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How to choose the correct fan or the blower for your applications?

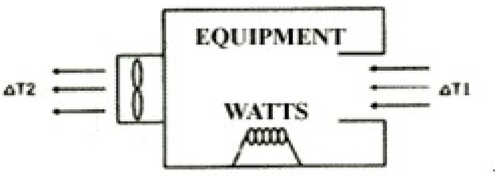
GTS-prima always take it as our mission to help global users to find the most proper thermal solution for their application.
All of designers or manufacturers in electronic fields which need fan to dispel the heat must determine the air flow needed to dissipate heat from a given system. A required air flow is determined by knowing the power consumption in the system and the amount of air needed to remove sufficient heat from the system to limit its rise in temperature. In fact, the service life of a system will be typically decreased by insufficient cooling system. The designer should also know that the price or the sales will be reduced if the service life of the system does not meet the user's expect.

To choose the correct ventilation fan, the following items should be considered:
The high efficiency of air flow
The most suitable size
The minimum noise
The lowest power consumption
The Maximum reliability and The longest service life
The most reasonable price

The following steps can help you to reach above-mentioned goals :

Step one: To know the total cooling demand, three key factors which can influence the total cooling demand are as follows:
1. The heat need to be transferred (DT difference temperature)
2. the watt of converted heat must be Offset (W)
3. the needed amount of air flow in order to move the heat (CFM)
The total cooling demand is very important to operating the system effectively. Efficient systematic operation must offer the desired operation condition , enable the component in all systems to give full play to function and the longest service life .

Step two: After getting the total cooling demand , the air flow can be worked out by the following methods :
1. Calculate the heat produced inside of the equipment.
2. Determine the temperature rise range which can be allowed inside of the equipment
3. Calculate the necessary wind amount from the equation.
If distribute the heat and rising amount of total temperature of allowing within the known system equipment, the cool wind amount equipment can be got.



The following is a basic hot conversion equation: $H = Cp * W * \triangle T$
H=The amount of heat transferred Cp = specific heat of air $\triangle T$ = Temperature rise inside the equipment W = Air weight Obviously $W = CFM * D$ D = The air density , we can receive the following heat dissipation equations by substitution

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after knowing the specific heat and the density of the sea level air : CFM =3160 * Kilowatt / / △℉

Example one: the power consumption inside of the equipment is 500w, The DT is 20 degrees Fahrenheit, the following is its result of calculation:

$$Q = \frac{3.16 \times 500(watts)}{20} = 79CFM$$

or

$$Q = \frac{0.09 \times 500(watts)}{20} = 2.25 \, M^3/Min.$$

Example two: the power consumption inside of the equipment is 500w, the DT is 10 degrees Centigrade:

$$Q = \frac{1.76 \times 500(watts)}{10} = 88CFM$$

or

$$Q = \frac{0.05 \times 500(watts)}{10} = 2.5 \, M^3/Min.$$

Conversion table of the wind amount

M^3/s	m^3/min	l/S	l/min	m^3/n	ft^3/S	CFM
1	6×10	1×10^3	6×10^4	3.6×10^3	3.531×10	2.118×10^3
1.66666×10^{-2}	1	1.66666×10	1×10^3	6×10	5.885×10^{-1}	3.531×10
1×10^{-3}	6×10^{-2}	1	6×10	3.6	3.531×10^{-2}	2.118
1.66666×10^{-5}	1×10^{-3}	1.666×10^{-2}	1	6×10^{-2}	5.9×10^{-4}	3.54×10^{-2}
2.77777×10^{-4}	1.66666×10^{-2}	2.77777×10^{-1}	1.66666×10	1	9.81×10^{-3}	5.886×10^{-1}
2.832×10^{-2}	1.69833	2.832×10	1.69833×10^3	1.019×10^2	1	6×10
4.72×10^{-4}	2.831×10^{-2}	0.472	2.831×10	1.6983	1.66666×10^{-2}	1

conversion table of Static pressure

Pa=N/m	MmH2O	InH2O	Kgf/cm	afm	bar	lbf/in
1	1.0197×10^{1}	4.017×10^{-3}	1.0197×10^{-5}	9.869×10^{-6}	1×10^{-5}	1.450×10^{-4}
9.80665	1	3.939×10^{-2}	1×10^{-4}	9.678×10^{-5}	9.806×10^{-5}	1.422×10^{-3}
2.49×10^2	25.4	1	2.54×10^{-3}	2.46×10^{-3}	2.49×10^{-3}	3.61×10^{-2}
9.80665×10^4	10^4	3.937×10^2	1	0.9678	0.980665	14.2234
1.01325×10^5	1.0332×10^4	4.071×10^2	1.03323	1	1.01325	14.6960
1×10^5	1.0197×10^4	4.018×10^2	1.01972	0.986923	1	14.5038
6.895×10^3	7.031×10^2	27.686	7.031×10^{-2}	6.805×10^{-2}	6.895×10^{-2}	1

