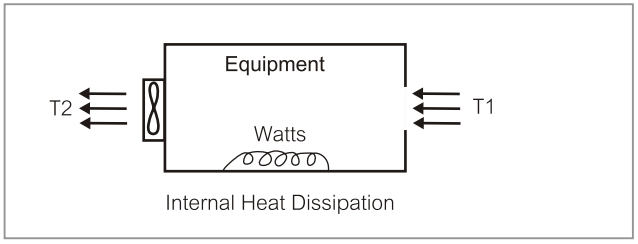
How to Choose a Fan

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 tubeaxial fans. Other air movers consist of impellers and blowers (centrifugal & crossflow). 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.

How To Choose The Right One For Your Application?
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 Cp DT

Where,

Q = the amount of heat transferred to system, Watts Cp = 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.

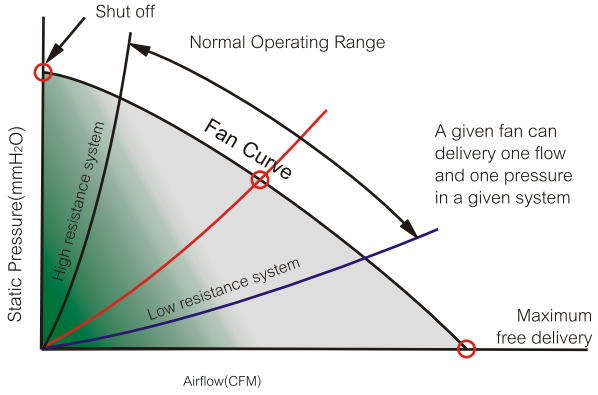
2) Computational commercial software:

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. This is an introduction to understand the main purpose of a fan and equations necessary to determine basis of fan selection.