绝缘电阻季度检测 Quarterly Test of Motor Insulation Resistance	每季度至少 1 次 No less than once a quarter	500V 绝缘摇表、万用表、端子清洁工具 500V megohm meter, terminal cleaning tool	1. 停机断电后，拆除电机三相接线，清理接线端子氧化、受潮霉斑 2. 用 500V 绝缘摇表检测电机绕组对地绝缘电阻 3. 检测三相绕组之间的绝缘电阻，记录检测数据 1. After the fan is shut down and power is disconnected, remove the three-phase wiring of the motor, and clean oxidation, moisture, and mildew from the terminals 2. Test the insulation resistance of the motor winding to the ground with a 500V megohmmeter 3. Test the insulation resistance between the three-phase windings and record the test data	1. 电机绕组对地绝缘电阻 $\geq 0.5\text{M}\Omega$ ，或符合电机安装与维护手册规定值 2. 三相绕组之间绝缘电阻平衡，无短路、无接地故障 3. 接线端子洁净无氧化、无受潮霉斑，接线牢固 1. The insulation resistance of the motor winding to the ground is $\geq 0.5\text{M}\Omega$, or meets the specified value in the motor installation and maintenance manual 2. The insulation resistance between the three-phase windings is well balanced, no short circuit or no ground fault 3. The wiring terminals are clean without oxidation or damp mildew, and the wiring is firm	1. 绝缘电阻不达标时，严禁开机，立即对电机进行热风烘干、除湿处理，复测合格后方可投运 2. 绕组短路、接地时，立即停机检修电机，严禁带病运行 3. 端子氧化、受潮时，立即清洁处理，做好绝缘防护 1. Start-up is strictly prohibited when the insulation resistance is non-compliant. Immediately perform hot air drying and dehumidification treatment on the motor, and put it into operation only after passing the retest 2. Stop the fan immediately to repair the motor when the winding is short-circuited or grounded, and operation with defects is strictly

序号 No.	项目 Item	周期 Frequency	使用工具 Tools Used	操作方法 Operation Method	合格判定标准 Acceptance Standard	异常处置要求 Abnormal Disposal Requirement
						prohibited 3. If terminals are oxidized or damp, clean them immediately and ensure proper insulation.
9	叶轮年度深度保养 Annual In-depth Maintenance of Impeller	每年至少 1 次 No less than once a year	动平衡检测仪、拆机工具、直尺、探伤仪 Dynamic balancer, disassembly tools, straight ruler, flaw detector	1. 停机断电后，全面拆解叶轮，彻底清理内部结垢、积尘、锈蚀 2. 全面检测叶轮叶片、轮毂的磨损、腐蚀、裂纹、变形情况 3. 对叶轮进行无损探伤，排查焊缝、母材的内部缺陷 4. 对叶轮进行动平衡校验，校正不平衡量 5. 磨损严重时，更换全新自制叶轮 1. After the fan is shut down and power is disconnected, fully disassemble the impeller and thoroughly clean the internal scaling, dust and corrosion 2. Fully inspect the wear, corrosion, cracks and deformation of the impeller blades and discs 3. Perform non-destructive testing (NDT) on the impeller to check the internal defects of welds and base metal 4. Perform dynamic balance test on the impeller and correct the unbalance 5. Replace with a new self-made impeller when the wear is serious	1. 叶轮洁净无结垢、无锈蚀、无油污 2. 叶轮无严重磨损、无裂纹、无变形，焊缝无内部缺陷 3. 叶轮动平衡校验合格，不平衡量在允许范围内 4. 更换后的叶轮尺寸、参数与原风机完全匹配 1. The impeller is clean without scaling, corrosion or oil stains. 2. No severe wear, cracks or deformation of the impeller, no internal defects in the welds 3. The impeller passes the dynamic balancing test, and the unbalance is within the allowable range 4. The size and parameters of the replacement impeller are completely matched with the original fan	1. 叶轮磨损、腐蚀、裂纹超标时，立即更换全新叶轮 2. 动平衡校验不合格时，立即校正不平衡量，直至合格 3. 叶轮有内部缺陷时，严禁继续使用，立即更换 1. Replace with a new impeller immediately when the wear, corrosion or crack of the impeller exceed the standard 2. Correct the unbalance immediately until the dynamic balancing test is passed 3. It is strictly prohibited to continue to use the impeller with internal defects, replace it immediately