In Thermal management, fans are classified as objects that forces air at a volumetric rate to cool certain devices, like a CPU microprocessor. There are numerous types of air moving products including axial, propeller, and tube axial fans. Other air movers consist of impellers and blowers (centrifugal & cross flow). Fans, impellers, and blowers could be distinguished by their size, shape, but more importantly, the flow of air (measured in CFM) given the static air pressure. A fan can basically have a high output of CFM, but at a lower level of air pressure, whereas blowers and impellers move smaller amounts of air at a greater level of pressure.

Basic Description of Fans, Impellers, and Blowers

Fans: Tube axial fans could vary in many sizes, from 20x20mm (0.79" inches) to 172x51mm (6.77 inches). They are relatively inexpensive and readily available due to the high volume usage in the automotive, computer, and power supply markets. For its low cost, using tube axial fans is an efficient approach to dissipate heat. Fans: Axial fans have high performance airflows, relatively good efficiency, and has an axial airflow pattern. Also known as "box fans", the optimal operating performance of axial fans is at low-pressure or low system impedance conditions. One special characteristic is that acoustics could be reduced or increased by simply modifying the speed of the fan.

Impellers: Impellers have the best performance when it comes to noise. Typically, they are less powerful when it comes to airflow, but impellers do have various airflow alternatives, including tangential air flow. Extremely efficient, there is greater pressurization in water with impellers than fans.

Blowers: Blowers are usually installed in high system impedance that requires a backpressure, like in network servers and telecommunication systems. A drawback for blowers is their high level of noise compared to fans. Some benefits include more concentrated airflow (largely due to its ability to in take air from one side and release air directly onto the unit that requires cooling on the other); a circular impeller that provides direct airflow given a substantially high-pressure environment; and blowers have option for single or dual inlets.

GTS Fan Composition

GTS sells both inductive AC and brushless DC fans. The major raw materials that are used in the production of our fans include the following: housing, impellers, rotor, bearing, PC board, lead wires, and terminal leads (AC only).

Housing:

- The housing material on GTS DC fans is made of a plastic material which is UL 94V-O, has a P.B.T. +30% GF black, has various dimensions, and usually 4 poles for convenient installation.

- Most AC fan housings is made of an aluminum painted / plastic material.

Impellers:

- The blades on the DC fans are of a plastic material with UL 94V-O P.B.T., whereas the AC line is made of thermoplastic material.

Rotor:

- The rotor runs in a counter-clockwise direction. GTS fans have a locked rotor protection where the fans were tested for a continuous period locked at the rated voltage and no damage was made.

Bearing:

- Bearings can be classified as sleeve, dual ball, and ball/sleeve. GTS bearings have a life of 35,000, 50,000, and 65,000 for sleeve, ball/sleeve, and dual ball, respectively.

PCB Board:

- A PCB board is built into the fan and acts as the central control that keeps the fan operating. Special functions, like alarm and speed sensor function can be added to the PC board to detect abnormal operating conditions.

Lead Wire:

- Both DC and AC fans can have lead wires to connect to a power source. The standard lengths are 12 inches or 7 inches. Customers may specify lead wires to any length necessary for an application.

Terminal Leads:

- Sometimes, in the design process, customers would like to do away with dangling wires. Terminal leads offer an alternative for those customers who have done so. Unfortunately, GTS only provides this alternative for our AC line at the current moment.

Selecting the Right Fan (Part I)

Measuring Heat

The main purpose of a fan is to cool other components; therefore, the most important factor to consider before choosing a fan is exactly how much heat dissipation is necessary. The amount of heat transferred could be derived using the following equation:

$Q = m\ C_p\ DT$

Where,

Q = the amount of heat transferred to system, Watts C_p = the specific heat of air, J/kg x K

m = the mass flow rate of air, kg/s

DT = the desired air temperature differential (cabinet to ambient outside air), K

Yet, there still a relationship between mass flow rate and volumetric flow rate:

m = rG

Where,

G = the volumetric flow rate, m3/s

r = the air density, kg/m3

Therefore, the required volumetric flow rate is then calculated as:

G = Q / (rCp DT)

By utilizing this formula, a rough estimate of the airflow to obtain the desired overall air temperature rise in DT, but it does not specify actual airflow. Actual operating airflow is determined by the intersection of the fan curve and the system resistance curve. This point of intersection can be calculated using one of three approaches.

