Understanding the Differences in Fans, Impellers and Blowers

Select either AC or Brushless DC models:

Tubeaxial Fans

- Readily available and inexpensive
- Many sizes and performances
- Good to excellent efficiency
- Axial air flow pattern

Axial & Propeller Fans

- Very high air flows
- Good efficiency
- Many sizes and performances
- Axial air flow pattern

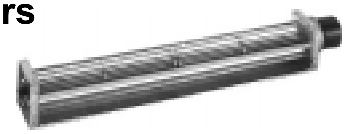
Backward Curved Impellers

- Compact package size
- Excellent efficiency
- Quietest performance
- Many airflow options
- Even, tangential air flow

Centrifugal Blowers

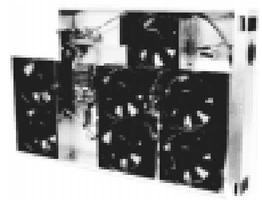
- Excellent pressure performance
- Very good efficiencies
- Air in axially – out tangentially
- Single or Dual inlet options

Crossflow Blowers



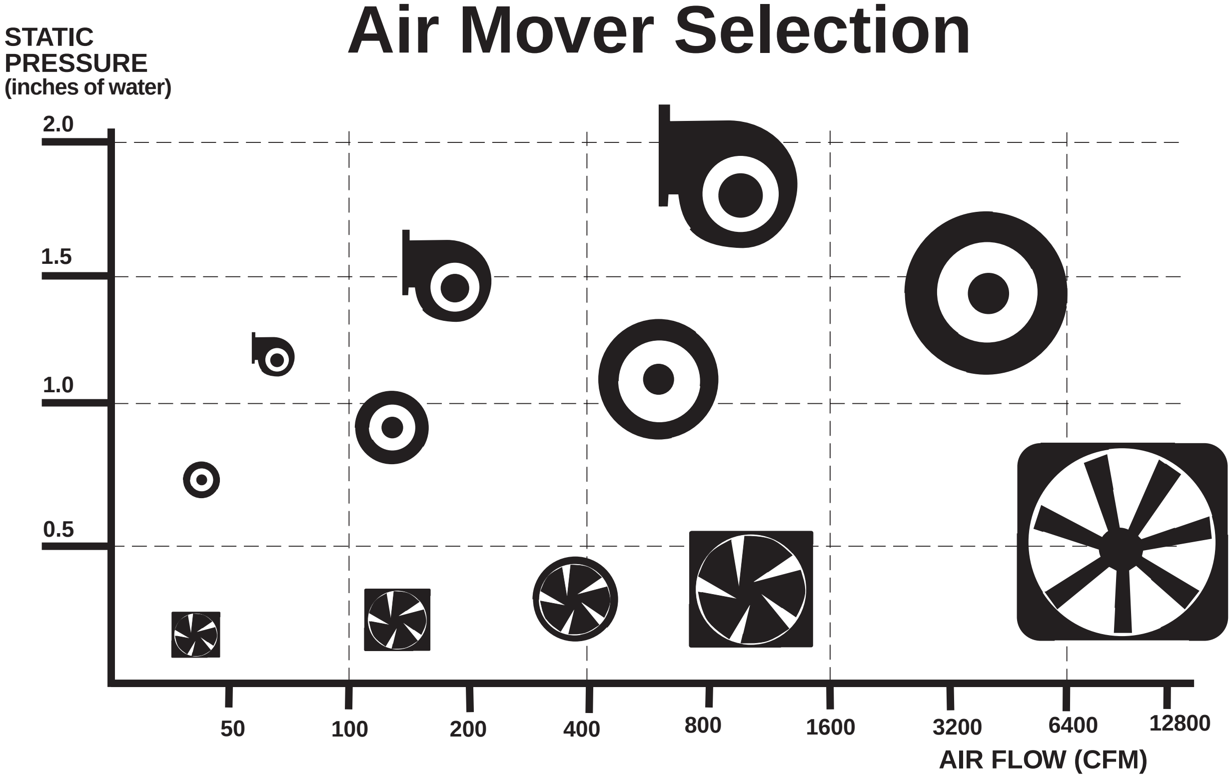
- Fair to good efficiency
- Narrow, controlled air flow direction
- Good for air curtains and paper/ converting transfer

Fan Trays & Flo-Thru Modules



- Compact, custom-fit package sizes
- Built-in redundancy, if needed
- Simple, space-saving designs
- Efficient, cost-effective solutions

Air Mover Selection



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Motor Design, Quality and Performance are Critical to Reliable Operation of Fans & Blowers

Most electronic systems create heat which needs to be removed. Blowers and fans are the most reliable, efficient way to control heat rise in electronic equipment. Although blower selection relies on a variety of design parameters, including air flow, system impedance, package size, electrical characteristics and acoustics, the motor which powers the impeller or fan is critical to safe and reliable operation and protection of valuable system components.

