Blower System Design Guide

Layout Considerations for a Reliable, Energy Efficient, and Safe Blower System

By KAESER's Blower and Engineering Experts
KAESER COMPRESSORS, INC.

About this eBook

This e-book, created by KAESER's blower system experts, aims to help you maximize the benefits of your blower system. We are dedicated to providing the most current information for efficient installation, operation, and maintenance.

Our objective is to guide you in installing the most successful blower system possible. The tips, guidelines, and warnings within this e-book are designed to achieve this.

While this e-book offers comprehensive information, we acknowledge the uniqueness of each system and application. Applying the principles here is an excellent starting point. For tailored system optimization, please contact us for additional support.

> "Throughout the e-book, you'll find efficiency tips and resources. The included links will direct you to more information, carefully selected by our engineers and blower system experts to assist you with your blower system needs."

More Resources:
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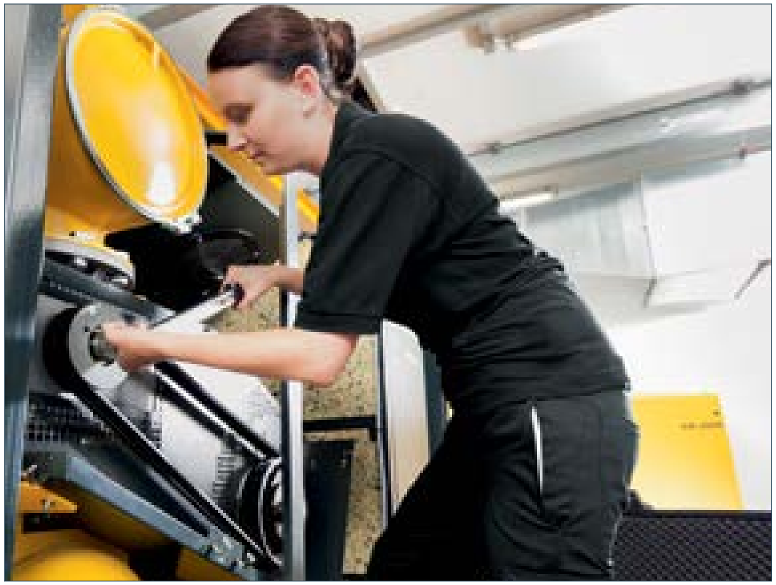
Introduction

Blowers are critical for many applications, and system failures can lead to plant shutdowns. Therefore, proper planning is essential for new installations. When upgrading, physical restrictions may require innovative solutions. This e-book offers guidance on optimizing blower system configuration and performance, whether for new or existing systems.

For the purposes of this e-book, it's assumed you have already determined pressure, flow, and sizing requirements. If not, we highly recommend consulting a blower system specialist for accurate measurements.

This e-book should be used as a supplement to the blower equipment service manuals, which contain model-specific installation information.

> Note that the diagrams in this e-book are examples only and may not be optimal for your specific system. For installation assistance, contact your local authorized KAESER representative for expert advice.



Building an Efficient System

Package vs. System Efficiency

Building an Efficient System

System engineers prioritize energy efficiency in equipment selection, leading to significant advancements in blower technology. This focus on energy optimization has spurred innovations, with manufacturers now highlighting “wire-to-air efficiency” to promote new, more efficient blowers for various performance needs.

Wire-to-air efficiency quantifies the total energy consumed to achieve a specific flow and pressure, expressed as a power-to-flow ratio. While a relatively new concept in the blower market, this metric, also known as specific performance, is well-established in industrial compressors and compressed air systems.

> “Organizations like ISO, CAGI, PNEUROP, and ASME have developed standards for testing and comparing specific performance.”

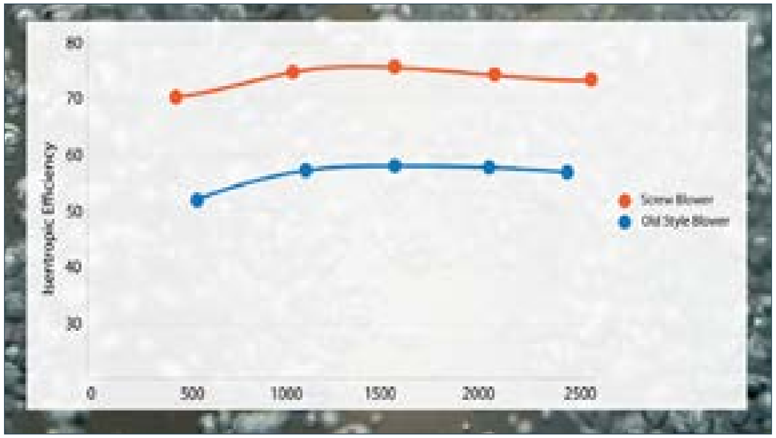
More Resources:
Click here to download a copy of our white paper on energy efficient system design for wastewater treatment plants.

Building an Efficient System

When considering blower efficiency, it's vital to look beyond individual equipment and focus on the overall system performance. Selecting highly energy-efficient blowers isn't enough; they must be properly applied and controlled to deliver the expected energy savings. This is why system specific power is a critical factor in system design.

System specific power accounts for the combined efficiency of all package components, and, in variable frequency drive units, drive losses. This comprehensive approach allows for the allocation of combined machine performance to specific operating points of system demand, ultimately determining the overall blower system performance. These results can then be compared across different solutions and blower technologies.

> Beware of the efficiency curves of oversized blowers. If a blower doesn't operate within its optimal performance curve for your specific application, it won't achieve the anticipated energy savings, even if it's individually efficient.



More Resources:
Our Aeration Blowers Explained video demonstrates how to design an energy efficient blower system. Watch it here

Measuring Blower Performance

For an accurate measurement of power consumption from wire to air, a comprehensive system or package evaluation is essential. Power consumed solely at the shaft does not reflect the total power consumption of the entire package and its components.

Industry performance standards, including ISO 1217 (Annex C & D), BL300, and PTC-13, outline the considerations and compensation methods for incomplete data.

Technology Considerations

Isentropic efficiency measures a machine's actual power consumption against its ideal, theoretical (isentropic) power. Selecting the right technology can significantly impact your system's operating costs.

However, these highly efficient machines represent a substantial investment, so it's crucial to understand the process and power costs before making a decision.