1) Airflow network methods:

For this approach to be effective requires certain criteria to be true. First, the flow path to the cabinet must be known or roughly estimated. Secondly, the geometry must remain simple, meaning the three-dimensional flow path cannot be complex.

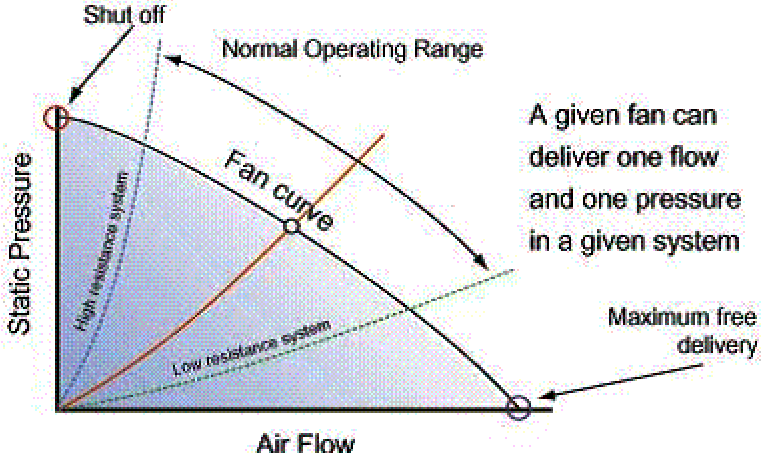
2) Computational commercial software:

When the flow path is more complicated, the use of computational fluid dynamics (CFD) may simplify things greatly. A fan's performance curve is used as reference input to the CFD software where the operating point and system resistance is determined. While even taking into account the effects of turbulence and gravity, CFD assesses the flow of air and heat transfer in a three dimensional view, as in a real life application. Even more complex calculations, like fans in series or in parallel formation, can be easier analyzed using CFD software.

3) Experimental evaluation mockup of the system:

The total airflow or the system resistance curve can be measured using the experimental method. In this method, the operating airflow is obtained when the engineer superimpose the airflow and system resistance curve.

Regardless of how the operating airflow within a system is derived, all systems are depicted by a system resistance curve as the one shown below.



This non-linear expression of airflow versus static pressure can be stated as:

DP = KrGN

Where,

DP = system pressure loss
K = the load factor specific to the system
r = density of air
G = rate of airflow
N = a constant which varies between 1 and 2. If N=1, then airflow is completely laminar. If N=2, then completely turbulent.

Once actual airflow is determined, a comparison between actual and required airflow need to be evaluated. If the actual value is considerably less than the required value, the packaging system must be reexamined so the diminishment of airflow resistance can be asserted and renovated.

In summary, the first and foremost important factor to choosing your fan is determining the airflow and the required pressure to move the volumetric rate flow to dissipate heat within your system. Before first making this analysis, to determine other factors like fan dimension, bearing, and the need for special functions might be meaningless or irrelevant. Part I serves as an introduction to understand the main purpose of a fan and equations necessary to determine basis of fan selection. In Part II, we will continue to explore other important variables such as noise, voltage, and bearing, which are more specific to the selection of a fan. Furthermore, in the proceeding section, other alternatives like fans in series and in parallel will be offered to the reader as a consideration in the selection process.

Selecting the Right Fan (Part II)

In Part I, we established the basis of selecting a cooling unit by determining the most important attribute, which is the airflow given a static amount of pressure. In the section, "What is a fan," we described the composition within a fan but since there are different variables within each attribute, the major issue is to determine which combination of variables is best suited for the application. Furthermore, the reader will find a brief analysis of using multiple fans and a small portion devoted to selecting a fan from an economical standpoint in this section.

What is the best combination of variables to choose?

There is no universal answer to the above question because each application is unique due to the originality of the engineer. For example, ten years ago, computers used a 92x92x25mm to cool the internal system. Today, we have engineers designing their computers using both a 60x60mm and an 80x80mm. And hypothetically speaking, engineers might create desktop computer systems using just a 40x20mm fan ten years from now.