In most applications, the fan/blower motor operates continuously when the system in on and in operation. Although speed control is possible with most motors, it is rarely a major factor when selecting major features of the motor. Similarly, many of the common motor evaluation criteria are not major factors when choosing a fan or blower. Typical speed/torque curves are not important. Acceleration, deceleration are not critical. What is important? Long-life operation, maintenance-free performance, size, weight, efficiency and power compatibility with other components which are being assembled into one integrated system. The external rotor motor which is available in both AC and brushless DC versions provides the best performance and most reliable operation for most applications.

THE ADVANTAGES OF EXTERNAL ROTOR CONSTRUCTION

Since most motor heat is produced in the rotor, making it the rotating element and keeping the stator stationary (see Photo) have several very important effects on performance:

- More effective cooling improves reliability and extends the life of the motor
- Motor efficiency and size/output relationships are better than with induction-type motors.

Even if the external rotor motors operate at low speeds which in turn increases heat, current (amps) increases only slightly (in many internal rotor motors current often rises 30% to 40%). Superior cooling and heat dissipation from the motor still occurs because the air flow passes over the rotor. Speed control is very easy with external rotor motors by voltage reduction using fixed or variable resistors, auto-transformers, or electronic speed controllers. Speed control has better linearity, too.

Because motors are totally enclosed they run clean and stay clean for long life operation. Shorter lamination stacks reduce copper losses. Less induction is required to reach equivalent torque. The operating temperature range for most blowers or fans is commonly – 22° F to + 300° F (-30° C to + 150° C) but varies with motor type and power selection. Most AC motors include built-in overload protection by impedance or thermal cutout.

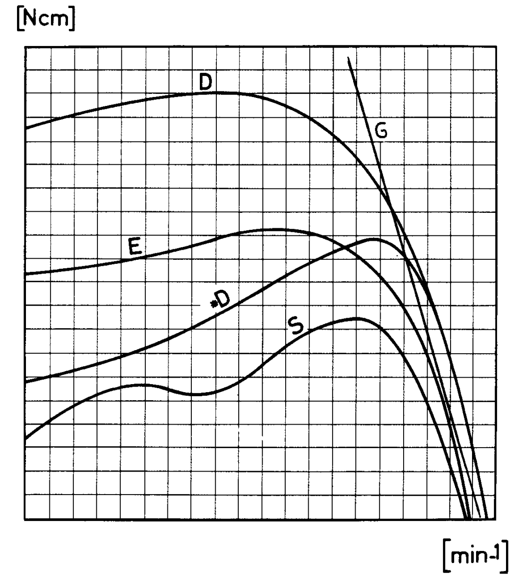
Many options can be added depending on user needs. They include: Hall Effect sensors, a choice of different alarms, different windings, dual voltage, constant speed back up if a speed controller fails, adaptation to substantial load changes, impeller attachment and a choice of bearing systems. External rotor motors are also better when multiple motors operate simultaneously in a system at a common frequency or speed, for example, using several fans in a fan tray or fan rack, or using one blower at an intake inlet and another at an exhaust outlet.

A VARIETY OF MOTORS

The motors used in ebm blowers and motorized impellers are either shaded-pole, permanent split capacitor or brushless DC designs with Class "B" insulation. AC units operate at 115V or 230V, 50/60Hz. Dual voltage (115/230 volt) motors, three phase motors and other special AC models rated from 12 to 440V are available on a special order basis. AC motors are thermally protected in accordance with UL, CSA and VDE requirements.

Brushless DC models are available in 12, 24, 48 and special voltages. Motors are up to 5 times as efficient as AC motors. Voltage can deviate ±30% from the nominal voltage. DC motors feature electronic locked rotor protection. Electronic features such as Hall effect for failure monitoring or output for external control, temperature sensing and control can be integrated in the motor. Dimensions will vary with each motor. NEW brushless DC motors and blower products are constantly being introduced. Call us for complete and current information, 860-674-1515.

The motor ratings listed correspond to the maximum power demand of the impeller occurring at zero static pressure.