序号 No.	项目 Item	周期 Frequency	使用工具 Tools Used	操作方法 Operation Method	合格判定标准 Acceptance Standard	异常处置要求 Abnormal Disposal Requirement
10	机壳与整机结构年度检修 Annual Overhaul of Casing & Whole Machine Structure	每年至少 1 次 No less than once a year	拆机工具、探伤仪、直尺、焊接工具 Disassembly tools, flaw detector, straight ruler, welding tools	1. 全开机壳，彻底清理内部积尘、结垢、锈蚀、杂物 2. 全面检测机壳内壁的磨损、腐蚀、穿孔、变形情况 3. 对磨损、腐蚀、变形部位进行修补、校正，严重时更换机壳 4. 全面检查机座、支架、地脚的结构强度，加固薄弱部位 1. Fully open the casing and thoroughly clean the internal dust, scaling, corrosion and debris 2. Fully inspect the wear, corrosion, perforation and deformation of the inner wall of the casing 3. Repair and straighten the worn, corroded or deformed parts, and replace the casing when severe 4. Fully inspect the structural strength of the base, bracket and anchor, and reinforce the weak parts	1. 机壳内部洁净无积尘、无结垢、无杂物 2. 机壳无严重磨损、无腐蚀穿孔、无变形，焊缝无内部缺陷 3. 修补后的机壳结构强度达标，密封性能完好 4. 机座、支架、地脚结构牢固，无变形、无锈蚀隐患 1. The inside of the casing is clean without dust, scaling or debris 2. No severe wear, corrosion perforation or deformation of the casing, no internal defects in the welds 3. The structural strength of the repaired casing meets the standard, and the sealing performance is intact 4. The base, bracket and anchor bolts is firm, no deformation or corrosion hazard	1. 机壳腐蚀穿孔、严重变形时，立即修补或更换全新机壳 2. 机座、支架结构薄弱时，立即加固整改，消除安全隐患 1. Repair or replace with a new casing immediately when the casing is corroded, perforated or seriously deformed 2. Reinforce and rectify immediately when the base and bracket structure is weak to eliminate potential safety hazards
11	整机外观防腐美化 Annual Whole Machine Appearance Anti-corrosion & Beautification	每年至少 1 次 No less than once a year	除锈工具、防腐漆、毛刷 Derusting tools, anti-corrosion paint, brush	1. 对风机整机、机壳、电机、支架、地脚的所有表面进行去污、除锈、打磨 2. 对漆面脱落、锈蚀部位进行补漆，必要时整机翻新 1. Decontaminate, derust and polish all surfaces of the fan, casing, motor, bracket and anchor 2. Repair the paint at peeling and rusted areas, and refurbish the whole unit if necessary	1. 表面洁净无油污、无锈蚀、无积尘 2. 漆面完整均匀，无脱落、无鼓包、无露底，防腐性能完好 1. The surface is clean without oil stains, corrosion or dust 2. The paint surface is complete and uniform, no peeling, no bulging, no substrate exposure, or the anti-corrosion performance is intact	整机锈蚀严重、漆面大面积脱落时，立即进行整体防腐翻新 Perform overall anti-corrosion renovation immediately when the whole machine is seriously corroded or the paint surface is largely peeled off

6.4 维保通用要求 General Requirements for Maintenance

1) 所有带电操作、拆机操作必须严格执行断电挂牌上锁安全规程，严禁带电作业、无防护拆机。

All live operations and disassembly operations must strictly follow the Lockout-Tagout (LOTO) safety procedures, and live operations and disassembly without proper safeguards are strictly prohibited.

2) 所有更换的备件必须与原设备型号、规格、材质完全匹配，严禁使用不合格备件。

All replaced spare parts must completely match the model, specification and material of the original equipment, and unqualified spare parts are strictly prohibited.

3) 所有维保工作完成后，必须先进行手动盘车、空载试运行，确认无异常后方可带载投运。

After all maintenance work is completed, manual barring and no-load test run must be carried out first, and the load can be put into operation only after confirming no abnormality.

4) 户外/潮湿环境下应加密绝缘检测、密封检查、防腐保养频次，防止设备受潮、锈蚀、绝缘击穿。

In outdoor/humid environment, the frequency of insulation test, seal inspection and anti-corrosion maintenance must be increased to prevent the equipment from becoming damp, corroding, or experiencing insulation breakdown.

6.5 皮带张紧度调整 Belt tension adjustment

6.5.1 检查操作 Inspection procedure:

1) 在两带轮跨距中点，用弹簧秤或张力指示计施加力，每米跨距挠度 16mm 为合适，如图 13 所示。

At the midpoint of the span between the two pulleys, apply a force using a spring scale or tension indicator. The deflection shall be 16 mm per meter of span, as shown in Figure 13 below.

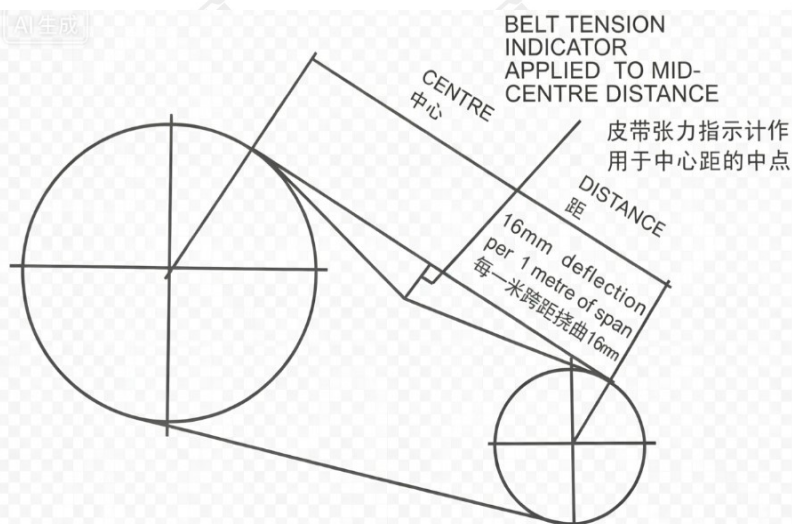


图 13 皮带张紧度检查

Figure 13 Belt tension inspection

2) 施加力的大小依据皮带类型和小皮带轮直径而异，如下表所列：

The applied force varies depending on the belt type and the diameter of the small pulley, as listed in the table below.