Type	Description	Isentropic Efficiency*
Rotary Lobe	Positive displacement, adaptive pressure	45-65%
Multistage	Dynamic, adaptive pressure	45-65%
Rotary Screw	Positive displacement, internal compression	65-80%
High Speed Turbo	Dynamic, adaptive pressure	50-80+%

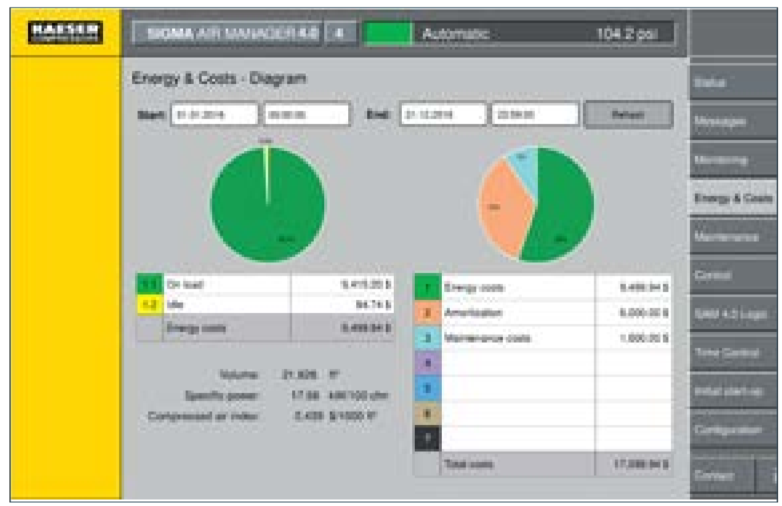
Higher Efficiency with System Controllers

For systems with multiple blowers, consider implementing system controls. These controllers enhance efficiency and pressure stability by optimizing the operation and service hours of multiple blowers.

A system controller's advanced computing capabilities allow it to quickly detect changes in demand and select the most efficient combination of blowers.

KAESER's SIGMA AIR MANAGER® (SAM) 4.0 simplifies the control and monitoring of up to 16 blowers. Its customizable control profiles can be tailored to your specific needs, directly influencing your facility's productivity and energy efficiency.

> Advanced system controllers can communicate directly with a plant SCADA, receive information on the needed flow rate, and select the most efficient blowers to meet it.



Higher Efficiency with System Controllers

Benefits of System Controllers:

Optimize Energy Consumption:
- Reduce blower operation time.
- Align air production with demand.
- Decrease kW/cfm production.
- Minimize system pressure (if regulated).

Reduce Maintenance Expenses:
- Less cycling and switching extends valve life.
- Fewer motor starts prolongs motor life.
- Optimize service hours.

Enhance Operational Stability and Performance:
- Improve production equipment efficiency.
- Decrease downtime from pressure alarms.
- Reduce scrap and product quality issues.

Control Considerations:
Dissolved oxygen (DO), measured in mg/L, is the most common metric for basin control. Blower output is adjusted to maintain a consistent DO level. Excessively high DO levels, caused by more air than required, lead to increased power consumption. Conversely, low DO levels negatively impact basin activity and can prevent a plant from meeting treatment standards.

> "The productivity and energy efficiency of your facility will be directly affected by the controls you implement."

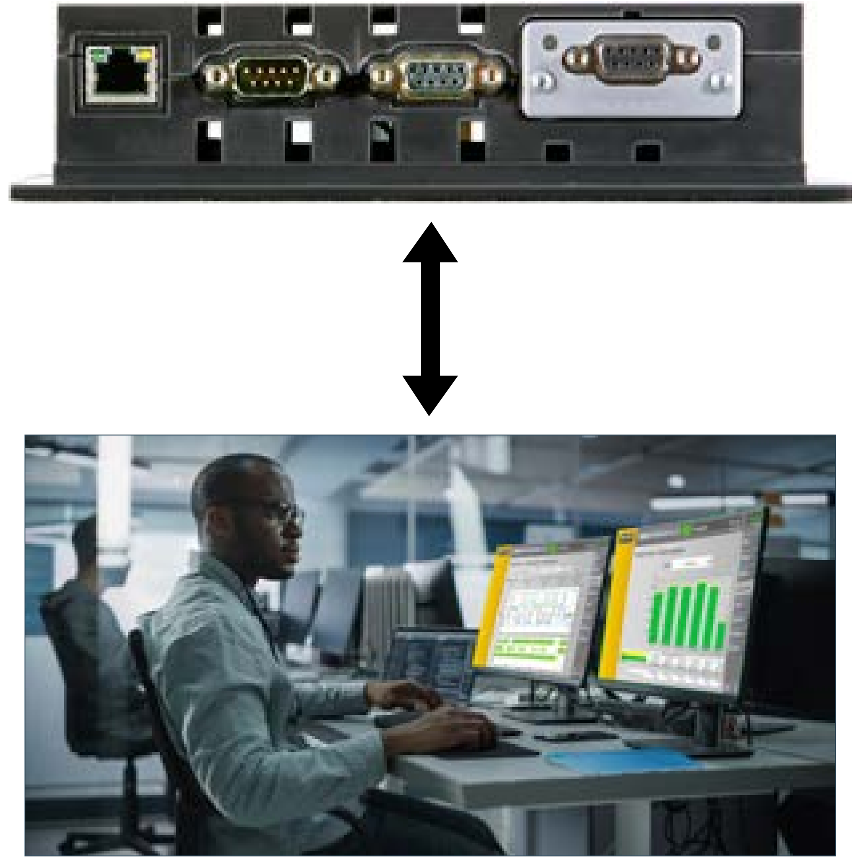
Control Mode	Description	Technology
On/Off	Blower cycled at fixed speed on and off based upon process needs	Rotary Lobe, Rotary Screw, High Speed Turbo
Speed Control	Blower speed adjusted to meet demand variations from min speed to max speed	Rotary Lobe, Rotary Screw, Multistage, High Speed Turbo
Modulating Valve/Throttling	Inlet Valve increases or decreases air to blower	Multistage
Flow Control	Flow set point given to blower and speed (and/or inlet valve) is adjusted to adapt capacity with varying ambient conditions (temperature)	Rotary Lobe, Rotary Screw, Multistage, High Speed Turbo
Pressure Control	Blower speed is altered to adjust to flow output to maintain a constant header pressure. Utilized on plants with a common header pressure. Utilized on plants with a common header feeding multiple basins where a control valve is installed which modulates to maintain basin conditions... typically DO. Can also be done with throttling on multistage machines	Rotary Lobe, Rotary Screw, High Speed Turbo

Pant PLC/Blower Integration

Modern industrial operations increasingly rely on BUS-based communication. For precise control, it's crucial that data flows seamlessly between plant processes and their corresponding blowers. Programmable Logic Controllers (PLCs) in the plant transmit blower data using a specific BUS language. Therefore, it's essential to identify this language to ensure the supplied equipment is compatible and can communicate effectively on-site.

Customer-to-BUS interface via data BUS:

- PROFIBUS® DP
- Modbus RTU/TCP
- Profinet® IO
- Ethernet/IP™
- DeviceNet™



More Resources:
Contact your [local authorized KAESER representative] for sample control schemes and for help customizing a solution for your system.

Package Integration

Blower and System Controls

Package Integration

Optimizing a plant's energy consumption necessitates proper controls in any blower system. This includes both individual unit controls and broader system controls that manage and coordinate the overall low-pressure air system.

A complete package design streamlines the engineering and purchasing processes for individual components. Each component is specifically chosen for optimal efficiency and synergy, ensuring the best possible package performance. Factory-built integrated machines come equipped with a suite of sensors and an onboard controller that monitor package performance and health. They also include comprehensive documentation, testing, and verified performance values.

