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PROPER SELECTION OF PRESSURE BLOWERS

INTRODUCTION

In general terms, a pressure blower provides relatively high pressure at low volume when compared to other types of centrifugal fans. For purposes of this letter, fans with volumes to 10,000 CFM with pressures to 80" WG are considered pressure blowers. Typical applications require constant pressure throughout the system's operating range. A fan outlet damper or system damper is usually used to control air volume. Consequently, a requirement of pressure blowers is that they provide stable performance from full-closed to full-open.

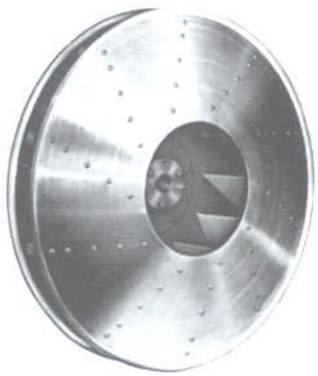


Figure 1 – Dual-Tampered Pressure Blower Wheel

Most pressure blowers employ a radial-blade wheel design. New York Blower's research has resulted in a unique wheel design that is not truly radial. The blades are slightly canted backward and dual tapered from the hub to the blade tip. See Figure 1. This design provides better efficiencies and, as a result, significantly lower noise levels. The volume-pressure characteristics remain the same as radial-blade wheels.

POINT OF OPERATION

Since typical pressure-blower applications require a constant pressure, selections are normally near the flat peak of the static pressure curve. See Figure 2. Because of the flat nature of the pressure-blower curve, a typical question is, "what keeps the fan's performance from fluctuating between different points on the fan curve?" The answer lies in the relationship between the fan's performance curve and the system curve.

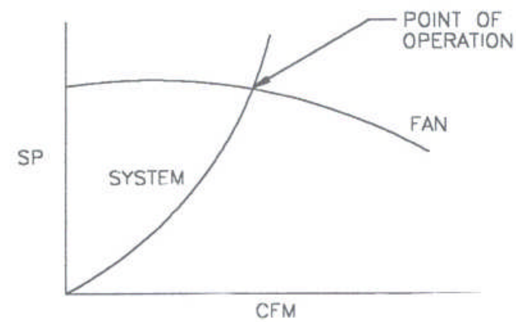


Figure 3 – Typical Pressure Blower and System Curves

At a given RPM, the fan can only operate on its performance curve. The only way to alter this curve is to either increase or decrease the fan's speed. Conversely, the system can only operate along one system curve. The only way to change this system curve is to increase or decrease the resistance through the system. Since the two curves can only intersect at one point, the actual performance of the fan can occur only at the intersection of the fan curve and the system curve. This is depicted in Figure 3.