S = Shaded pole motor: low starting torque, low efficiency
E = Single phase motor: high starting torque, good speed control, fair efficiency
D* = 3Ø motor with capacitor: high pull out torque, high efficiency, excellent speed stability
D = 3Ø motor: high starting torque, very high efficiency, good speed control characteristics
G = DC, brushless motor: highest starting torque, exceptionally high efficiency, 100% speed controllable.

SPEED CONTROL

All ebm external rotor motors are 100% speed controllable by voltage reduction or other means and operate at very low voltages without overheating or reducing reliability. The outstanding advantage of ebm/Papst motors, when speed controlled, is their STABILITY which permits proper balance between air flow and noise.

It is possible to make any ebm fan or blower with a PSC motor a multi-speed blower by adding a second or third capacitor on the load line (see wiring diagrams) at or near the value of the motor run capacitor. Actual capacitor value and RPM achieved are dependent on the uniqueness of the customer's application.

To maintain operating reliability of AC products, a reactive filter (sine filter) should be used when controlling speed with a variable frequency drive (VFD).

For brushless DC motors the speed/torque relationship is more linear than that of most AC induction motors. Speed control electronics can be built in to the DC motor assuring high quality performance of the motor and the air mover.

GROUNDING

Grounding can be achieved through mounting to the metal chassis. Additional ground connections on the blowers can include an unpainted M4 tapped hole or separate ground wire to meet VDE requirements.

HIGH QUALITY, SPACE-SAVING DESIGN

Flexible air flow design, long life and structural stability are inherent properties of all ebm fans, blowers and motorized impellers. The external rotor motor, shaft and impeller blades are each manufactured by ebm/Papst and assembled into a single unit which is dynamically balanced in accordance with DIN 1940.

The external rotor motor is mounted in the center of the fan or impeller to save space, improve efficiency and minimize the vibration that commonly occurs when the impeller is mechanically affixed to the motor shaft with set screw and hub.

ACOUSTICS

Sound measurements are made in an anechoic chamber at nominal voltage with a microphone one meter from the air inlet. Sound values are determined using a Bruel and Kjaer sound level meter 2131. Low noise levels are achieved by computer-aided-design of impeller blades and by precision manufacturing and balancing.

BEARING SYSTEMS

Product life will depend on ambient temperature, duty cycle, mounting position and environmental conditions. 100,000 operating hours is common. Bearings are totally maintenance free. MTBF and L-10 life information is available on request

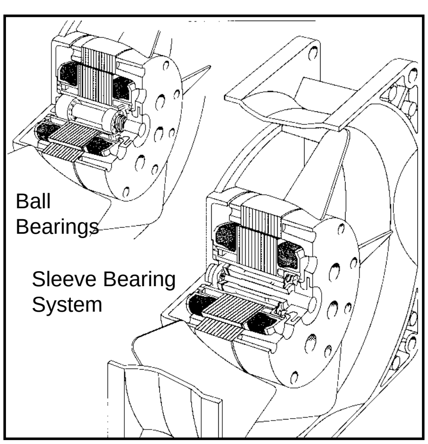
Two bearing systems are common in air moving products, sleeve bearings or ball bearings. ebm SINTEC SLEEVE BEARINGS utilize high technology to achieve outstanding performance in tubeaxial fans. The benefits of these porous double-sintered bearings are:

- Constant low-noise load during the lifetime of the fan, at normal speed ranges
- Long-life operation equal to the service life of ball bearings
- Lower shock sensitivity
- Extremely good temperature resistance

SINTEC BEARINGS are a single part bearing which has two precisely aligned bearing positions and an extremely large lubricant reservoir. Immediately after start up a dynamic lubrication film develops which prevents contact between the bearings and the shaft. The high temperature, non-aging, high viscocity lubricant penetrates the pores of the bearing to effectively reduce wear. SINTEC BEARINGS are available in both DC and AC tubeaxial fans.

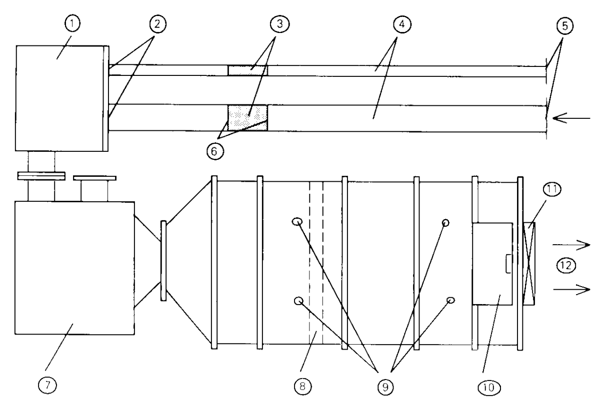
Several factors make it important to think about bearings in your selection of the proper motor you choose for a specific application:

- Two factors play a major role in bearing life:
  - Lubrication of the bearing
  - Operatiing temperature range
- Larger bearings extend operating life.
- Larger bearings reduce alignment sensitivity and permit more precise shaft positioning.



