Fan Facts

The Effects of Air Density on Fan Performance

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Hartzell Fan

Flow and Density

Let's make sure we understand some basic concepts. Fans are constant volume machines. You've heard that before right? Let us explain.

Imagine the fan wheel being a series of scoops. As it rotates each scoop gets filled with material. The volume of material is always the same, whether it is feathers or rocks. Of course the rocks weigh more so it takes more effort (BHP) to move them. Remember, a scoop is a scoop!

Now expand this concept to a system. Let's throw a scoop of rocks against a wall (resistance to flow). The energy imparted to the wall is greater than the energy you would get from the scoop of feathers hitting the wall. The same is true of duct systems. It takes more energy (static pressure) to push a denser material through the duct. In the same manner, a fan is unable to generate as much static pressure when handling a less dense material.

This illustration should help explain why we make corrections to the static pressure and not to the CFM.

Standard air is defined as: sea level, 70 degrees Fahrenheit, 29.92 inches Hg, and 50% relative humidity. Standard density is therefore by definition 0.075 lb/ft^3. Fans are rated at standard air, so corrections must be made to the static pressure only before selections from the rating tables can be made.

Most applications require operating conditions other than standard air: temperature, elevation, molecular weight, moisture content, barometric pressure, etc. Some of these corrections are quite complex so usually they are handled by a computer program.

Here's an example: 5,000 CFM, 1" SP @ 2500 feet elevation, 170 degrees Fahrenheit, saturated air. The density corrections are as follows:

2500 ft. elevation	= 0.913 x
170° F	= 0.842 x
Saturated air	= 0.831 (water vapor, i.e. a cloud is lighter than air)
Sub-total	0.639 x
Standard density	= 0.075
Result	0.048 lb/ft^3 actual density

The selection would be made at 1.56" SP (1" divided by 0.639) from the standard density tables. That will select the fan at a higher RPM which will compensate

Continued on 2

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for the lower density air. The resultant BHP needs to be multiplied by 0.639 to account for the lower density.

ACFM vs. SCFM

ACFM is the actual CFM required at the operating conditions. Sometimes you need to know the equivalent airflow to move the same mass of air at standard density. That value is called SCFM. In our example on the previous page, the actual CFM needed is 5,000 ACFM. When you convert that to SCFM, you get 3,194 SCFM. Make sure you select the fan using the ACFM.

Here's the best way to avoid problems. First, specify the actual CFM at the point in the system that the fan operates. Also, obtain the actual static pressure rise needed at that point, and the non-standard conditions. Take this information, calculate the density, correct the actual static pressure to the equivalent standard static pressure, and select the fan. Don't forget to adjust the brake horsepower as well! You may need to select your motor size for some other density during startup.

To learn more about this topic and others, refer to Hartzell Bulletin A-108, Fan Engineering Data.

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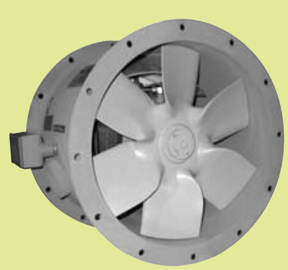

Hartzell News

Hartzell Fan received notice from the United States Patent Office that Patent Application #7,494,325 on the Adjustable Pitch Aluminum Prop (AL Prop) has been approved. This patent is based on the shape, arrangement, and location of the ribs that go the length of the blades and how they reduce the sound generated in the lower octave bands.

The AL Prop is constructed of cast aluminum material (blades and hub) and is used in multiple products that include roof ventilators, panel fans, and duct axial fans. The AL adjustable prop is well suited for industrial air moving applications requiring high flow and low to medium pressure and is available in multiple blade configurations to allow precise selection by adjusting the blade angle. Some low speed selections are available for installations where low sound levels must be maintained. Sound levels may be decreased by as much as 5 to 10 dBA for lower speed operation.