类型 Type	小皮带轮直径 Small pulley diameter (mm)	施加力 Applied force (N)
SPZ	56 - 95	13 - 20
	100 - 140	20 - 25
SPA	80 - 132	25 - 35
	140 - 200	35 - 45
SPB	112 - 224	45 - 65
	236 - 315	65 - 85

类型 Type	小皮带轮直径 Small pulley diameter (mm)	施加力 Applied force (N)
SPC	224 - 355	85 - 115
	375 - 560	115 - 150
8V	≥335	150 - 200
Z	56 - 100	5 - 7.5
A(& HA)	80 - 140	10 - 15
B	125 - 200	20 - 30
C	200 - 400	40 - 60
D	355 - 600	70 - 105

6.5.2 调整操作 Adjustment procedure:

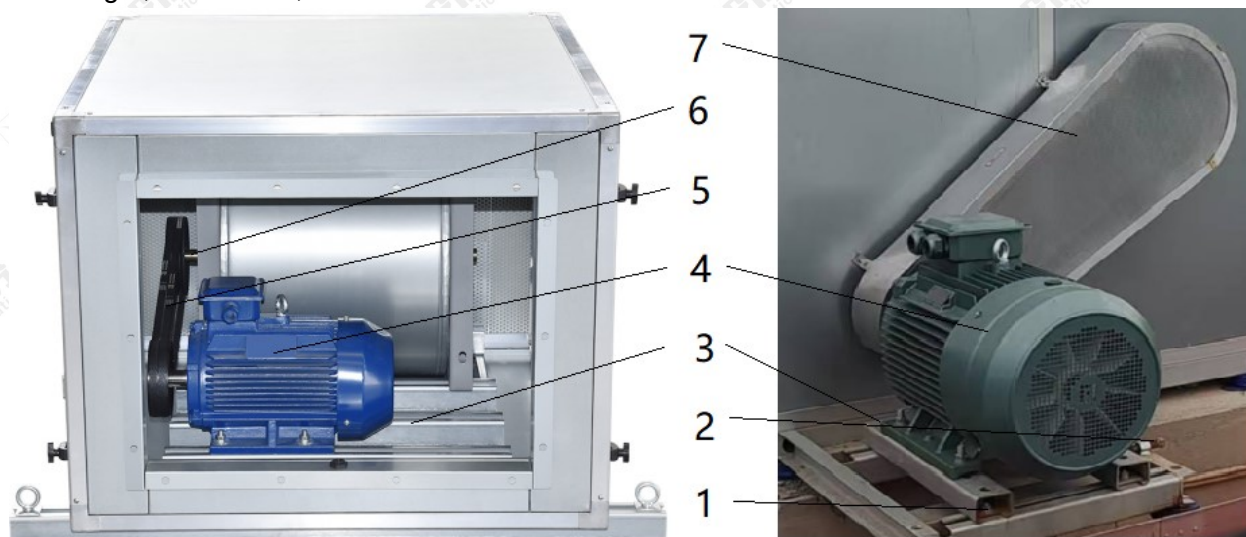
1) 拆去皮带罩 Remove the belt guard;

2) 松开图 14 中电机导轨的固定螺栓（共 4 处，不取下）；

Loosen the fixing bolts of the motor guide rails shown in Figure 14 (4 places, do not remove them);

3) 拧动调节螺杆调整电机导轨位置，从而改变电机和主轴间的中心距。当皮带松时让中心距增大；皮带紧时让中心距减少。

Turn the adjusting screw to move the motor guide rail, thereby changing the center distance between the motor and the main shaft. When the belt is loose, increase the center distance; when the belt is tight, decrease it;



1. 导轨固定螺栓；2. 调节螺杆；3. 电机导轨；4. 电机；5. 皮带；6. 主轴；7. 皮带罩。

1. Guide rail fixing bolts; 2. Adjustment screw; 3. Motor guide rail;
4. Motor; 5. Belt; 6. Main shaft; 7. Belt guard.

图 14 皮带张紧度调整

Figure 14 Belt tension adjustment

4) 按 6.5.1 的方法检查全部皮带张紧度合格，用直尺、拉线或平直的铝材校验校正两带轮端面平齐，然后对角对称锁紧电机导轨的相应固定螺栓；

Check that all belts are properly tensioned according to the method in 6.5.1. Use a straightedge, tension line, or a flat aluminum bar to verify and correct the alignment of the two pulleys so that their end faces are flush. Then tighten the corresponding fixing bolts on the motor guide rail diagonally and symmetrically;

5) 手动盘车，确认无明显卡滞、无过度吃力、不跑偏；

Manually bar the fan to confirm there is no significant sticking, excessive resistance, or belt misalignment;

6) 装回皮带罩, 待风机其他条件具备时通电试运行, 确认皮带运转平稳。

Reinstall the belt guard. When other conditions of the fan are ready, energize and run the fan to confirm that the belts operate smoothly.

6.5.3 当张紧度无法调整时应考虑更换新皮带, 且同一台机全部皮带一般同时更换。

When the tension cannot be adjusted properly, the belts shall be replaced. All belts on the same fan should generally be replaced at the same time.

6.6 叶轮现场拆装 On-site impeller disassembly and reassembly

6.6.1 适用场景: 叶轮因损坏难以在风机上修复或需要更换新轮时。

Applicable scenarios: When the impeller is damaged beyond repair while installed on the fan, or when a new impeller needs to be replaced.