> A complete package design reduces time spent engineering and purchasing individual components.

More Resources:
Visit CAGI's website for more information on their testing standards.

Package Integration: Blower Controls

Individual unit control systems range from basic packages, offering essential pressure and vacuum gauges, to comprehensive systems that include temperature, oil level, and filter monitoring sensors, as well as remote monitoring capabilities.

The appropriate choice of control system depends on the application and the overall sophistication of the installation. Basic controls may suffice for smaller, individual unit applications, with regulation based on either blower discharge pressure or a user-defined variable. However, larger, multi-unit installations will benefit significantly from more in-depth controls, particularly when incorporating variable frequency drive (VFD) units, system controllers, or integrating the system into larger plant management systems. Adaptive control profiles often provide the best efficiency and performance, requiring more extensive unit controls.

> The choice of control depends greatly on the application and overall sophistication level of the installation.

Package Integration: System Controls

System controllers offer varying levels of system control. When selecting a system controller, evaluate its compatibility with your current network infrastructure and its ability to connect seamlessly with your SCADA system. For blower systems in remote areas, prioritize system controllers that offer advanced remote monitoring, maintenance tracking, and notification features. As the Internet of Things grows, integrated packages and robust communication capabilities will be increasingly crucial for effective plant energy and asset management.

For more information, see the System Controllers section.

> When looking for a system controller, consider its overall ability to integrate with your existing network communications.

More Resources:
Click here to read our blog entry on the benefits of adaptive control systems.

Receiving Equipment

General Tips

Receiving Equipment

Preparing for a new installation includes careful consideration of your shipment's arrival. Freight damage can occur, so it's crucial to protect yourself by thoroughly inspecting commercial freight before signing for it. Our freight tips video provides comprehensive guidance on successfully receiving any commercial shipment.

Key inspection steps:

- Tears or punctures to the carton and/or shrink wrap
- Broken slats on the pallet
- An oversized or undersized pallet
- Equipment not secured to the pallet
- Non-branded packaging without KAESER's logo
- Tip N Tell Indicator activate or missing

> "Always conduct a thorough inspection of your commercial freight prior to signing."

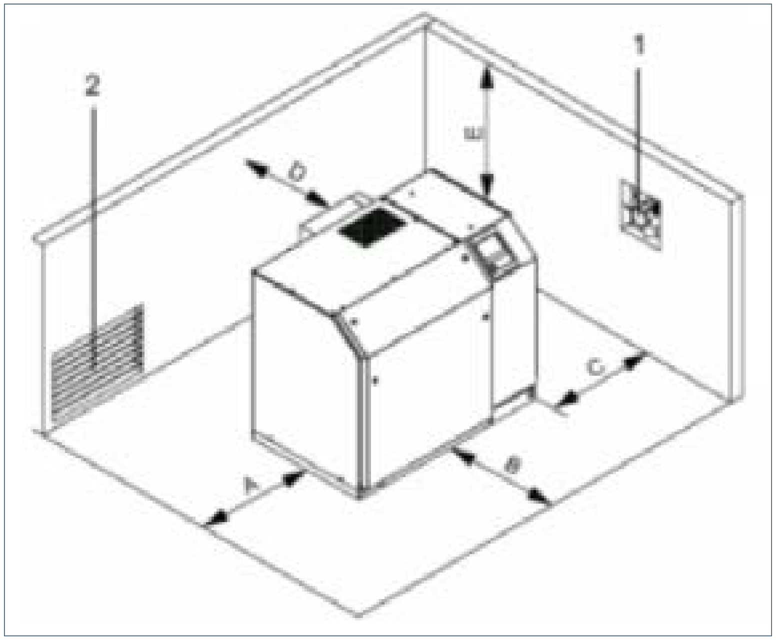
Location

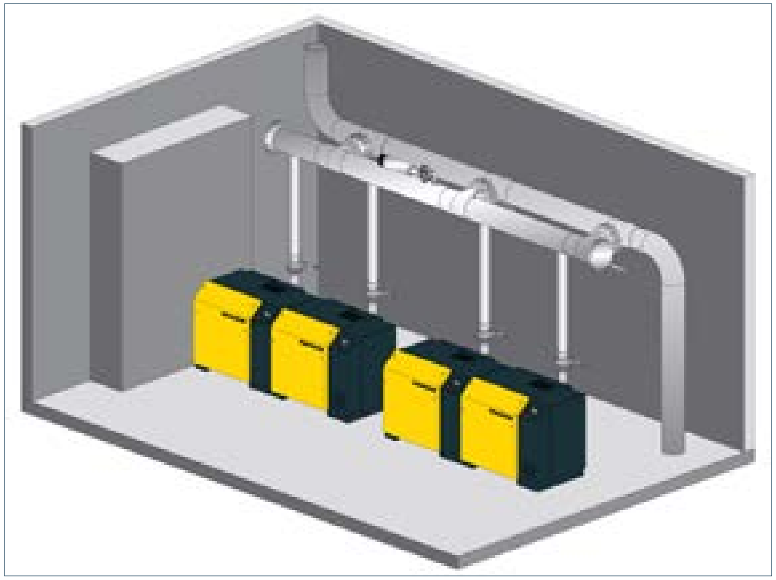
Placement Affects Performance

Location: General Tip

KAESER blower packages are designed for side-by-side installation. However, it's crucial to ensure adequate airflow between units and in corners to prevent air stagnation.

> Consult your local NEC code for rules and regulations on drive cabinet clearances for packages.





Location: Floor and Anchoring

KAESER's blower packages do not require a special foundation or base. They should be placed on a level surface that can support the combined weight of the blower and the equipment used for its installation.

While KAESER blowers exhibit minimal vibration, many customers opt to anchor them.
- Use appropriate fixing bolts to secure the machine to the floor and prevent shifting

The service manual contains a drawing detailing the anchoring procedure, and suitable fastening elements are provided with the machine.

Location: Access

The blower room's entrance must be wide enough to accommodate the blower package and any equipment, such as a forklift, crane, or pallet truck, needed to move it into position.

The designated space for the blower system requires sufficient clearance to:

- Maneuver the unit into place
- Open maintenance doors and access panels
- Remove and replace components
- Ensure adequate ventilation

KAESER blower packages are designed for easy front access to internal components. This feature should not be compromised by blocking the maintenance doors. Refer to your service manual for dimensional drawings specific to your model.

> "KAESER has designed its blower packages so that the internal components can be easily accessed from the front. Contact us for help planning your installation to ensure proper clearances for service and your plant equipment."

More Resources:
Check out some of our more creative system design solutions in this blog entry.

Location: Environmental Considerations

Be sure to monitor system temperatures, as they can impact equipment operation. Temperatures must remain within the manufacturer's specified ranges.

Low temperatures can hinder the proper flow of some lubricants and encourage moisture condensation. For applications with lower ambient temperatures, KAESER provides an optional sound enclosure heater to protect the blower package.

