ENGINEERING INFO

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- MagLev presentation
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More about Engineering information:

- The Power of SUNON MagLev, Power Motor, Mighty Mini Fan
- EMI Resolution
- How to Measure the Airflow vs. Pressure
- How to Select the Right Fan or Blower
- 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 :

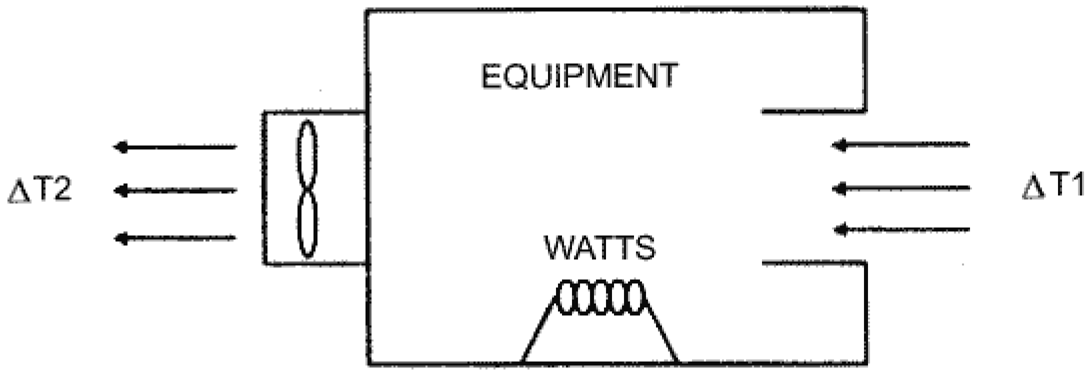
- The heat (ΔT) which must be transferred.
- The heat transfer (W) in watts to offset ΔT.
- The amount of air flow (CFM) needed to remove the heat.

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.

1. Determine the amount of heat generated inside the equipment.
2. Decide the permissible temperature rise inside the equipment.
3. Calculate the air volume necessary from equation.
4. Estimate the system impedance in the unit.
5. 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.



The Basic Heat Transfer equation is :

H=Cp x W x ΔT

where,
H = Amount of heat transferred
Cp = Specific heat of air
ΔT = Temperature rise within the cabinet
W = Mass flow

Obviously we have W = CFM x D where, D = Density

By substitution, we obtain :

$$Q(CFM) = \frac{Q}{Cp \times D \times \Delta T}$$

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

CFM=3160 x Kilowatts / Δ°F

Then, we obtain the following equations :

$$Q(CFM) = \frac{3.16 \times P}{\Delta Tf} = \frac{1.76 \times P}{\Delta Tc}$$

$$Q(M^3 / Min.) = \frac{0.09 \times P}{\Delta Tf} = \frac{0.05 \times P}{\Delta Tc}$$

where,

Q : Required air flow

P : Internal heat dissipation

Tf : Allowable temperature rise in °F

Tc : Allowable temperature rise in °C

$\Delta T = \Delta T_1 - \Delta T_2$

The Conversion of Temperature vs. Air Flow

ΔT °C	KWh / ΔT °F	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
50	90	18	35	53	70	88	105	123	141	158	176
45	81	20	39	59	78	98	117	137	156	176	195
40	72	22	44	66	88	110	132	154	176	195	220
35	63	25	50	75	100	125	151	176	201	226	251
30	54	29	59	88	117	146	176	205	234	264	293
25	45	35	75	105	141	176	211	246	281	316	351
20	36	44	88	132	176	220	264	308	351	396	439
15	27	59	117	176	234	293	351	410	469	527	586
10	18	88	176	264	351	439	527	615	704	791	879
5	9	176	351	527	704	879	1055	1230	1406	1582	1758

Example 1 :

If the internal heat dissipation is 500 watts and ΔT is 20°F. The following is the result :

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

or

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

Example 2 :

If the internal heat dissipation is 500 watts and ΔT is 10°C :

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

or

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

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STEP 2 : Total System Resistance / System Characteristic Curve

While air is moving, the flow of air will encounter resistance of other components in the system along the path of moving air. This impedance restricts free air and passage of air. This change in pressure (ΔP) is the static pressure measured in inches of water.

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 :

$$\Delta P = Kq^n$$

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

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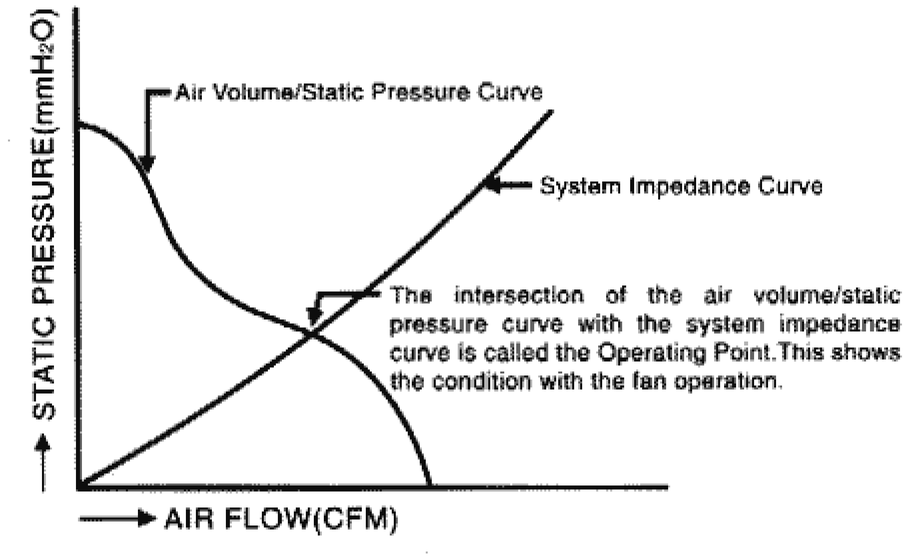
STEP 3 : System Operating Point

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 :

- The Parallel and Series Operation
- Acoustical Noise Level
- Fan 3rd Wire Signal



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

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.