6.6.2 拆卸步骤 Disassembly procedure:

1) 停机断电并悬挂检修警示牌, 确认风机完全停转、释放管路余压;

Shut down the fan, disconnect power, and hang a maintenance warning tag. Ensure the fan has come to a complete stop and release any residual pressure in the duct;

2) 拆除叶轮周边部件以便为拆卸腾出空间, 包括机壳上部(分体机壳适用)、出风口接管、进风口阀门和部分箱体等, 清理机壳内部及作业空间内杂物;

Remove components around the impeller to create sufficient working space, including the upper part of the casing (for split casings), the outlet duct connection, the inlet damper, and part of the box, etc. Clean debris from inside the casing and the working area;

3) 用一较结实的物体(木棒或铁棒)将叶轮固定住, 防叶轮转动;

Secure the impeller with a sturdy object (such as a wooden or iron bar) to prevent it from rotating;

4) 将叶轮托住或用吊索吊起, 保持拆卸过程中叶轮不掉落;

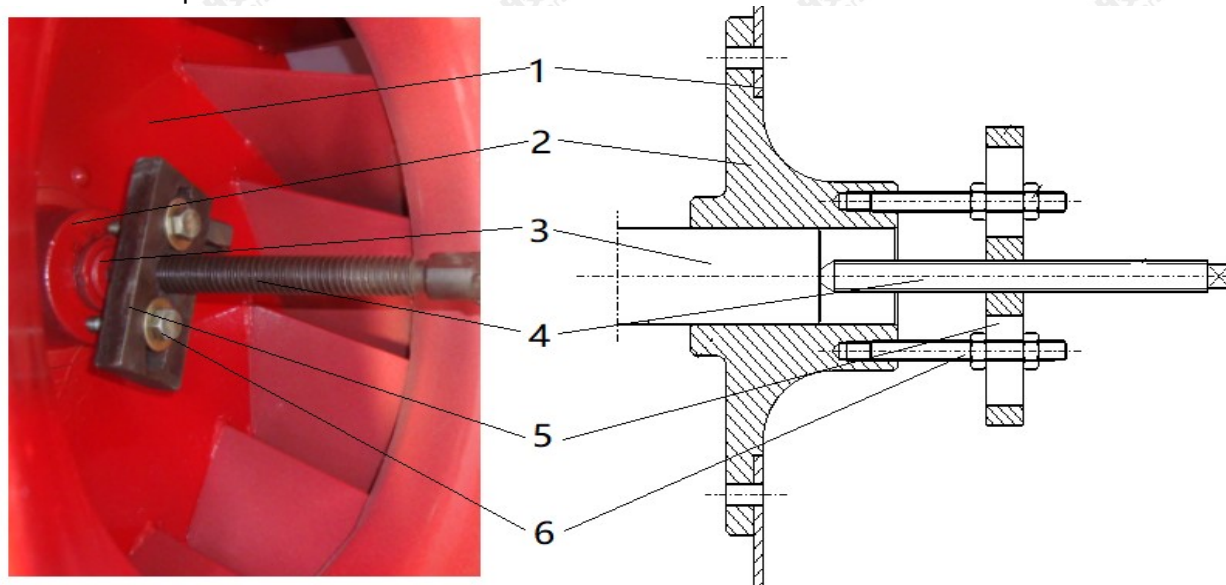
Support the impeller from underneath or lift it with slings to keep it from falling during disassembly;

5) 依次拆下叶轮限位的轴端螺栓或圆螺母、止动垫圈等紧固零件;

Remove the fastening parts that secure the impeller in sequence, including the shaft end bolt(s) or round nut, lock washer, etc. ;

6) 施加轴向拉力将叶轮从主轴轴肩位置缓慢拉出。必要时借助拉马等拆卸工具(如图 15 所示)或加热叶轮轴盘表面使其内孔膨胀完成。

Apply axial pulling force to slowly withdraw the impeller from the shaft shoulder position. If necessary, use a puller (as shown in Figure 15) or heat the surface of the impeller hub to expand its bore to complete the removal.



1. 叶轮后盘; 2. 叶轮轴盘; 3. 主轴; 4. 顶出螺杆; 5. 中板; 6. 固定螺杆。

1. Impeller rear disc; 2. Impeller shaft disc; 3. Main shaft; 4. Ejector screw;

5. Middle plate; 6. Fixing screw.

图 15 叶轮的拆卸

Figure 15 Disassembly of the impeller

6.6.3 安装步骤 Installation procedure:

1) 检查确认预装的叶轮型号规格与风机匹配、叶轮表面状态正常并经平衡合格;