AIR PERFORMANCE

The air performance of ebm products is precisely determined in ebm's laboratory by using the test chamber shown. Blower performance curves are determined in accordance with DIN1952, DIN24163 and AMCA 210-85. A few blowers and motorized impellers must be operated against a minimum static pressure (as shown in the performance curves) to avoid overloading. The nominal CFM, watts and noise level figures listed correspond to the free air flow or minimum static pressure point on the performance curve.



1	Collector
2	Shutter
3	Venturi tube or nozzle
4	Ducts for different air vloumes
5	Air intake
6	Measurement of differential pressure, air volume
7	Auxiliary fan with shutter
8	Air flow straightener
9	Measurement of static pressure by pipe ring
10	Door
11	Fan under test
12	Direction of air delivery, free air

SAFETY

All fans and blowers are designed to meet existing UL, CSA, VDE AND CE standards. Approved products are listed in UL Files E54522, E76226, and E123518, CSA LR43145 and several VDE files. Products are also marked with the CE logo where applicable. It is the responsibility of the user to be sure blowers are installed and operated in accordance with all safety codes.

How to Select the Best Fan or Blower for Your Application

Every design engineer faces several problems when it comes to specifying an air moving device.
The biggest challenge is to integrate empirical and calculated data because all the parameters are not easily quantifiable, yet they are usually all interrelated. Here is a list of commonly considered design objectives for air moving devices:

- Optimize air flow efficiency
- Minimize form factor and fit
- Minimize acoustic disturbance
- Minimize power consumption
- Maximize reliability and service life
- Justify the "total" cost

STEP 1 is to determine the total cooling requirements which will be needed to operate the system efficiently and which will provide the desired operating conditions to maximize the performance and life from all components within the system. Three factors are critical:

1. The heat [ΔT] which must be transferred.
2. The heat transfer [W] in watts to offset ΔT.
3. The amount of air flow [CFM] in cubic feet per minute needed to remove the heat.

The formula for determining the necessary air flow is:

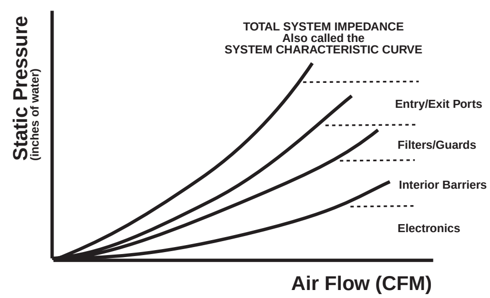
$$Q = \frac{1760 \times KW}{\Delta T_K}$$

Where:

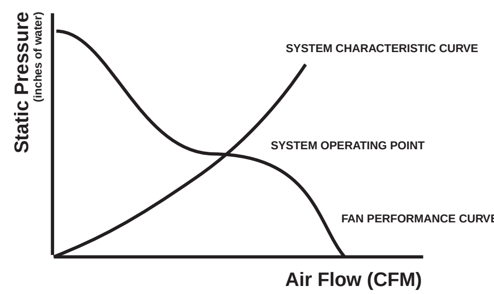
Q	=	required air flow in CFM
KW	=	heat to be dissipated
ΔT_K	=	Allowable temperature rise in Kelvins

Of course, it isn't this simple. Several other factors must be considered in conjunction with the basic heat rise: such things as cleanliness of the air passing through the system. Will it need to be filtered? Will it need to be isolated from the air within the cabinet or system? Can the air be exhausted back into the local environment or does it need to be exhausted to the outside. Which is better – pressurized air, exhaust air or some kind of push/pull approach? How important are other factors such as noise, power consumption, or form-factor (size) in determining which air moving approach is best for this specific application?

Determining STATIC PRESSURE
(Resistance of components to air flow)



THE OPERATING POINT
(Matching the Air Performance to System Resistance)



The Quick, Easy Selection Process

If the Watts to be expelled are:

50	100	200	300	400	500	1000	2000	2500	5000	7500

the CFM generally needed are:

9	18	36	54	72	90	180	360	440	880	1300

Because all fans are rated at 0" Static Pressure, Choose a fan or blower with higher CFM rating; we recommend higher rating of 20% to 30%:

12	23	45	68	90	113	225	450	550	1100	1625

STEP 2 is to define the total system impedance or System Characteristic curve of the enclosure or of the system which needs to be cooled. Once the load parameters are define in terms of the heat which needs to be removed or the number of air changes per hour that are required, and the required air flow (CFM) is determined, it is necessary to define the static pressure characteristics which the moving air will encounter as it passes through, over and around components located within the path of the air flow. All these elements which impede the flow of air create a pressure rise within the system which restricts free flow and passage of air. This change in pressure [ΔP] is the static pressure measured in inches of water.

