THE NEW YORK BLOWER COMPANY
7660 Quincy Street
Willowbrook, IL 60527-5530
Visit us on the Web: http://www.nyb.com
Phone: (800) 208-7918 Email: nyb@nyb.com

ENGINEERING SUPPLEMENT
ES-721
June 2007

INTERNAL INLET DAMPER PERFORMANCE CHARACTERISTICS

An inlet damper mounted on a centrifugal fan is one of the best means of volume control. On that type of fan the damper works by not only restricting the flow of air into the fan but by prespinning the air in a direction of the fan wheel rotation. By inducing a pre-rotated flow, the output of the fan is reduced. This device also has the advantage of smooth control over the entire fan curve. Because of the way that horsepower is also proportion-ally reduced such that substantial horsepower savings can be gained when a fan is operated in its dampered position over long periods of time.

The concept of an inlet damper has been made even more attractive with the design of the new New York Blower internal inlet damper. This damper operates on the principle of pre-rotation, yet accomplishes this in a compact package that requires no more space than the fan itself. Considering the need for control in modern variable volume systems, this device provides an ideal, economical solution.

I. Construction

The New York Blower internal inlet damper is a combination damper section and inlet cone assembled in one piece, such that it can be bolted directly into a centrifugal fan. The damper features control vanes that pivot on a shaft mounted in oil impregnated bronze bearings. The blade itself is cantilevered and attached only at one end, such that there is no need for any type of center hub. The vanes are driven through a crank arm to a control ring mounted on the inside of the cone. See Figure 1. Because of a unique combination of vane angle and crank arm length, the damper is able to operate smoothly through its entire 90 degree swing. The damper is controlled while in the fan housing by a rod and crank arm assembly extending to the control quadrant on the outside of the fan. Because the control quadrant is mounted on the outside of the fan it can easily be used for both manual or automatic control. A similar arrangement is used for both single width and double width fans, where both dampers are driven off the same controlled shaft. (Note: Because inlet dampers on DWDI fans must be linked internally, access doors are supplied on all DWDI fans ordered with inlet dampers for ease of installation and maintenance.)

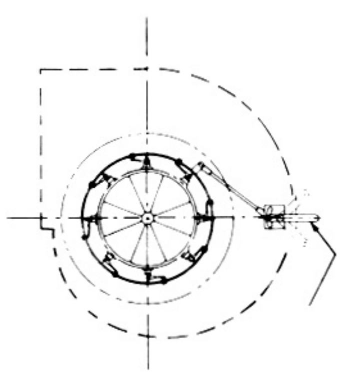


Figure 1

II. Application

These dampers are intended for use on nyb AcoustaFoil, PLR and Tubular AcoustaFoil Fans. They are available for fan sizes ranging from 16 to 73. They can be installed on all fan arrangements and on fans of Class I, Class II, or Class III construction. Because the vane and control linkage are located in the airstream, it is recommended that internal inlet dampers be considered exclusively for clean air applications. The temperature limitation on the damper is 650°F., but it should be realized that it is impossible to retain lubricant in the bearings above 200°F. so that some shortening of the life of the bearing might be expected at high temperatures. Because of the method of construction and tooling design, the internal damper is available in steel construction only. Also, it does not lend itself to application of special coatings.

The internal inlet damper centrifugal fan combination can be incorporated in any system requiring variable air flow. Internal inlet dampers are often used as the means of system balance or may be controlled manually to compensate for a change in air flow between winter and summer conditions. In more sophisticated systems such as variable volume, they can be directly connected to a controller which maintains a constant static pressure in the duct. In this way the fan will constantly correct its volume to compensate for heat load changes throughout a building. Mounted in a Tubular AcoustaFoil, either belt or direct drive, the internal inlet damper can create an extremely compact package with all of the advantages of variable flow control without the expense and noise of other products such as an adjustable pitch Axial Fan. Everything considered, when variable fan volume is required, the centrifugal fan inlet damper combination should be considered.

III. Installation Losses

Because the control vanes of the inlet damper are placed within the venturi section of the inlet cone and take up space even in their wide open position, certain minimum losses must be considered when a damper is installed on a centrifugal fan.

In larger sizes, the loss can be considered negligible but in Sizes 40 and smaller, a correction to the cataloged speed and horsepower should be made to compensate for this loss. Correction factors are shown in Chart I.

Chart I

Size	RPM Factor	BHP Factor	Size	RPM Factor	BHP Factor
16	1.08	1.16	27	1.03	1.06
18	1.07	1.14	30	1.025	1.05
20	1.06	1.12	33	1.02	1.04
22	1.05	1.09	36	1.015	1.03
24	1.04	1.08	40	1.01	1.02

Note: Because inlet damper controls are intended for volume modulation, they are not designed for total "valve" shutoff. Consequently, even at complete shutoff, air would flow through the damper at a rate of about 7% of wide open volume.