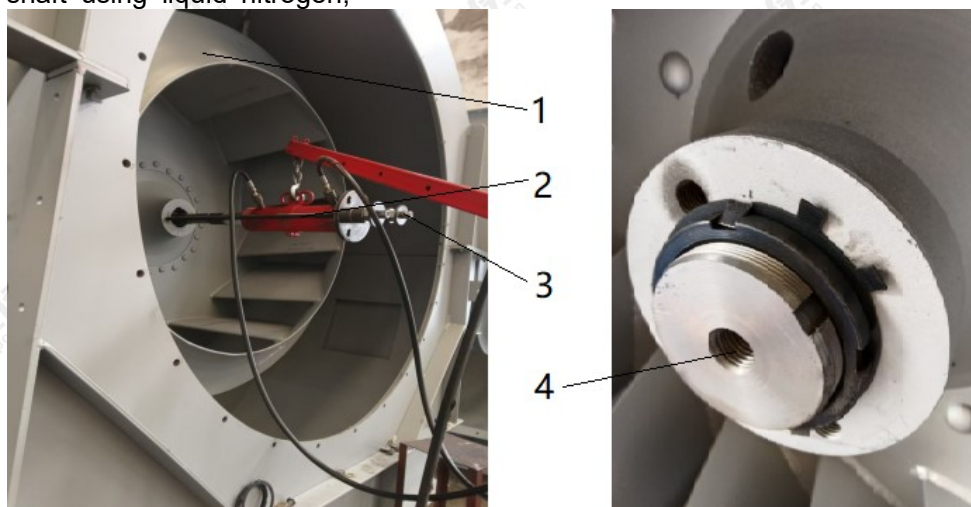
Check and confirm that the replacement impeller model and specifications match the fan, that the impeller surface condition is normal, and that it has passed dynamic balancing;

2) 检查主轴轴肩装配面无变形、毛刺和脏物, 并在其上均匀涂抹润滑脂; 清理叶轮内孔杂质;

Inspect the mounting surface of the shaft shoulder for deformation, burrs, and contamination. Apply an even coat of grease to the surface. Clean any debris from the impeller bore;

3) 将叶轮托起或吊起让其轴盘内孔对准主轴、两者键槽正对, 通过铜棒击打、利用主轴端部螺孔安装液压千斤顶等施加轴向推力, 将叶轮平稳推入主轴直至轴盘贴合主轴轴肩端面, 如图 16 所示。必要时预先均匀加热叶轮轴盘内孔, 或采用液氮冷缩主轴;

Lift or hoist the impeller, align its hub bore with the shaft, and align the keyway of the hub with that of the shaft. Using a brass bar or by mounting a hydraulic jack on the threaded hole at the shaft end, apply axial force to push the impeller steadily onto the shaft until the hub contacts the shaft shoulder end face, as shown in Figure 16. If necessary, preheat the impeller hub bore evenly, or chill the shaft using liquid nitrogen;



1. 叶轮; 2. 液压千斤顶中空油缸; 3. 支撑螺杆; 4. 主轴螺孔。

1. Impeller; 2. Hollow cylinder of hydraulic jack; 3. Supporting screw; 4. Main shaft screw hole.

图 16 叶轮的安装

Figure 16 Installation of impeller

4) 依次安装键、止动垫圈、轴端螺栓或圆螺母等, 锁定止动片防松;

Install the key, lock washer, shaft end bolt(s) or round nut, etc., in sequence, and bend the lock tab to prevent loosening;

5) 回装机壳上部(分体机壳适用)、出风口接管、进风口阀门和部分箱体等周边部件, 检查和调整进风口与叶轮前盘进口间配合符合要求(无规定时, 轴向重叠长度 S_1 为叶轮直径的 0.8%-1.2%, 径向单侧间隙 S_2 为叶轮直径的 0.15-0.4%, 如图 17 所示);

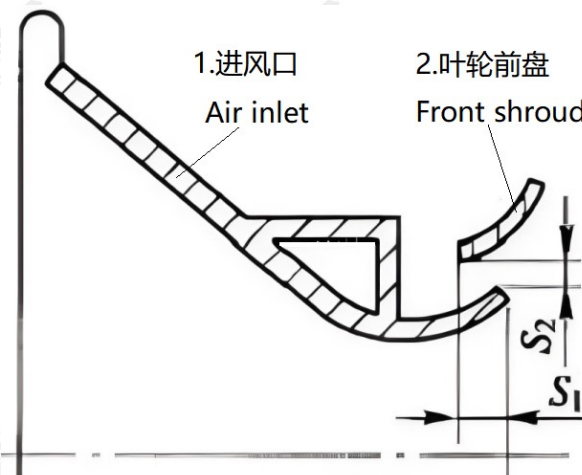


图 17 进风口与叶轮的配合

Figure 17 Fit between air inlet and impeller

Reinstall the upper part of the casing (for split casings), the outlet duct connection, the inlet damper, part of the box, and other surrounding components. Check and adjust the fit between the inlet and the impeller front shroud inlet to meet the requirements (where not specified, the axial overlap length shall be 0.8-1.2% of the impeller diameter, and the radial clearance on one side shall be 0.15-0.4% of the impeller diameter, as shown in Figure 17);

6) 清走所有杂物, 手动盘动叶轮数圈, 确认无刮壳、碰擦现象。

Remove all debris, then manually bar the impeller for several revolutions to confirm that there is no rubbing or interference with the casing.

6.6.4 注意点 Note

1) 优先采用工具装拆, 采用铁锤敲打时应垫放铜块、铅块或其他软材料作缓冲;

Always use tools for assembly/disassembly. If hammering is unavoidable, use a copper or lead block (or other soft material) as a buffer;

2) 所使用的键应无翘边、表面无毛刺等外观问题, 头部为圆头或两侧带倒角;

Keys must be free of warping, burrs, etc., and have a round or chamfered head;

3) 动火、高空作业、操作叉车和起重机时应按相关安全规范执行。

Hot work, high-altitude work, and forklift/crane operations must follow applicable safety codes.

6.7 长期停机或备用风机保养 Long-term shutdown/standby fan maintenance

6.7.1 应在容易锈蚀的各部分适当涂抹防锈剂;

Apply a suitable anti-rust agent to all parts that are prone to corrosion.