Conversely, high ambient temperatures often shorten lubricant life. KAESER's lobe blower packages are designed to operate in ambient temperatures up to 104°F, and screw blowers up to 113°F. Operating blower packages at higher temperatures than recommended can negatively affect performance, cause component damage, and potentially void the warranty.

Operation at elevated temperatures necessitates a derating of electrical components and confirmation of machine operating temperatures to ensure both machine and process limits are not exceeded.

Location: Outdoor Installations

While indoor installation is ideal for all blowers, outdoor placement is possible if proper protection from rain and snow is ensured. However, integrated and screw blower packages equipped with wye-delta start or variable frequency drives should never be installed outdoors.

Protective Measures for Outdoor Blowers:

- **Weather Hoods:** If the blower lacks natural shelter or is exposed to wind-driven rain or snow, weather hoods are essential. These must be added to the air inlet and exhaust openings on the cabinet exterior. KAESER offers these both as a factory-installed option and as a retrofit kit.
- **Sound Enclosure Heaters:** For ambient temperatures between 5°F and 23°F, a sound enclosure heater is mandatory. These heaters raise the machine's internal temperature to approximately 50°F, ensuring proper oil viscosity during startup and preventing moisture accumulation within the enclosure. The heater is thermostatically controlled, deactivating when the sound enclosure reaches 41°F. KAESER provides sound enclosure heaters as either a factory-installed component or a retrofit kit.

> "Integrated and screw blower packages with wye-delta start or variable frequency drive should never be installed outdoors."

Location: High-dust Environments

Blowers often operate in dusty environments, making it crucial to protect them from ingesting particulates and preventing dust/dirt accumulation on components. This practice extends service life and maintenance intervals.

KAESER blower packages include inlet silencers/filters with differential pressure indicators, signaling when service is required. Enclosures are also highly recommended to minimize particle load on inlet air and prevent particulate buildup on drive components.

> "KAESER blower packages come standard with inlet silencers/filters equipped with differential pressure indicators to signal when service is needed."

More Resources:
Contact your local authorized KAESER representative for accessories for a high-dust environment.

Location: Other Options

Alternatively, the entire blower system can be installed in a custom-built enclosure. This approach can save time and money on installation, as it eliminates the need for special building permits.

Enclosure systems provide solutions for nearly any project. These systems are engineered to meet specific project requirements and arrive fully assembled, wired, and tested. Installation involves setting the enclosure in place, connecting a single power feed, and installing the piping to the blowers.

More Resources:
Click here to see more examples of custom enclosed systems.

Ventilation

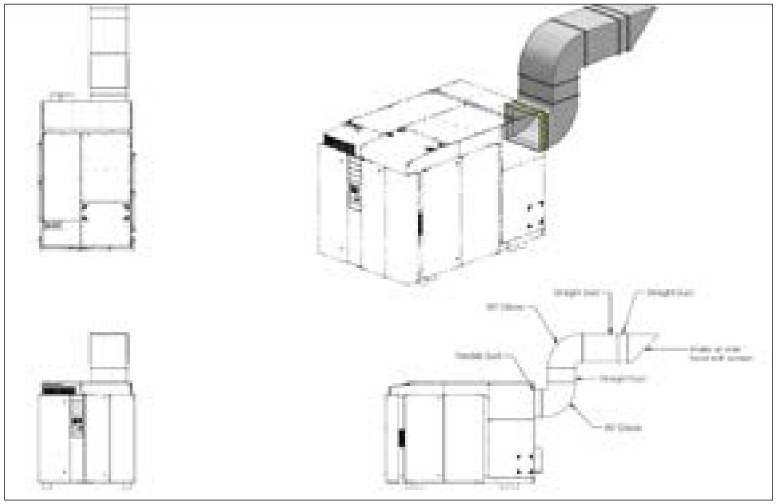
Ensuring Proper Cooling and Equipment Longevity

Ventilation

Proper ventilation is crucial for optimal equipment performance and longevity. Inadequate planning and ventilation of the blower room can lead to equipment downtime, increased maintenance, and reduced performance.

To mitigate noise, ventilation openings should be fitted with louvers or other silencing devices. An exhaust fan can be installed for forced ventilation. Arrange openings so cooling air flows over the blower inlet and exhaust ports, minimizing stagnant air. Avoid thermal short circuits where discharged cooling air recirculates, and ensure the blower is not positioned too close to a wall, obstructing the cooling air inlet.

Always consult the Blower Installation Data Sheets for specific ventilation recommendations.



> "Failure to properly plan and ventilate the blower room can cause equipment downtime, increased maintenance intervals, and reduced performance."