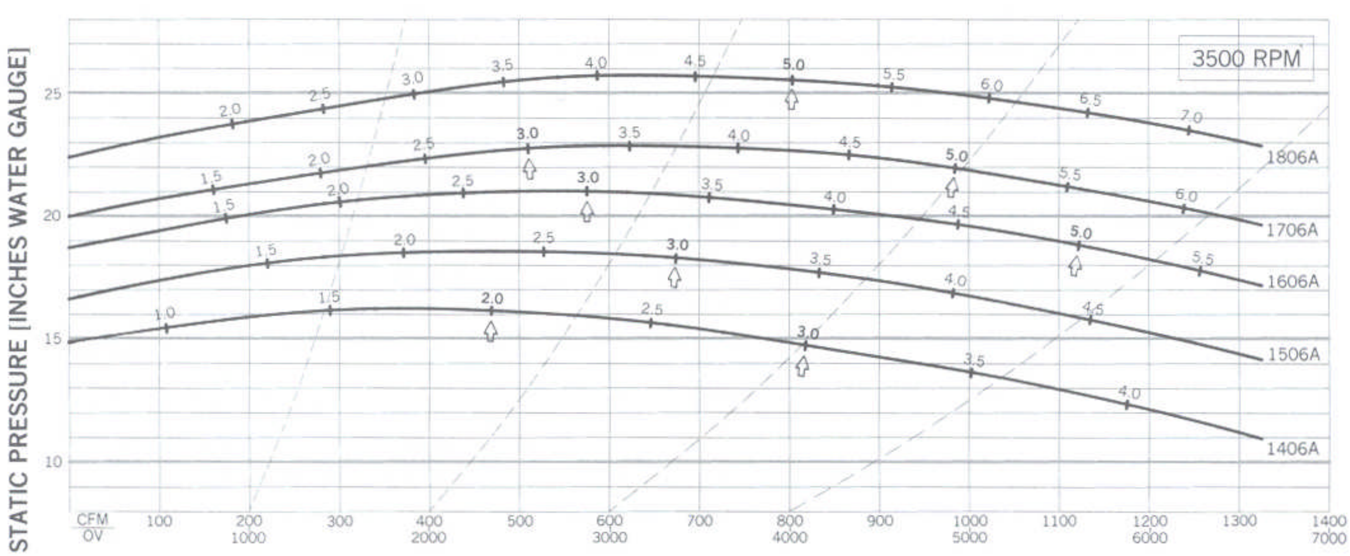


Figure 2 – Typical Pressure Blower Performance Curves
Note: Broken lines denote typical system curves.

Considering that pressure blowers are often selected near the peak of their pressure curve, dampering usually results in an operation left of the pressure peak. One benefit of radial-blade wheel design is that it delivers stable performance left of peak.

Radial wheels bring other advantages to pressure blowers. The radial design delivers greater pressures at a specific RPM than both the radial-tip and backwardly-inclined designs. The inherent strength of the radial wheel allows for the relatively high wheel tip speeds required for the development of high pressures. Remember, pressure is approximately proportional to the square of the change in wheel tip speed. Therefore, a 2 PSI pressure blower must be capable of speeds 1.414 times as fast as a 1 PSI unit.

$$1.414^2 = 2$$

SINGLE-STAGE VS. MULTI-STAGE

Single-stage pressure blowers are the most common and least expensive of the two designs for the range of flows and pressures noted in the introduction. A single-stage pressure blower consists of a single wheel in a volute-shaped housing design, such as shown in Figure 4.

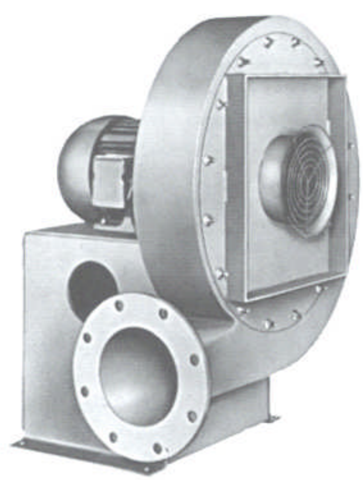


Figure 4 - Single-Stage Pressure Blower

Single-stage units are usually far more economical in applications up to about 3 PSI. They are also less complex and easier to maintain than multi-stage pressure blowers. Power consumption is also less because the single-stage blowers are more efficient.

It is possible to place two, and sometimes more, single-stage pressure blowers in series to develop pressure as high as 5 PSI and still represent an economical alternative when compared to the multi-stage units for the same performance. There is the added reliability factor of being able to “limp along” with one unit while the other unit is down for maintenance. When a multi-stage unit is down, the entire system is down. Consult the manufacturer for proper selection and application information when designing pressure blowers for series operation.

SELECTION PROCEDURES

Selecting pressure blowers or any other type of fan for applications involving relatively high pressure requires some special considerations. Pressure blowers are generally used with the pressure entirely on the inlet or entirely on the outlet. Air is compressed as it passes through the fan, lowering the volume and raising the density. In negative pressure systems, air is rarefied to become less dense. The extent to which the effects of compression and rarefication must be considered depends largely on the degree of accuracy employed in the actual system design and calculation process.

