M&P

Air Components, Inc.

M & P Air Components, Inc. provides Components, Technologies, Guidelines, Sales and Technical Services for Industrial Air and Dry Solids Processes.

Our Goal is to provide Clients with the correct components selection and system design to achieve the best Utilization, Reliability, Safety and Economy for their plant processes.

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Technical Bulletin

Fan Selection – Fan Laws & Terminology

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Fan Laws are used to predict the performance of a fan or a series of geometrically similar fans at speeds and densities other than as originally provided.

Because of the relationship between volume and pressure, each calculation is specific to each "Point of Operation". A Point of Operation is a specific operating point of the fan on its curve.

To develop a new fan curve by applying the Fan Laws to an existing curve, calculations are made for a series of Point of Operation locations in order to generate a reliable new curve for the new operating conditions.

Terms used in Fan Selection include:

Fan Speed is the rotating speed of the fan shaft, measured in revolutions per minute, RPM

Fan Capacity is the volumetric capacity of the fan in cubic feet per minute, CFM.

Fan Performance Tolerance, as stated by AMCA is +/- 2.5 % by capacity and +/- 5 % by pressure.

SCFM (standard cubic feet per minute) is used when the inlet airstream is within 40 to 100 F, +/- 20 in wg SP, +/- 1,000 ft elevation, 0.02 lb water/lb dry air or less and 28.964 mw. Standard density is 0.075 lbm/cu ft.

Total Pressure is the total energy of the airstream and is the algebraic sum of the static and velocity pressures. Total Pressure is measured in the direction of flow.

Velocity Pressure is the kinetic energy in the direction of flow that makes a fluid at rest to flow. Velocity Pressure, which is Total Pressure - Static Pressure, cannot be measured directly and is always positive.
$VP = (Velocity \div 1096.2)^2$ (Airstream Density)

Static Pressure is the potential energy exerted in all directions. Fan static pressure is the fan total pressure minus the fan outlet velocity pressure and is mutually convertible with velocity pressure. Fan static pressure is negative on the fan inlet and positive on the fan outlet.
$FSP = SP_{out} - SP_{in} - VP_{in}$

Air Horsepower is the energy added to the airstream by the fan. AHP = (TP x CFM) ÷ (6,356) x 100 %

Chart Horsepower is the energy required to drive the fan shaft (less drive losses) and is provided by the fan manufacturer.

Operating Horsepower is the Chart Horsepower corrected for airstream density, including drive losses. CHP is the actual horsepower consumed.

The Fan Laws are:

Fan Capacity varies directly with change in speed.

$$\frac{CFM_{new}}{CFM_{old}} = \frac{RPM_{new}}{RPM_{old}}$$

Fan Pressure varies with the square of the change in speed or volume.

$$\frac{SP_{new}}{SP_{old}} = \left(\frac{RPM_{new}}{RPM_{old}}\right)^2$$

Fan Horsepower varies with the cube of the change in speed or volume.

$$\frac{HP_{new}}{HP_{old}} = \left(\frac{RPM_{new}}{RPM_{old}}\right)^3$$

Density: Fan Pressure, Horsepower, and Mass Flowrate vary directly with the change in standard density, while Volumetric Capacity remains constant. Standard density is 0.075 lbm/cu ft.

Fan Efficiency is the measurement of horsepower delivered by the fan into the airstream (AHP) versus the horsepower required at the fan shaft (BHP or CHP).

Mechanical Efficiency is based on Total Energy or Pressure, and is the most reliable means to evaluate Fan Efficiency.

ME = (TP x CFM) ÷ (6,356 x CHP) x 100 %

Static Efficiency is based on Potential Energy or Static Pressure, and is sometimes used to evaluate Fan Efficiency.

SE = (SP x CFM) ÷ (6,356 x CHP) x 100 %

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