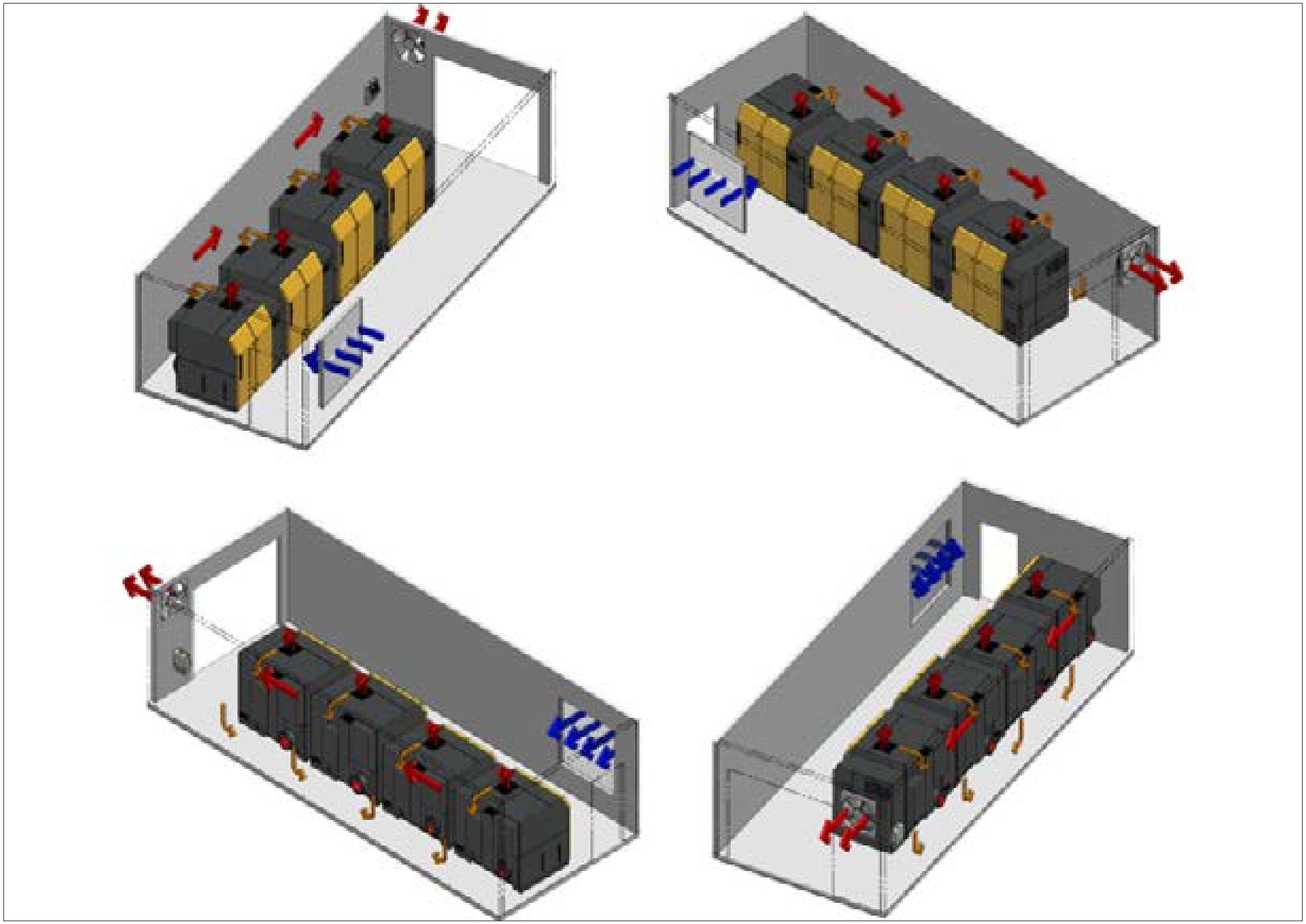
Ventilation

If a blower is situated in the center of a large room, its exhaust air can be captured via a duct positioned above the exhaust port. Although this air may not be warm enough for process applications, it can be recovered and utilized to heat other areas of the plant, thereby reducing heating costs. Should a duct not be necessary, extract the exhaust air from the upper third of the room, as this is where heat accumulates.

Refer to Appendix B for formulas to calculate the volume of air flowing into the room, ventilation fan capacity, and effective cross-section of ventilation openings. Installation diagrams on the following pages illustrate examples of proper blower room ventilation.

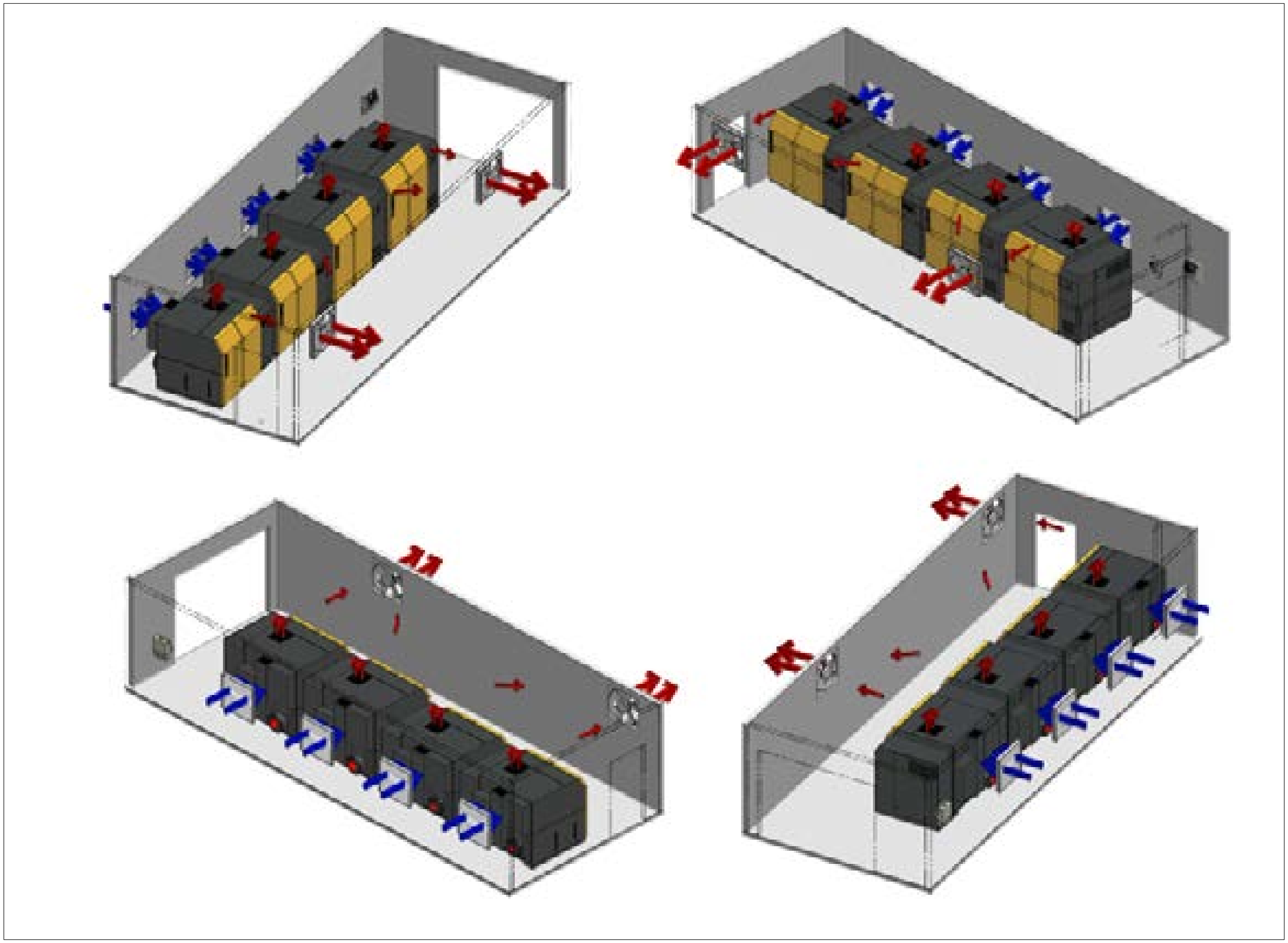
Ventilation

This example shows a poorly ventilated blower room. The orange arrows indicate air that is short circuiting or preheated cooling air at the blower inlets.



Ventilation

This example shows a properly ventilated blower room. The airflow is properly pulled across the blower packages and preheating of the air is prevented. Although not shown here, it is also important to insulate any exposed discharged piping.



Electrical Supply

Important Warnings to Follow

Electrical Supply

Before installing the blower, verify that the electrical service voltage matches the voltage listed on the blower's nameplate (found inside the electrical cabinet or on the machine's exterior tag). If your blower is a dual or tri-voltage model, confirm it is internally wired for the correct voltage.

WARNING: For warranty coverage, the actual operating voltage must be within ±10% of the blower's nameplate voltage. KAESER does not recommend, for instance, operating a 230-volt system on a 208-volt circuit, as damage or failures resulting directly or indirectly from insufficient or excessive voltage may void the warranty.

For optimal safety and functionality, KAESER recommends equipping each blower with its own dedicated electrical circuit and disconnect panel. This setup allows for individual equipment lockout and tagout without disrupting other machinery connected to the same panel. Disconnects must completely cut power to the entire machine, including all accessories and instruments.

If a system controller (multi-unit control device) is to be installed, electrical planning should account for the necessary wiring.