During compression there is also a temperature rise associated with the energy expended to overcome the system resistance and fan inefficiency. The rule of thumb is to allow 1°F. temperature rise for every 2" static pressure differential. For example: a supply fan with 40" SP at the outlet will develop a 20°F. temperature rise at the fan outlet, as compared to the air temperature at the fan inlet. To determine the proper air volume for selection purposes, the effect on density of both compression and temperature must be considered.

One notable exception to these rules for performance corrections is the combustion-air-supply application. Burner manufacturers use SCFM ratings to arrive at lbs./hr. of air. The air will be compressed through the fan to a proportional lower volume, yet higher density so that the total weight of air in lbs./hr. remains constant and is sufficient for the combustion process.

PERFORMANCE CORRECTIONS

Fan performance is based on a standard density of .075 lbs./ft.^{3} Density corrections for positive or negative pressure are based on changes in absolute pressure.

A. Standard absolute pressure is 408" WG at sea level.

B. Compressed density for + 40" SP at the fan outlet is:

$$\left(\frac{408 + 40''}{408''}\right) \times .075 = .082 \text{ lbs./ft.}^3$$

C. Rarefied density for - 40" SP at the fan inlet is:

$$\left(\frac{408 - 40''}{408''}\right) \times .075 = .0676 \text{ lbs./ft.}^3$$

Density corrections for temperature changes are based on absolute temperature in degrees Rankin (°R).

A. Standard absolute temperature is 530°R., 70°F. (0°F. = 460°R.)

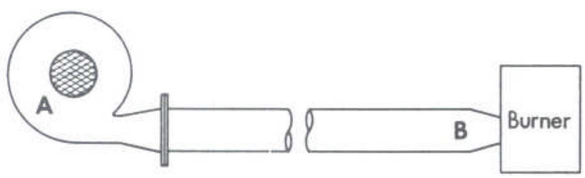
B. A 20° temperature rise over a fan inlet temperature of 70°F. gives the following density:

$$\left(\frac{460° + 70°}{460° + 70° + 20°}\right) \times .075 = .072 \text{ lbs./ft.}^3$$

Also refer to the following sample selections

SAMPLE SELECTIONS

Example 1: No performance correction due to compression.



What actually happens in the system?

A. 2300 ACFM at 70°F. at 408" atmospheric pressure enters the pressure blower inlet (A).

B. The pressure reading at (B) is 34.6" gage pressure or 408" + 34.6" = 442.6" absolute. The temperature has increased to 87°F.

$$\left(\frac{34.6}{2} + 70°\right)$$

C. Density ratio is:

$$\frac{442.6}{408} \times \frac{460° + 70°}{460° + 87°} = 1.05$$

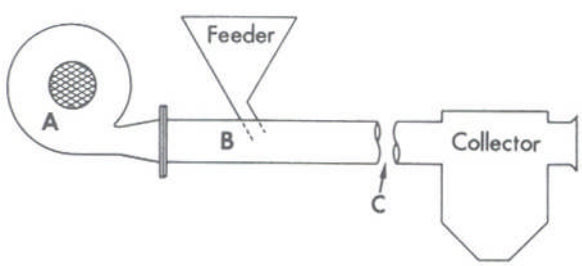
D. Air density at the burner (B) will be:
.075 x 1.05 = .0788 lbs./ft.^{3}

E. ACFM at (B) will be:
2300 ÷ 1.05 = 2190 ACFM

F. The SCFM equivalent at (B) will be:
2190 x .0788 = 172.6 lbs./minute
2300 x .075 = 172.5 lbs./minute

Note: The changes in volume and density can be ignored in this case because the proper amount of air by weight will still be available at the burner (B). Select the pressure blower for 2300 CFM at 34.6" WG pressure at .075 lbs./ft.^{3} density.