6.7.2 注意防止电机及其它电气部件受潮, 重新开机前应检查其的绝缘电阻值;

Take care to prevent the motor and other electrical components from becoming damp. Before restarting, check their insulation resistance values.

6.7.3 每三个月开机或手动盘车将转子旋转 120-180°, 以免主轴弯曲;

Every three months, start the fan or manually bar the rotor to rotate it by 120-180° to prevent bending of the shaft.

6.7.4 如果风机停用了很长时间, 轴承的润滑层会被氧化并在轴承上会形成粘性的一层东西。在这种情况下, 应清洗轴承以把原来的润滑层去掉, 重新换上一层新的同样组成成分的润滑层。

If the fan has been out of service for a long time, the lubricating film on the bearings may become oxidized and form a sticky layer. In such cases, the bearings shall be cleaned to remove the old lubricant, and a new layer of lubricant with the same composition shall be applied.

7. 润滑指引 Lubrication Guide

7.1 总体原则 General Principles

1) 按具体润滑点、使用工况等选用对应的润滑油脂牌号、定期按时加注和更换;

Select the appropriate lubricant grade according to the specific lubrication points and operating conditions, and add or replace it regularly at the specified intervals;

2) 加注作业保持环境洁净, 避免杂质、水汽混入;

Keep the working environment clean during lubrication to prevent contamination by impurities or moisture;

3) 不要往轴承及内腔内加注太多润滑油脂, 否则会容易造成轴承过热损坏;

Do not overfill bearings and their housings with grease; otherwise, overheating and bearing damage may occur;

4) 如需更换特性不同的润滑油脂, 需对轴承及内腔清理干净后才允许加新的, 不许混用。

If a different type of lubricant needs to be used, the bearings and their housings must be thoroughly cleaned before adding the new lubricant. Mixing different lubricants is not permitted.

7.2 电机轴承 Motor bearings

7.2.1 中心高<160mm 的电机轴承一般采用免维护免润滑结构, 日常不需加注润滑油脂, 仅需按周期更换轴承; 中心高≥160mm 的电机两端轴承外壳处装有注油嘴或引出铜管用于加注润滑油脂, 并支持不停机加注;

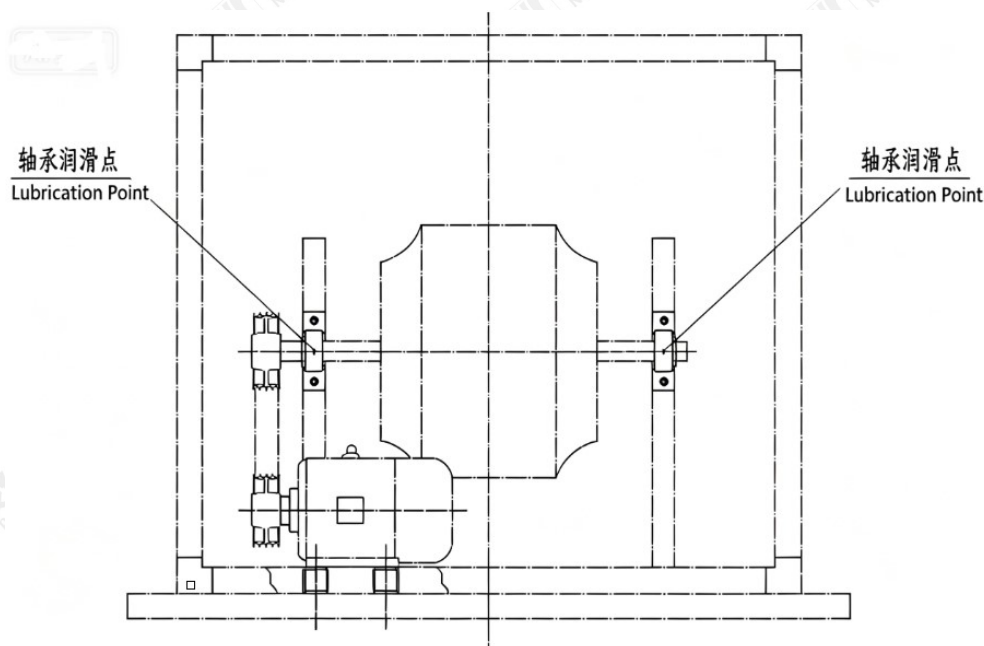
For motors with a center height < 160 mm, the bearings are generally maintenance-free and grease-free, requiring no regular greasing and only periodic bearing replacement. For motors with a center height ≥ 160 mm, grease fittings or copper tubes are provided on the bearing housings at both motor ends for grease injection, and this can be done without stopping the motor.