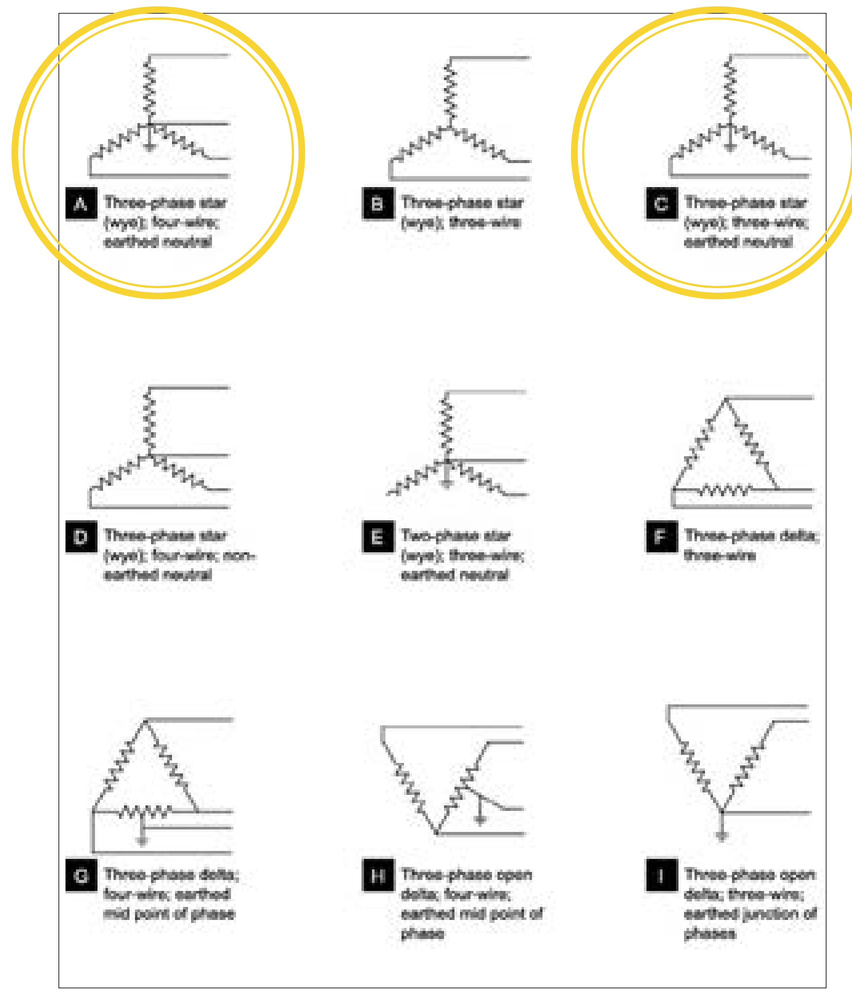
Proper grounding of the blower is essential. Install a suitably sized fuse or circuit breaker between the blower and the main electrical service, adhering to the NEC and local electrical codes for sizing guidelines.

Electrical Supply

For variable frequency drive units, ensure the power supply transformer has a symmetrical, three-phase supply, meaning phase angles and voltages are identical.

KAESER's VFD units specifically require a symmetrical power supply transformer with a wye configuration output. The two acceptable options for KAESER's VFD packages are indicated by circled configurations. The ground wire should be the same size as the power conductors.

> "Always consult the NEC Code and local regulations to determine acceptable limits for ground electrode impedance."



Electrical Supply

WARNING: Insufficient and/or improper grounding practices may lead to premature motor or VFD component failure.

WARNING: Never use air piping or electrical conduit as a means of grounding.

WARNING: All wiring and electrical connections must be performed by a qualified electrician in accordance with NEC and local electrical codes. Supply conductors must be properly sized in accordance with all applicable national and local codes.

WARNING: The electrical service disconnect should be within sight of the blower and have an easily recognizable lock-out tag.

WARNING: Some projects/installations will have limits on Total Harmonic Distortion (THD). THD limits must be clearly defined by the methods outlined in IEEE 519. To achieve a desired THD value, additional external ancillary devices may be required. These devices may either be a passive harmonic filter or an active harmonic filter. All KAESER packages include passive harmonic filters, but may not meet stringent project requirements.

Piping

Impact of Pressure Drop and Piping Materials

Piping

Pressure drop directly affects blower temperature, and consequently, blower efficiency. Positive displacement blowers use external compression. This means the more resistance there is to airflow, the more energy they will consume. Additionally, while a blower may be designed for 15 psig, it will only operate at 15 psig if there is enough resistance to the airflow that would require 15 psig pressure from the blower.

Limiting pressure losses between the blower and the point of use reduces the load on the blower as well as the kW consumption of the machine, leading to lower operating temperatures and lower electrical costs.

Using larger diameter piping and eliminating elbows and T's whenever possible will help keep pressure drop as low as possible.

> "Reducing pressure losses leads to lower operating temperatures and lower electrical costs."

Piping: Materials

Piping material choices are crucial, as certain materials can lead to contaminant buildup and increased pressure drop.

KAESER advises against using PVC piping, despite its low cost and availability, due to significant limitations. PVC piping is not suitable for operating temperatures above 140°F, including Schedule 40 and 80. A thermal derating factor must be applied to determine the maximum allowable working pressure when temperatures exceed 20°C (68°F). Larger pipe diameters are also subject to faster derating.

Therefore, it is essential to understand how operating conditions will affect PVC piping if you currently use it or are considering it. For both pressure drop and safety, using an alternative material is generally recommended.

> PVC piping is not recommended for operating temperatures above 140°F—this includes Schedule 40 and 80 piping.

Burst PVC piping from a compressed air installation.

More Resources:
For more information on the dangers of using PVC piping, read our blog entry.

Preventive Maintenance

Keeping Your System Up and Running

Preventive Maintenance

All mechanical and electrical equipment needs regular attention to operate efficiently. Consistent preventive maintenance of your blower system ensures optimal performance, extends equipment life, and reduces costly downtime and repairs by maintaining an uninterrupted supply of flow.

Establish and follow a regular maintenance routine, as outlined in your blower service manual, and maintain a service log for each component. Taking a few minutes to perform these checks will maintain the quality of your flow and equipment, reducing the costs associated with repairs and lost production.

KAESER's integrated and screw blower packages are equipped with computerized controllers. These controllers monitor equipment health and operation in real time, provide maintenance interval reminders, and can send messages to plant control systems or directly to plant personnel responsible for the equipment.

> Regular preventive maintenance will ensure optimal performance and longer equipment life.

More Resources:
Click here explore our screw blower packages.

Need a service manual? Contact your local authorized KAESER representative.

Preventive Maintenance: General Guidelines

The following is a general list of maintenance items to monitor. Refer to your service manual for additional recommendations. The frequency of these tasks may need to be adjusted based on your application and operating environment. For further questions, please contact your local authorized KAESER representative.

Monthly:

- Check oil level via sight glasses.
- Check belt tension visual indicator.
- Check differential pressure indicator on silencer and enclosure.