Example 2: Performance correction required due to compression.



Given: injector conveying system, as illustrated.

Required: 2300 CFM for the velocity required at (B).
Resistance is 20 oz. or 34.6" WG.

What actually happens in the system?

A. Air enters at 70°F. at 408" atmospheric pressure at the pressure blower inlet (A).

B. The pressure reading at (B) is 34.6" gage pressure or 408" + 34.6" = 442.6" absolute. The temperature has increased to 87°F.

$$\left(\frac{34.6}{2} + 70°\right)$$

C. Density ratio is:

$$\frac{442.6}{408} \times \frac{460° + 70°}{460° + 87°} = 1.05$$

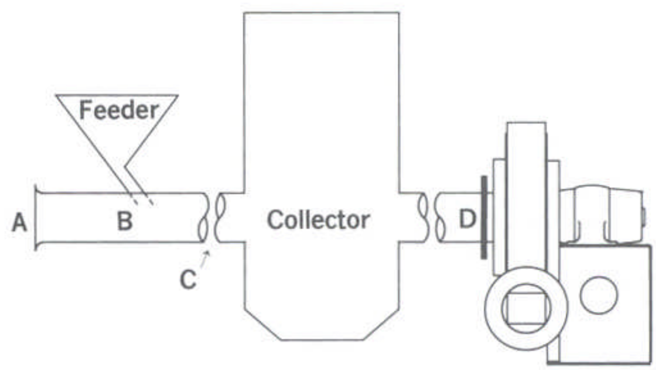
D. Air density at the burner (B) will be:
075 x 1.05 = .079 lbs./ft.^{3}

E. ACFM at (B) will be:
2300 ÷ 1.05 = 2190 ACFM

F. To get 2300 ACFM at (B), the volume of air entering at (A) must be increased by the density ratio:
2300 x 1.05 = 2415 ACFM

Select the pressure blower for 2415 CFM at 34.6" WG pressure at .075 lbs./ft.^{3} density.

Example 3: Performance correction due to negative pressure.



Given: draw-thru pneumatic conveying, as illustrated.

Required: 4800 SCFM at - 34" WG.

What actually happens in the system?

A. Air enters at 70°F. at 408" atmospheric pressure at the system inlet (A).

B. The resistance at the pressure blower inlet (D) is - 34" gage pressure or 408" 34" = 374" absolute.

C. Density ratio is:

$$\left(\frac{374}{408}\right) = .92$$

D. Air density at (D) will be:
.075 x .92 = .069 lbs./ft.^{3}

E. To get - 34" at (D) at .069 lbs./ft.^{3} density, the pressure must be increased by the density ratio for proper fan selection: -34" ÷ .92 = - 37" WG.

F. Capacity = 4800 ÷ .92 = 5217

G. Select the pressure blower for 5217 ACFM at 37" WG.

H. Operating horsepower would be:
.92 x rated BHP, corrected for the lower density.

Note: The actual air volume at the fan outlet will be less than the volume at (A) by the density ratio, but the actual air volume at the fan outlet is not important in this system.

NOISE ATTENUATION

A rising concern in many of today's industrial applications is OSHA's criteria for noise levels. To meet these requirements, many pressure blowers require sound attenuation. The backward-canted and dual-tapered wheel design can result in an 8-10 db noise reduction over the traditional straight blade design. In some cases, this may eliminate the need for a silencer.

If attenuation is required, silencers are readily selected based on their connection to either the inlet or outlet of the pressure blower. The most common connection is directly on the blower, flange to flange. See Figure 5. Silencers are rated in dynamic insertion loss (DIL) in decibels. These values are subtracted from the pressure blower sound power level's eight octave bands.

The pressure drop through the silencer must be added to the system requirements, but generally the values are less than 0.2" and are insignificant.

Figure 5 – Pressure Blower Silencer