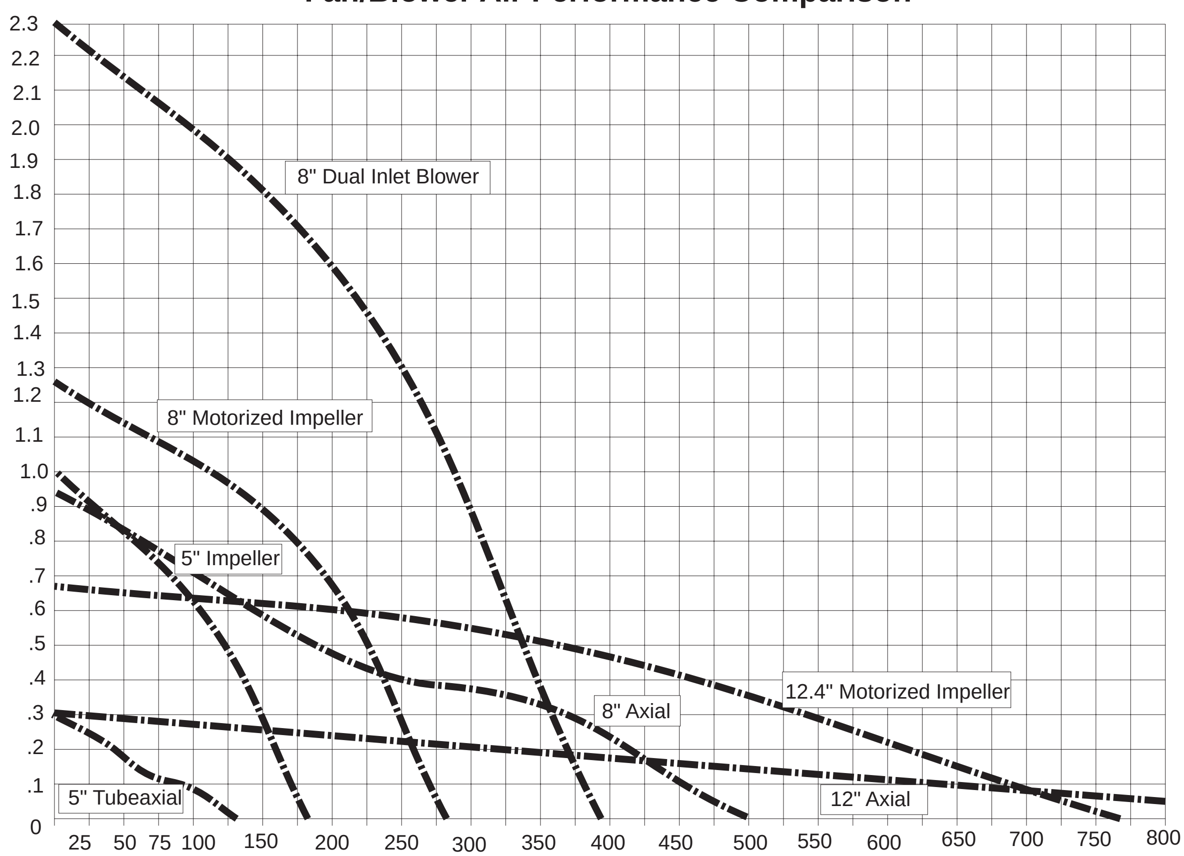
The System Characteristic Curve formula is:

$$\Delta P = K Q^n$$

K = system characteristic constant
Q = air flow, CFM
n = turbulence factor, $1 \leq n \geq 2$
Laminar Flow, n = 1
Turbulent Flow, n = 2

STEP 3, the final step, in solving the air moving challenge is the process of curve fitting which overlays your system characteristic curve on the air performance curves of selected, alternative, air moving devices. Points of intersection are "possible fits" as exemplified in the Operating Point graph. Now is the time to consider static efficiency. Static efficiency is the optimum relationship of air flow times static pressure divided by power. Rather than calculating this separately, it is most easily found by looking at the slope of the static pressure curve. When the Δ slope is at it lowest point in the fourth quadrant (270° to 360°) you can be assured that static efficiency is being maximized. The best air mover for your application will be the point of intersection of the system characteristic curve and the air performance curve when the intersecting point is on a rising portion of the fan curve, and when the rate of change in the slope is minimized.