7.2.2 一般采用脂润滑，具体牌号、加注量和周期等以电机产品铭牌或其出厂随机手册的规定为准。

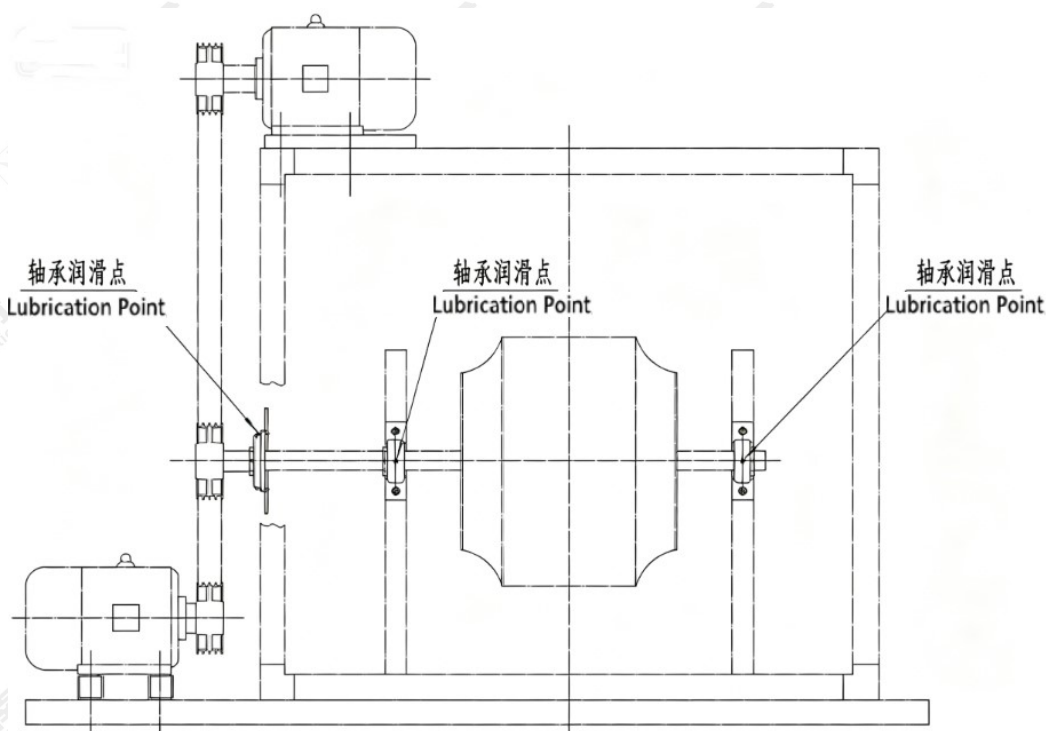
Grease lubrication is generally used. The specific lubricant grade, filling quantity, and interval shall be as specified on the motor nameplate or in its accompanying manual.

7.3 风机本体轴承 Fan main body bearing

7.3.1 润滑点：分布如图 18 所示 Lubrication points-distribution as shown in Figure 18:



a) 电机内置型 Built-in motor type



b) 电机外置型 External motor type

图 18 润滑点的分布

Figure 18 Distribution of lubrication points

7.3.2 油脂牌号：如无特别注明，其国内牌号为 2 号锂基润滑脂（默认）或复合锂基润滑脂（高温环境）。润滑脂的稠度等级按 NLGI（美国润滑脂协会）规定的 2 级，工作锥入度(1/10mm)为 265~295；如采用 SKF 品牌，介质温度<150℃时可用 LGWA2，≥150℃时可用 LGET2；

If there is no special annotation, its domestic mark is 2# Lithium base lubricating grease (applicable for fans) or compound Lithium base lubricating grease (applicable for induced draft fan). Grease consistency class press NLGI (grease American organization) Level 2 Worked penetration (1 / 10mm) from 265 to 295. For SKF brand: use LGWA2 when the medium temperature is <150℃, and LGET2 when the medium temperature is ≥150℃.

7.3.3 UKF 和 UKP 带座轴承的加注量参考下表：

For UKF and UKP housed bearing units, refer to the table below for the grease filling quantity:

轴承型号 Bearing model	轴承内径 Bearing inside diameter (mm)	建议初次用量 Recommended initial grease fill (g)	补充用量 Supplemental grease quantity (g)
UKF206、UKP206	30	4.0-4.8	3.6-4.5
UKF207、UKP207	35	4.9-5.8	4.5-5.5
UKF208、UKP208	40	5.9-7.0	5.5-6.8
UKF209、UKP209	45	7.2-8.5	6.8-8.2
UKF210、UKP210	50	8.5-10.0	8.0-9.5
UKF211、UKP211	55	9.8-11.5	9.2-11.0
UKF212、UKP212	60	11.2-13.2	10.5-12.5
UKF213、UKP213	65	12.8-14.8	12.0-14.0

7.3.4 SN 和 NSN 轴承座的加注量参考下表：

For SN and NSN bearing housings, refer to the table below for the grease filling quantity:

轴承座型号 Bearing housing model	中心高 (Height of Centre) (mm)	建议初次用量 Recommended initial grease fill (g)	补充用量 Supplemental grease quantity (g)
SN512、NSN70	70	15	12
SN515、NSN80	80	30	20
SN616、NSN112	112	45	40
SN526、NSN150	150	70	60

7.3.5 润滑脂一般第一次运行 50 小时更换，以后每运行 15 天到 30 天左右补充润滑量。一般以装满轴承空间 20%-30%为宜，以后视脂质量状况及时更换。

Generally, the grease shall be changed after the first 50 hours of operation. Thereafter, additional grease shall be supplied every 15 to 30 days of operation. The bearing cavity should be filled to 20%-30% of its volume. Subsequently, the grease shall be replaced in a timely manner depending on its condition.

7.3.6 注意点 Precautions:

1) 环境粉尘越大、温度越高、湿度越大、转速越高，则加注或更换周期应缩短。

The higher the dust concentration in the environment, the higher the temperature, the higher the humidity, or the higher the rotational speed, the shorter the grease filling or replacement interval shall be.