Annually (or as noted):

- Tighten electrical connections: after the first 50 hours, then annually thereafter.
- Change oil: after the first 500 hours, then at least annually thereafter.
- Replace air inlet filter/silencer.
- Check safety valve and other safety device operation.

Every Three Years:

- Lubricate/replace motor bearings: permanent bearings every three years, regreasable bearings every five years.
- Replace belt set.
- Install check plate kit.
- Install start valve kit (if applicable).

Every Eight Years:

- Check compensator/hose lines.

> Keep in mind that, based on your application and operating environment, you may need to adjust the frequency of the service intervals.

Preventive Maintenance: General Guidelines

In addition to routine checks by your plant personnel, an effective preventive maintenance program includes regular professional servicing. While standard service intervals are typically based on manufacturer recommendations, more frequent servicing may be advisable depending on usage and operating environment.

KAESER's factory-trained, national distribution network is readily available to assist with your maintenance requirements. Please contact your local authorized KAESER representative to schedule a service appointment.

WARNING: Lack of proper maintenance may invalidate any warranty claims if failures are directly related to a failure to perform routine preventive maintenance. A preventive maintenance contract with your local KAESER representative is a means of having this work carried out properly.

CAUTION: Before performing any work, be sure to follow OSHA recommendations for electrical lock-out/tag out.

Safety Advisories

Health and Safety Considerations

Safety Advisories: Health and Safety Considerations

Adherence to all safety regulations, including OSHA and local guidelines, is paramount during installation. Compressed air is hazardous and must never be directed at individuals, as improper contact can lead to severe injuries such as eye damage, subcutaneous embolisms, and even death.

For technicians working in elevated areas, the use of appropriate harnesses and rigging is mandatory.

Only qualified technicians should perform electrical work, utilizing UL-approved materials, properly insulated tools, and suitable personal protective equipment (PPE). All relevant local, state, and national electrical regulations must be observed.

The blower system must be installed to guarantee safe operation and adequate ventilation, preventing any health or safety risks to personnel.

Hearing protection, in accordance with OSHA standards, is required. Signs warning of noise hazards should be prominently displayed where applicable. Refer to KAESER service manuals for blower operating sound levels.

Always follow OSHA recommendations for electrical lock-out/tag-out procedures and all safety guidelines outlined in the manufacturer's service manual.

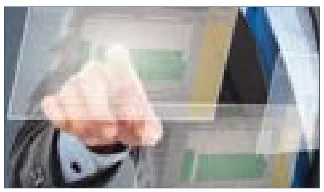
Additional Resources

More Tips and Resources

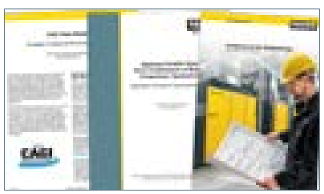
Additional Resources

KAESER Talks Shop - Blog
Our company blog features posts on a wide range of compressed air topics written by our subject matter experts and is updated regularly. You can also sign up to follow the blog to receive updates whenever there is a new post.

About CAGI
KAESER is a member of the Compressed Air and Gas Institute (CAGI), a non-profit organization of competitive companies that manufacture air and gas compressors and related equipment.



Compressed Air Resources
This web page has a collection of technical articles, material safety data sheets (MSDS), tools, presentations, and much more.



KAESER Air System White papers
Our collection of white papers provide in-depth technical information on challenges those in the compressed air industry are currently facing.

Our online KAESER Toolbox has a number of handy tools for making common compressed air calculations.

Appendices

Charts and References

Appendix A: Elevation Derate Chart for Motors

Altitude (ft.)	1.0 SF	1.15 SF
3,300 - 9,000	93%	100%
9,000 - 9,900	91%	98%
9,900 - 13,200	86%	92%
13,200 - 16,500	79%	85%
Over 16,500	Consult Manufacturer	

Appendix A: Elevation Derate Chart for Motors

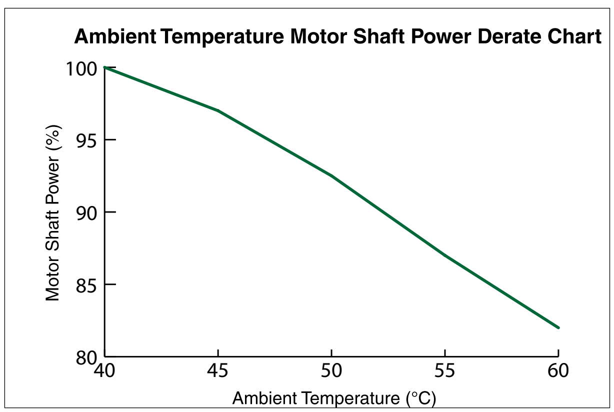
Motor derating:
Three-phase asynchronous motors Class F windings are designed by KAESER so that they are loaded to Class B at air cooling temperatures up to only 40°C, elevations up to 1000m above sea level and their mentioned rated power.

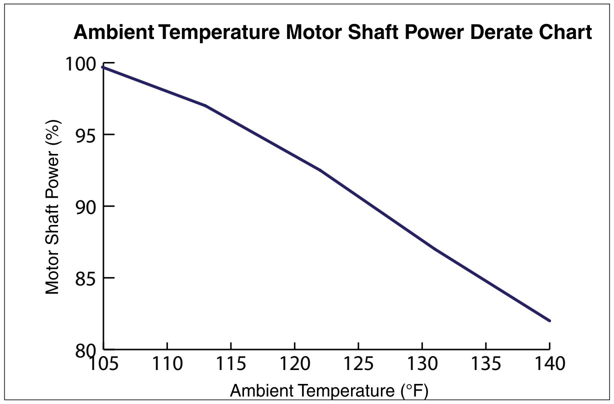
If these limitations are exceeded, the motor must be de-rated so that the motor windings used are Class F and not Class B.

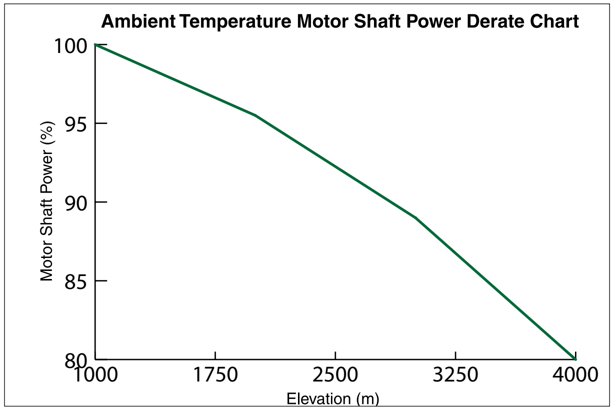
Mains voltage fluctuations, particularly under-voltage, can then lead to motor overheating, as there is no longer a reserve.