Fan/Blower Air Performance Comparison



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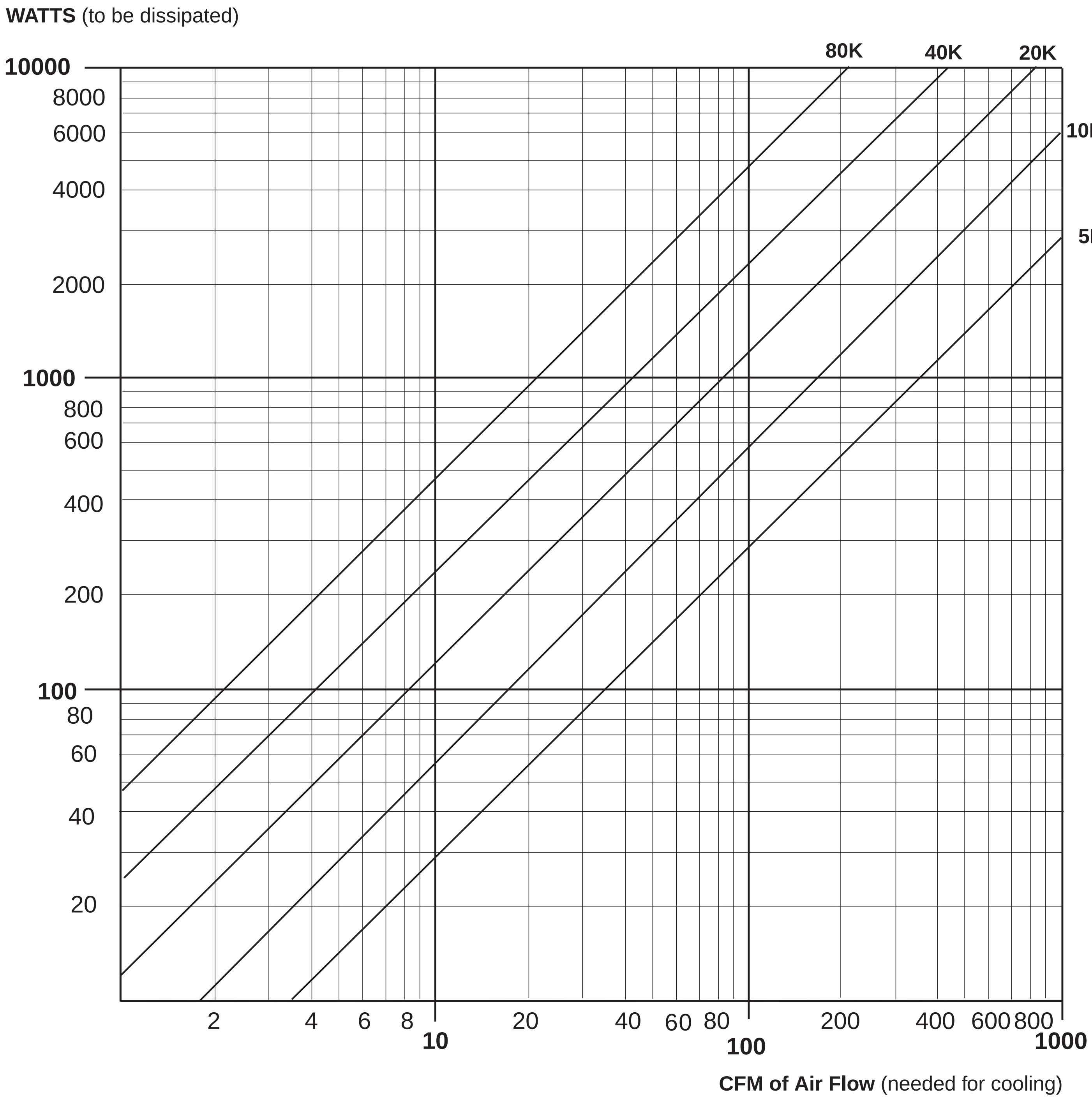
Matching Heat Dissipation to the correct Air Flow for heat transfer (of Watts):

NOTE: The CFM indicated should be the CFM provided at the suitable static pressure needed the system to operate effectively and to provide the required air flow through the system.



