How to Select the Right Fan or Blower

All of designers in electric and electronic fields determine the air flow needed to dissipate heat from a given system. A required air flow is determined by knowing the power consumed in the system and the amount of air needed to remove sufficient heat from the system to limit its rise in temperature. In fact, years of experience has shown that the service life of a system is typically decreased by insufficient cooling system. The designer should also know that the price or the sales may be reduced if the service life of the system is not user expected.

To select a right air moving device, one has to consider the objectives in the following list.

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

Here are three essential steps to select a right fan or blower for your application to achieve objectives in above list.

STEP 1:
The Total Cooling Requirements

STEP 2:
Total System Resistance / System Characteristic Curve

STEP 3:
System Operating Point
STEP 1: The Total Cooling Requirements

The first step is to recognize three critical factors to obtain total cooling requirements. There are:

• The heat (DT) which must be transferred.
• The heat transfer (W) in watts to offset DT.
• The amount of air flow (CFM) needed to remove the heat.

The total cooling requirements are critical to operate the system efficiently. An efficient operating system is to provide the desired operating conditions that maximize the performance and life from all components in the system.

When making the selection of the fan motor for ordinary use, the following methods are used.

• Determine the amount of heat generated inside the equipment.
• Decide the permissible temperature rise inside the equipment.
• Calculate the air volume necessary from equation.
• Estimate the system impedance in the unit.
• Select the fan by performance curve shown in the catalogue or data sheet.

The volume of air flow required to cool an equipment can be determined, if the internal heat dissipation and the total rise in temperature allowable are known.

\[ H = C_p \times W \times \Delta T \]

- \( H \) = Amount of heat transferred
- \( C_p \) = Specific heat of air
- \( \Delta T \) = Temperature rise within the cabinet
- \( W \) = Mass flow

\[ H = C_p \times W \times \Delta T \]
Then, we obtain the following equations:

\[
Q \text{ (CFM)} = \frac{3.16 \times P}{\Delta T_f} = \frac{1.76 \times P}{\Delta T_c}
\]

\[
Q \text{ (M}^3/\text{Min}) = \frac{0.09 \times P}{\Delta T_f} = \frac{0.05 \times P}{\Delta T_c}
\]

Q : Required air flow
P : Internal heat dissipation
Tf : Allowable temperature rise in °F
Tc : Allowable temperature rise in °C
D T = D T1 - D T2

Obviously we have
W = CFM x D
where, D = Density
By substitution, we obtain:

\[
Q \text{ (CFM)} = \frac{Q}{C_p \times D \times \Delta T}
\]

By incorporating conversion factors and specific heat and density for sea level air, the heat dissipation equation is arrived at:

\[
Q = \frac{3.16 \times 500\text{(watts)}}{20} = 79 \text{ CFM}
\]

or

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

Example 1: If the internal heat dissipation is 500 watts and D T is 20 °F.
The following is the result:

\[
Q = \frac{3.16 \times 500\text{(watts)}}{20} = 79 \text{ CFM}
\]

or

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

Example 2: If the internal heat dissipation is 500 watts and D T is 10 °C:

\[
Q = \frac{1.76 \times 500\text{(watts)}}{10} = 88 \text{ CFM}
\]

or

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

### The Conversion of Temperature vs. Air Flow

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In order to specify the cooling per slot in watts, the system designer/manufacturer must not only have a valid air flow curve to determine the maximum air flow, but must also know the system air resistance curve. There is a loss of air pressure due to resistance of components inside the enclosure. This loss varies with air flow and is known as system resistance.

The System Characteristic Curve formula is:

$$\text{DP} = KQ^n$$

- $K$ = system characteristic constant
- $Q$ = air flow, CFM
- $n$ = turbulence factor, $1 < n < 2$
  - Laminar Flow, $n = 1$
  - Turbulent Flow, $n = 2$

**STEP 3 : System Operating Point**

The intersection point of system characteristics curve and air performance curve of selected air moving device is named System Operating Point that is the best air moving device for your application.

The Operating Point:
At the point, the change in slope of the air performance curve is minimized while the change in slope of the system characteristics curve is at its lowest. Note that the static efficiency (air flow times static pressure divided by power) is also

Designing Considerations:
1. Keep the air flow path as unobstructed as possible. This air intake and outlet should be kept free for air flow.
2. Guide vertical air flow through your system, it will assure the flow moves more smoothly and increase cooling efficiency.
3. If a filter is required, you should consider the additional resistance to air flow.
Examples of selecting a best fan for your application:

Example 1. Figure #1 is an air performance curve of one of typical SUNON DC Cooling Fan, 60x 60x 25 mm. The fan might be, for example, applied at Point A or Point C, delivering 6 CFM or 20 CFM respectively, if the system resistance were imposed a pressure drop of 0.16(Point A) or 0.04(Point C) Inch-H2O on the air stream. If the system can be modified to apply at Point B, the fan might be delivering more than 12 CFM at a pressure of only 0.09 Inch- H2O.

Example 2. As shown in Figure #2, Curve 2 is a fan of the same size and configuration but lower speed than Curve 1. If the system requires only 15 CFM at 0.05 Inch-H2O, the pressure drop/flow rate parabola is through Point B. Therefore, a fan that provides an air flow of 18 CFM at zero static pressure is adequate for cooling. Thus, the final arrangement is to use a fan of lower speed.
Example 3. Figure shows the air performance curves of 40x 40x 6mm (Curve 3), 30x 30x 6mm (Curve 2) and 25x 25x 6mm (Curve 1) DC fans with middle speed.

Case 1: If the system acquires a system resistance of 0.025 Inch-H2O and requires an air flow of 2 CFM to cool off, 40x 6mm DC fan is recommended. (Please refer to the Operation Point B.)

Case 2: If there are more components added to the system and/or there is a more compact physical re-configuration, there will be a higher system resistance acquired. Now, assume that the system resistance is increased to 0.038 Inch-H2O and requires 0.85 CFM to cool off the system, there are two fans, 40x 6mm and 30x 6mm, available for selection. (Please refer to Operating Point A.) Another excellent option for cooling a system with a high system resistance is Micro DC Blower.