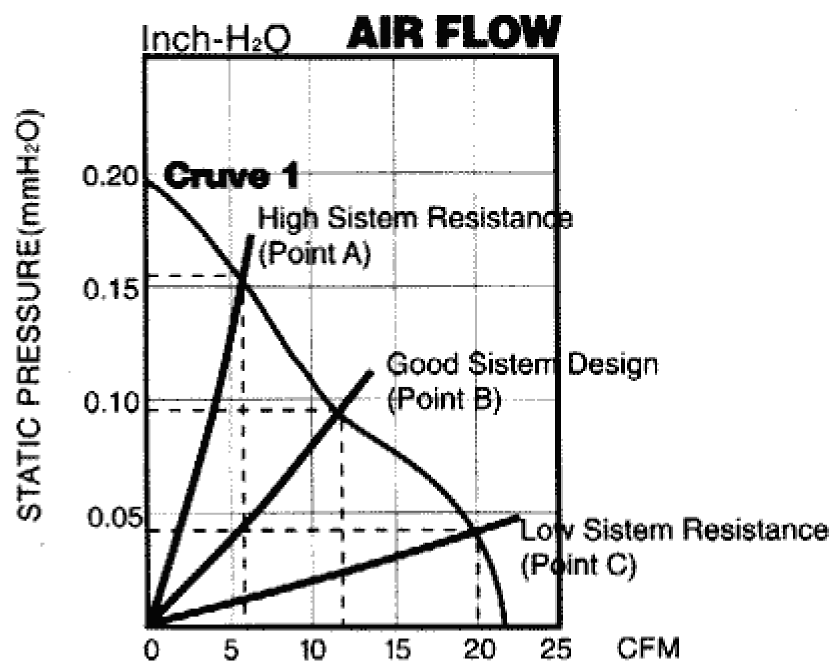
3. If a filter is required, you should consider the additional resistance to air flow.

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, 60x60x25 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-H_2O 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-H_20.

Figure #1 : Air performance Curve of 60x60x25 mm Fan with Middle Speed



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-H_20, 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.

Figure #2 : Air Performance Curve of 60x60x15 mm Fan with Low and Middle Speed

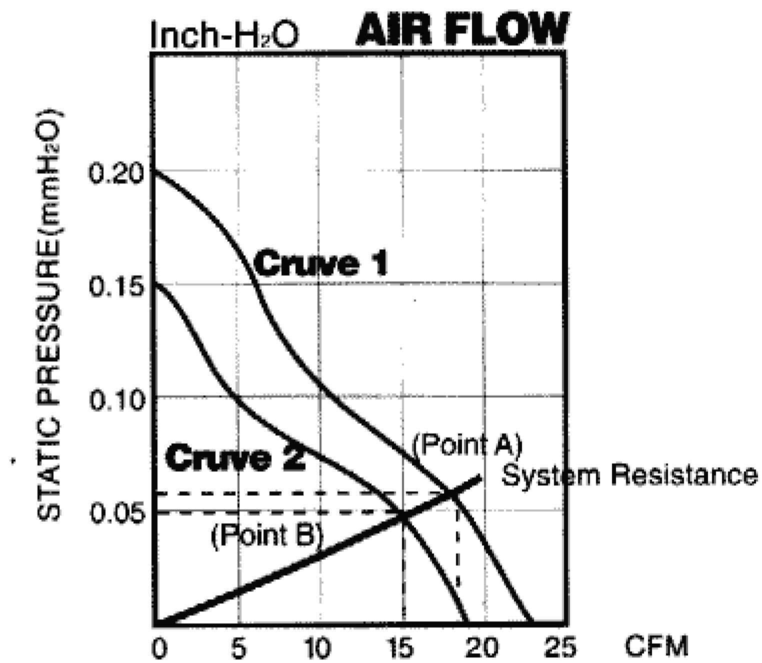


Figure #2 summarizes on one graph the change from one fan to the other. In some cases, of course, it may even be possible to move to a physically smaller fan with the same air flow, if system resistance is sufficiently reduced.

Example 3.

Figure #3 shows the air performance curves of 40x40x6mm(Curve 3), 30x30x6mm(Curve 2) and 25x25x6mm(Curve 1) DC fans with middle speed.

Case 1 : If the system acquires a system resistance of 0.025 Inch-$H_2$0 and requires an air flow of 2 CFM to cool off, 40x6mm 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-$H_2$0 and requires 0.85 CFM to cool off the system, there are two fans, 40x6mm and 30x6mm, 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.

Figure #3 : Air Performance curve of 40x40x6mm, 30x30x6mm and 25x25x6mm