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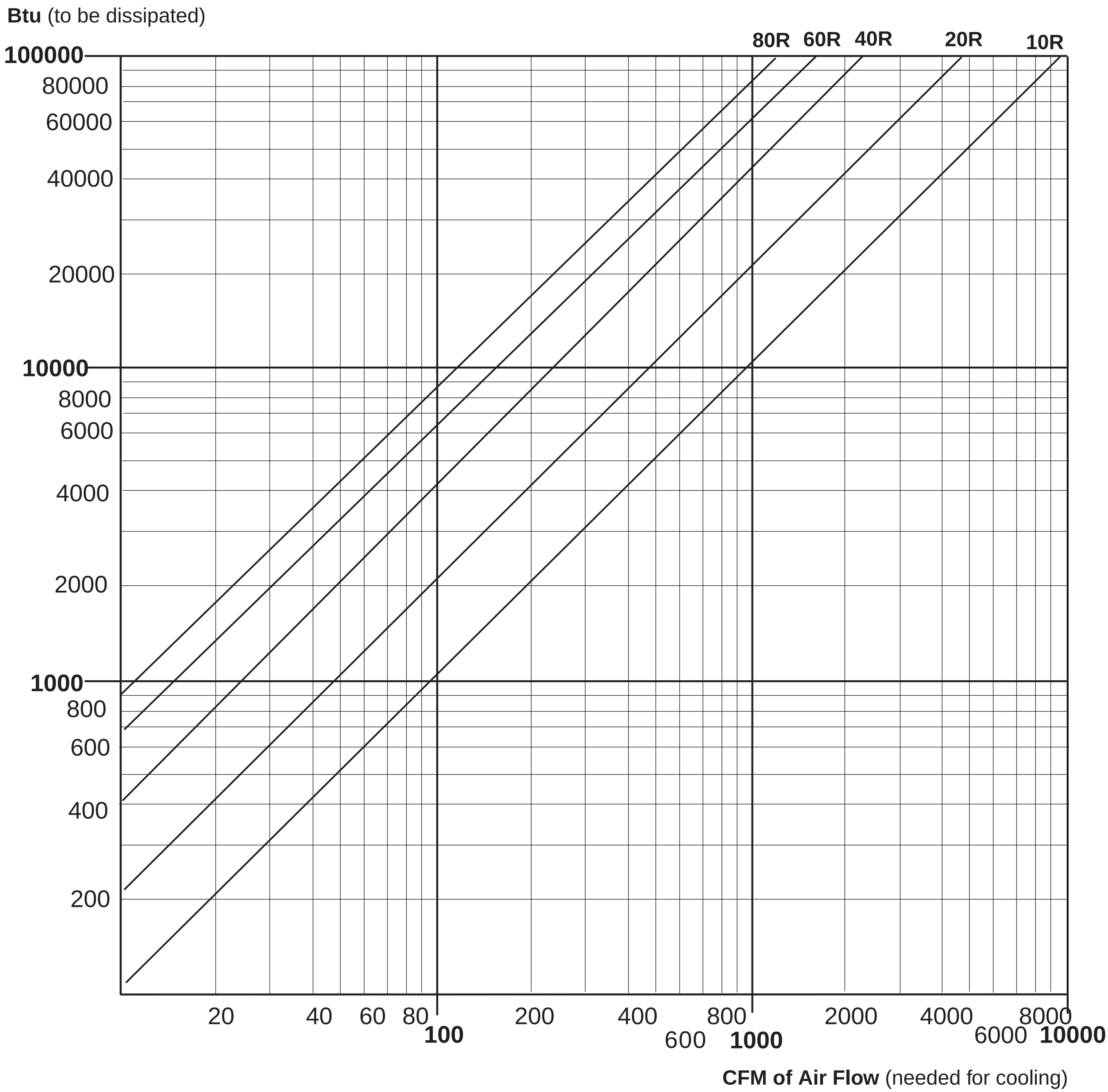
Matching Heat Dissipation to the correct Air Flow for heat transfer (of Btu):

NOTE: The CFM indicated should be the CFM provided at the suitable static pressure needed the system to operate effectively and to provide the required air flow through the system.



It is important to combine all the design criteria and determine the best way to evaluate and prioritize all the factors which play a role in the final selection of the right air mover for your specific application.