Though impelling air is the most important concept when choosing a fan, one cannot ignore size. An illustration of how important size is can be observed in laptop computers. Due to portability, the evolution of laptops has changed greatly in terms of compactness. Today, one can walk into an electronic store and find laptops that are less than one inch thick. This makes it absolutely impossible and impractical to install a fan with 25mm thickness because there would be no room for operation. And if a fan becomes non-functional, the amount of air exerted by it is irrelevant; therefore, size is a mandatory decision based on the design by the engineer.

Next, using the correct voltage is important. Voltage is very product specific and in some cases, industry specific. In the telecommunications industry, it is very common for engineers to use 48-volt DC fans. The components on the PCB require a great deal of power. To employ a fan with low voltage might cause the fan to burn out. Eventually, without a fan to dissipate heat, product failure becomes inevitable.

Other attributes of a fan like noise and bearing are also important because it enhances the concept of quality in the end product. For bearing, GTS manufacture fans with dual ball, sleeve, or a hybrid, ball/sleeve. These three types of bearings can be distinguished by price and the quality each one adds to the fan. Dual ball fans last longer in terms of operation hours; therefore, are most expensive. These fans last up to 60,000 hours. Next in line would be fans that are assembled using ball/sleeve bearings. These fans typically operate for 50,000 hours. As for sleeve bearings, they cost the least and function for around 30,000 hours.

Noise is an attribute that varies based on fan speed and bearing. One approach to reduce acoustical noise is by assembling a fan using a sleeve bearing. Overtime, however, when the sleeve bearing loses lubrication (which it does so faster than ball bearing), noise level will increase beyond fans with ball bearing. Another alternative to modifying noise level is to control fan speed. As the velocity of a fan rise, so does noise level. In effect, a direct correlation can be drawn between noise and airflow.

Finally, there exist value-added features for fan performance monitoring and failure detection. Lets take GTS's 120x120 DC models for example. Large fans have a higher likelihood of failure because of heavier composition material. GTS's 120x120 come standard with an auto-restart function to prevent fan failure. Once the fan stops or locks up, it will stop running and restarts itself after 2 - 6 seconds.

Some engineers may like to design fans with speed control to conserve power. GTS offers these engineers a thermistor speed control option. While in operation, a temperature sensor is in place to automatically regulate speed. If a system's internal temperature rises, the sensor will detect the change and speed up the rotation of the fan's rotor.

The consideration of multiple fans

Previously, the idea of using two or more fans was mentioned as an option. Utilizing more than one fan has its benefits. First, using two smaller fans rather than one large fan may save additional space inside the system. Also, by applying multiple fans during design can increase the airflow and pressure to reduce heat transfer. Two techniques being applied by engineers are 1) having fans in series and 2) having fans in parallel.

Fans in Series - Fans in series is simply having two fans operating one above the other. This technique achieves the most desired results in systems where resistance is high. Since static pressure nearly doubles when fans are in series, this technique might welcomed where there is a great amount of distance between the fans and the components that require cooling in the system.

Fans in Parallel - This technique is when multiple fans are set side by side. Different from fans in series, having fans parallel operates best in systems with low resistance. Likewise, parallel fans increases not static pressure but airflow.

Regardless of which method is used, a caution of using multiple fans is that too many will cause instability to the performance curve.

Price as the determining factor

Buyers who see fans as common commodities usually use price to form their final decision as to which manufacturer to choose. However, the importance of quality can never be over-emphasized. Some people have used the analogy of comparing systems to humans. If that is the case, the fan within the system is equivalent to the lungs in a human. Without healthy lungs, humans have a hard time breathing, sometimes leading to fatality. Likewise, if a fan stops operating, the system will be disrupted and in the long run malfunction due to over heating. GTS fans are most definitely price competitive, but unlike ordinary lungs, fans sold by GTS are of excellent quality and have great features to make sure the fans live up to their life expectancies.

Basically, the choice of fan is pretty much left up to how engineers wish to design their products. The essential concept to keep in mind is how much airflow is required to cool the enclosure. Once realized, the designer can then opt for the best method and characteristics.

With the goal in becoming a worldwide innovation leader in fans and motors and other thermal solutions , GTS-Prima has the ideal thermal solutions for virtually all ventilation technology and drive engineering missions. If we do not have it already, our more than 50 engineers and technicians will work out a most proper one for you.

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