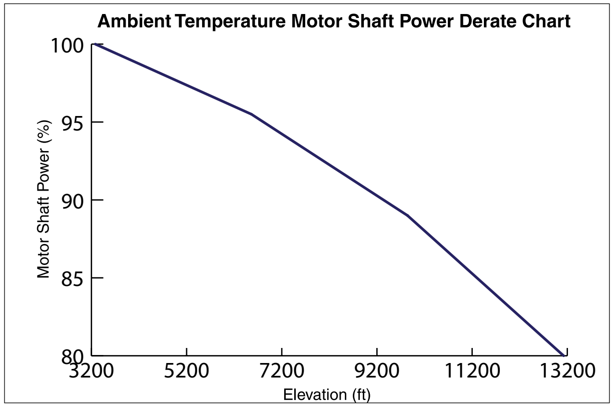
These diagrams should help in determining the motor shaft power depending on ambient temperature and elevation.

If derating is necessary because of simultaneously higher ambient temperature and elevation, the motor shaft power values must be multiplied together.









Appendix B: Helpful Formulas and Calculations

Thermal Output of Rotary Blowers:
$Q_{MOT.}$ Thermal output of the drive motor

Motor power:
- 3 - 7.5 kW ca. 14%
- 11 - 18.5 kW ca. 10%
- 22 - 55 kW ca. 7%
- 75 - 200 kW ca. 5%

The percentage values relate to the corresponding shaft power of the motors. Because of the V-belt transmission loss, these can be calculated as 1.03 times the block power consumption.

The thermal output of the motor increases by about 1% when under partial load down to half rated power.

Of the motor is driven from a frequency converter, the thermal output increases a further 3 - 6%.
- **Q_{KR} Thermal output of V-belt transmission:** ca. 3% of motor shaft power
- **Q_B Blower block thermal output:** 1 - 2% of block power consumption
- **Q_{SD} Silencer thermal output:** 1 - 2% of block power consumption

Overall thermal output:

$$Q_{COMBINED} \approx \sum_{i=1}^{n} Q_{MOT.} + Q_{KR} + Q_B + Q_{SD} \text{ [kW]}$$

Pipe work Thermal Output (not insulated):

$$Q_{LINE} \approx 3.2 \cdot 10^{-5} \cdot d \cdot l \cdot (0.6 \cdot T_2 - T_{AMB}) \text{ [kW]}$$

Because of the high flow velocity, the heat take-up of the gas is insignificant and can be ignored.
- d = pipe diameter in [mm]
- l = pipe length in [m]
- T_2 = blower discharge temperature in [°C]
- T_{AMB} = ambient temperature in [°C]

Appendix B: Helpful Formulas and Calculations

Volume flowing into the blower room:

$$V'_{BLOWER\ ROOM} = \frac{3600 \cdot (Q_{COMBINED} + Q_{LINE})}{\Sigma \cdot c_{\Sigma} \cdot \Delta T}$$

Σ= Cooling air density (1.19 kg/m^3 at 20°C, 1 bar)
c_{Σ}= Thermal capacity of air 1.0 kJ/kgK
ΔT= Room temperature rise 5-10 K

Airflow into the room not necessary if:

$$V'_{BLOWER\ ROOM} \leq \sum_{i=1}^{n} V'_{1\_Blower}\ [m^3/h]$$

Airflow into the room necessary if:

$$V'_{BLOWER\ ROOM} > \sum_{i=1}^{n} V'_{1\_Blower}\ [m^3/h]$$

Exhaust airflow from the room:
Blower air intake from the room (Figure 1):

$$V'_{INTAKE} = V'_{BLOWER\ ROOM} - \sum_{i=1}^{n} V'_{1\_Blower}$$

(If $V'_{INTAKE} = 0$, then $V'_{BLOWER\ ROOM} = V'_{1\_Blower}$)

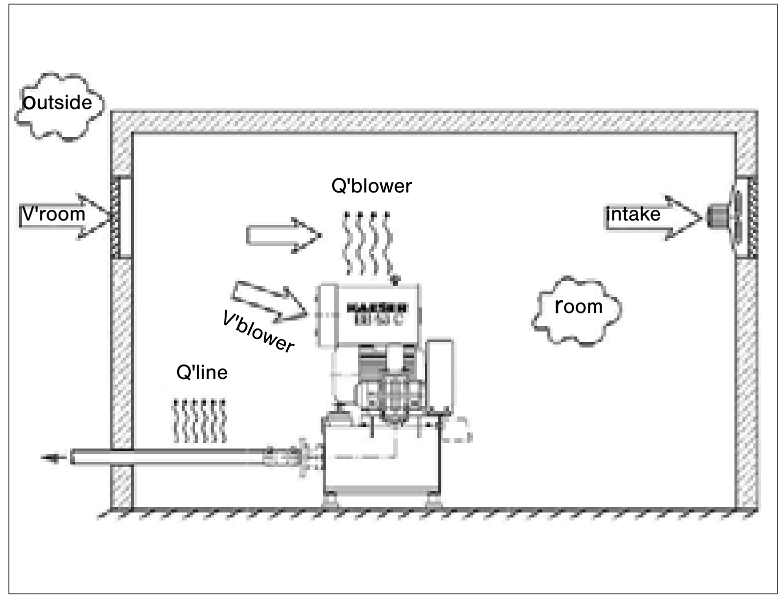
Blower air intake from outside the room (Figure 2):

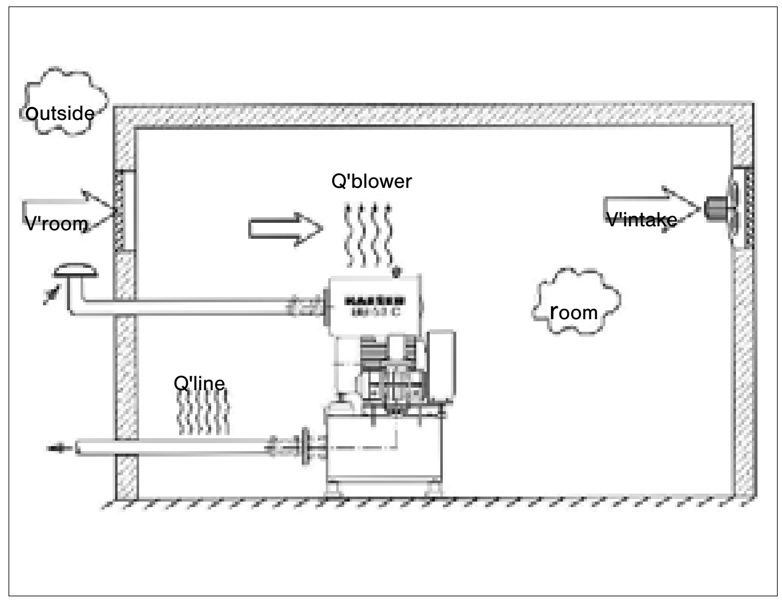
$$V'_{INTAKE} = V'_{BLOWER\ ROOM}$$

Effective cross-section areas of ventilation openings:

$$A_{EFF} = \frac{V'_{BLOWER\ ROOM}}{10800}\ [m^2]$$

Based on the recommended airflow rate of 3 m/s.





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