Some Basic Guidelines:

- Locate components with minimum heat rise closer to the air inlet and components with the highest heat rise closer to the exhaust end of the air flow path.
- A larger air moving device operating at a lower speed is the best way to reduce noise levels.
- If increasing the air flow causes a disproportionate increase in static pressure, the air passages or the exhaust outlets should be redesigned before any changes are made in the type or size of the air mover.
- 90% of the air flow passes through the blade or impeller tips, therefore, a filter must be placed far enough away to effectively use its entire surface area. Placing it too close will cause a ring to form close to the blade passage air.
- When directed volumes of high velocity air, such as forced air cooling of high horsepower drive motors) is required, centrifugal blowers should be selected. Preferable ones with external rotor motors which mount directly to the impeller to eliminate the extended shaft, hub, set screws and any maintenance problems.

Advantages of placing the air mover on the inlet side:

- Positive pressure is maintained which prohibits dust and dirt from entering through unsealed cracks and openings.
- Increased turbulence within the system improves overall heat transfer within the system and through exhaust outlets.
- The life of the air mover is extended because of lower operating temperatures.
- Ball bearings are preferred because they last longer and :
  - are maintenance-free
  - mount in any position
  - align better and have longer life expectancy than smaller sized bearings
  - have better temperature and life ratings than sleeve bearings
  - have lower breakaway torque (110 to 125%) than sleeve bearings (130 to 150%).
- Fan/blower life is extended when they are operated at lower temperatures.

Advantages of placing the air mover on the exhaust side:

- Better control of air flow through location of inlet openings near heat sources.
- Reduced noise levels because the exhaust is usually located away from user's hearing.
- Heat generating devices, if located near the air mover, will be placed away from the user, away from non-heat producing passive components and close to the exhaust opening which will eliminate the effect of heat on the rest of the system.

Air Performance is Only One Selection Factor

Now, the basic air performance calculations and selection criteria are behind us. It is time to evaluate other important design criteria:

NOISE – For most equipment this is a very important consideration. There are two basic sources of noise: 1.) Mechanical or moving components such as bearings or fasteners. 2.) Sound frequencies generated by air moving over, around or through parts and components. Tubeaxial and axial fans create a blade passage frequency which backward curved motorized impellers do not. A few tips to help reduce noise are:

- Larger and slower air movers are more quiet than smaller and higher speed air movers.
- Designing larger openings permits larger quantities of low velocity air to move at reduced noise levels.
- Think about the listening position – the location of sound emission relative to where the sound is heard is vital to determining its disruptive influence on the listener.
- Lower frequency sounds (pure tones) reduce interruptive noise. Blade passage frequencies are generally high frequency sounds (over 750 cps) and are more bothersome to the human ear.
- Mounting distances, from obstructions, reduce noise. More distance lowers noise, i.e. fingerguards or grills.
- Placement of "muffling", baffles and sound-proofing helps cut noise emissions.
- Effective speed control can help control noise.

PERFORMANCE / RELIABILITY –
This is the overall quality of the air moving product. It ranges from ISO 9001 certification, to SPC documentation, to life-cycle product testing, to FEMA geological charts, to pursuit of 6s quality levels sought by some major purchasers. The key here is documentation, not promises. Make sure your prospective suppliers can provide you with the documentation you need and require once you start installing and using their products. The time to discuss quality is up front in the design stage, not as you are about to place the purchase order.

POWER – Selecting AC or DC, particularly brushless DC, motors affects performance, reliability and life. The advantages of a brushless DC external rotor motor are numerous. In addition to a favorable form-factor (compact size because the motor is mounted within the blade or impeller), these motors eliminate voltage and frequency variables, reduce EMI (compared to AC units), operate more safely at 12, 24 or 48 volts, include built-in electronics for speed control, Hall Effect monitoring, smoother acceleration and reverse polarity protection. Here are some power considerations:

- Voltage and frequency requirements
- Power supply sizing
- Motor size profile
- Speed control
- Bearing system
- Available/Desired options

SIZE – Historically, when design engineers needed to move more air, they would simply add more fans. So, racks of 4, 6, or 9 tubeaxial fans were an easy solution. In today's world of higher densities (higher static or back pressure levels), smaller package sizes, ergonomic and environmental considerations, design engineers are finding new, better solutions, not "add-on's". One example of this is the increasing use of backward curved motorized impellers, which basically look like flying saucers. Air is drawn into the center of the wheel, or impeller, and is discharged 360° around the sides. There are several advantages to this versatile design:

- A shallow form-factor, narrow depth
- Good performance against higher pressures
- Easy mounting without an expensive housing
- Excellent noise characteristics
- Proven reliability in open spaces with only an inlet ring to control incoming air. they are also easy to place in fabricated boxes or flow-through modules, which fit standard rack enclosures, or can be manufactured to fit specific cabinets or systems.
- Lower total cost of operation and assembly in most applications.