2) 当轴承温度>65℃时，每上升 15℃则加注周期在原有基础上减半。

When the bearing temperature exceeds 65°C, the filling interval shall be halved for every 15°C rise above this threshold.

8. 常见故障及原因 Common Faults & Causes

8.1 风机振动剧烈 Fan's violent vibration

- 1) 叶片有积灰、污垢、叶片磨损、叶片变形，转子产生不平衡。

Blades have soot formation & dirt, it's damaged or deformed, imbalance occurs to rotor.

- 2) 机壳或进风口与叶轮磨擦。

Friction between the casing/inlet and the impeller.

- 3) 基础的刚度不够或不牢固。

Foundation's rigidity is not enough or unstable.

- 4) 风管接头重量等外力施加在风机外壳上。

External forces such as the weight of duct & connections are applied to the fan casing.

- 5) 叶轮铆钉松动或叶轮变形。

Impeller rivet is loose or the impeller is deformed.

- 6) 叶轮轴盘孔与轴或键配合松动。

There is looseness between impeller hub bore and shaft or key.

- 7) 电机与机架联接螺栓松动。

The connecting bolts between the motor and the frame are loose.

- 8) 轴承损坏或风机轴弯曲。

Bearing damage or fan shaft bending.

8.2 轴承温升过高 Bearing temperature rise is too high

- 1) 轴承箱（座）振动剧烈。

Bearing casing (pedestal) vibrates violently.

- 2) 润滑油（脂）质量不良、变质或含有灰尘、砂粒、污垢等，润滑油不足或太多。

Poor quality of lubricating oil (grease), it going bad & has dust, sand, dirt, etc, and Insufficient grease (oil standard oil level is below the lower limit) or too much (oil level exceeds the standard limit oil).

- 3) 轴承座锁紧套的锁紧力过大或过小。

The tightening torque on the bearing housing locking sleeve is excessive or insufficient.

- 4) 滚动轴承安装歪斜，前后两轴承不同心。

Rolling installation is inclined, front & rear bearings are not concentric.

- 5) 滚动轴承损坏或轴弯曲。

The rolling bearing is damaged or the shaft is bent.

- 6) 轴承因进水或受潮而发生锈蚀。

The bearing becomes corroded due to water ingress or moisture.

8.3 电流过大 Excessive current

- 1) 开机时进、出气风阀开度过大导致风机流量和功率过大。

Inlet and outlet dampers have an excessive opening at startup, causing excessive fan flow and power.

- 2) 电机输入电压低和电源缺相运行。

Low motor input voltage or power supply phase loss.

- 3) 按高温条件设计的风机在常温或低温条件下使用，风机输送气体密度大于设计值导致功率过大。

A fan designed for high-temperature conditions is operated at normal or low temperatures, resulting in higher air density than design and thus excessive power.

- 4) 叶轮转速超过额定值。

Impeller's rotating speed exceeds the rated value.

- 5) 轴承缺油或损坏。

Insufficient bearing lubrication or bearing damage.

8.4 风机不能启动 Fan fails to start

- 1) 电源缺相、相序错误、三相电压不平衡。

Power supply phase loss, incorrect phase sequence, or unbalanced three-phase voltage.

2) 断路器、接触器、热继电器跳闸损坏。

Circuit breaker, contactor, or thermal relay trips and gets damaged.

3) 控制回路故障：按钮、限位、消防联锁、温控保护断开。

Control circuit failure: buttons, limit switches, fire interlock, or temperature protection disconnected.

4) 电机绕组烧毁、绝缘击穿、匝间短路。

Motor winding burnout, insulation breakdown, or inter-turn short circuit.

5) 电机接线松动、虚接、断线。

Loose, poor, or broken motor wiring.

6) 潮湿环境电机受潮绝缘低，上电漏电跳闸。

Motor gets damp in a humid environment, causing low insulation and tripping due to leakage.

7) 过载保护整定太小，一启动就跳闸。

Overload protection setting too low, causing tripping immediately upon startup.

8) 轴承锈蚀、缺油抱死，盘车转不动。

Rusty or oil-starved bearings seize up, preventing the fan shaft from turning (barring).

9) 叶轮积尘过重、变形擦壳，与机壳摩擦卡滞。

Excessive dust accumulation on the impeller leads to deformation, rubbing against the casing, and jamming.

10) 长期停机静置，轴变形、叶轮偏心卡涩。

Long-term shutdown and static placement result in shaft deformation or impeller eccentricity, causing jamming.

11) 内部掉入杂物、异物卡住叶轮。

Foreign objects fall inside and jam the impeller.

12) 进风口 / 出风口阀门全开，启动负载过大，启动电流超限。

Fully open inlet/outlet valves result in excessive startup load and over-current tripping.

13) 起动机参数设置错误、启停逻辑锁定、频率下限限制。

Incorrect starter parameter settings, start-stop logic lockout, or frequency lower limit restriction.

9. 订货须知 Ordering Instruction

订货时请注明：风机的使用环境、机号、传动方式、转速、流量、压力、出风口角度、旋转方向，以及电机型号、配套附件等。

When ordering, specify the operating environment of the fan, model number, drive type, rotating speed, air flow, pressure, outlet angle, rotating direction & motor type, accessories, etc.

本公司可根据客户的要求特殊设计和制作，以满足客户性能参数的要求。

We will specially design and manufacture according to customer's request so as to satisfy customer's forwarded requirements of performance parameter.

——全文结束 END——