IV. Flow Characteristics

When an inlet damper is applied to a centrifugal fan, the damper and fan react to create a combined system that has its own characteristic curve. The curves in Figure 2 illustrate fan performance with no damper or with inlet damper "wide open" versus fan performance with inlet damper partially closed. With an inlet damper set at a particular vane angle, a new fan characteristic curve results which is lower in volume on the right-hand side of the curve, yet approaches the peak static pressure near closed off. This is the actual characteristic curve of the fan in this dampered position and it behaves like any fan curve when applied to a particular system. As the damper is moved to different vane angle settings, then an entire family of curves can be created down to the minimum allowable leakage rate of the damper.

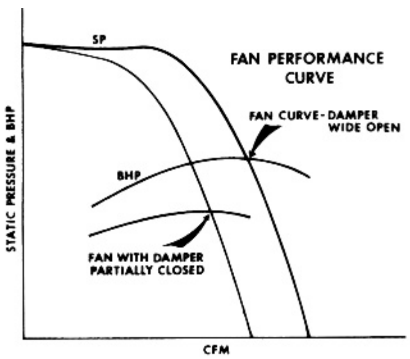


Figure 2

It is normally sufficient to know the range through which a fan can be dampered and the approximate static pressure capabilities in the dampered position. As an example, let us assume that a fan was to operate from its wide open position at some static pressure to a point of 50% CFM at the same pressure. Let us also assume that dampering will be done by automatic control. In this case it is not necessary to know the exact vane angle in this 50% dampered position. It is sufficient merely to know that the reduced volume can be obtained and that there will be sufficient static pressure at the lower volume to satisfy the requirement. A quick look at the dampered curves would convince one that this is the case. Most systems are sold with only these facts available.

If, however, more exact vane angles and their corresponding BHP values need to be determined, then the characteristic curve in Figure 3 should be used. These characteristic curves are created using relative values of CFM, SP, and BHP. By knowing the wide open design values of static pressure, CFM and brake horsepower, it is possible to obtain derated values at any vane setting by using the procedure outlined in the example below.

EXAMPLE:

1. Establish point of operation, including correction for installation loss (if used) on BHP.
   10,000 CFM at 8" SP at 18 BHP
   O.V. = 3200 FMP
2. Locate point of operation on wide open damper curve (90° setting) by calculating VP/SP.
   $VP = 3200/4000^2$ $VP = .64$
   $VP/SP = .64/8 = .08$
3. Identify the relative values on damper curve using the VP/SP value.
   CFM = 10,000 CFM = 65 relative value
   SP = 8" SP = 80 relative value
   BHP = 16 BHP = 100 relative value
4. To find any other point on the curve and its damper vane setting, use the following relationship.

Wide open capacity x
<u>(new relative value)</u> = new capacity
(wide open relative value)

Example: To calculate actual capacity at 50° setting on a system curve:

CFM = 49 relative value
SP = 48 relative value
BHP = 68 relative value

CFM at 50° setting = 49/65 x 10,000 = 7550 CFM
SP at 50° setting = 48/80 x 8 = 4.8" SP
BHP at 50° setting = 68/100 x 18 = 12.2 BHP

To determine performance of DWDI fans with inlet dampers, use the same procedure with the curves in Figure 4.

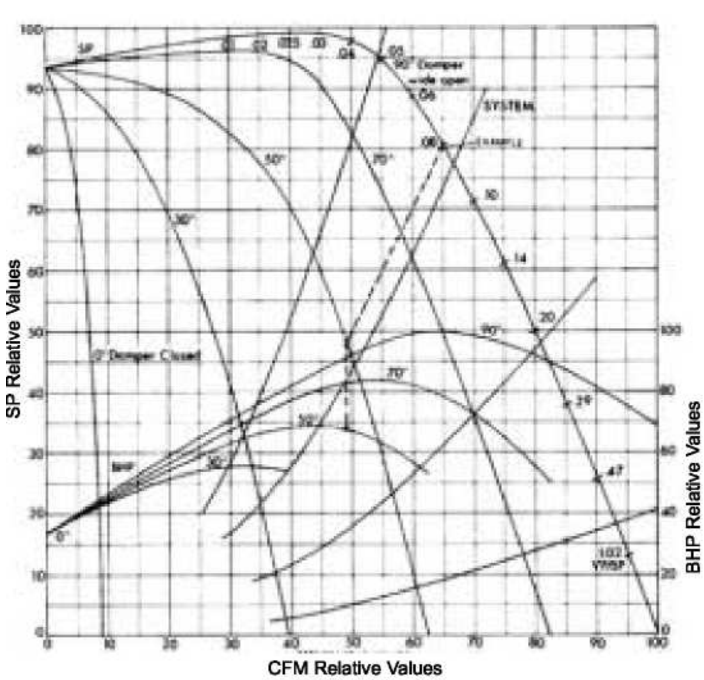


Figure 3

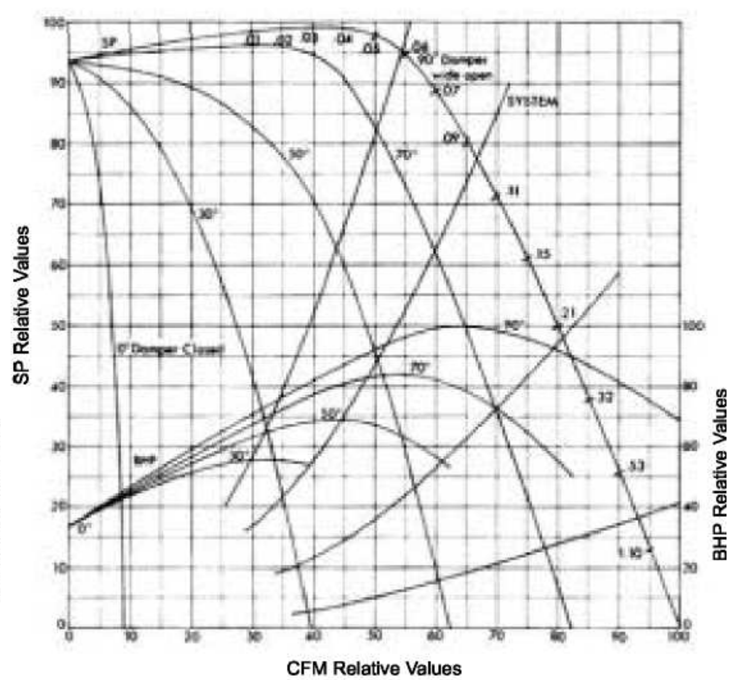


Figure 4

To determine performance of Tubular Centrifugal Fans with inlet dampers use the same procedure with curve in Figure 5.

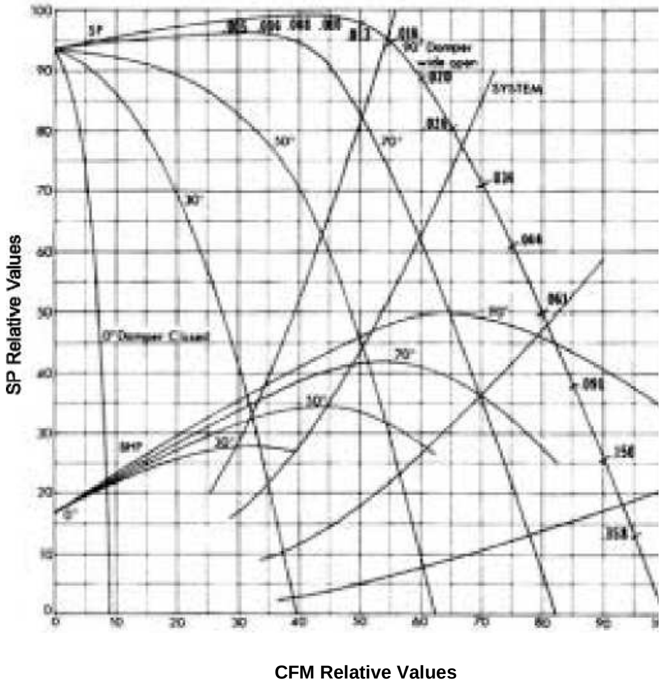
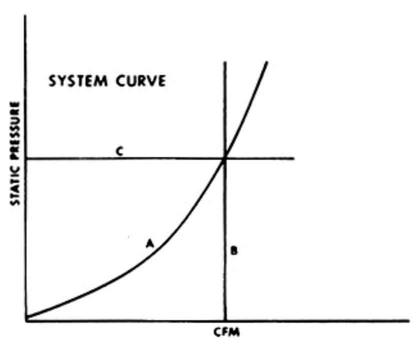


Figure 5

V. System Curves

No discussion of inlet damper flow characteristics would be complete without some coverage of basic system curves. For years people in the fan industry have talked about a system curve being the reaction of the system in static pressure to any induced flow. It is normally represented as a parabolic curve as shown in Figure 6, Curve A.

Figure 6



This assumes that the static pressure in a system will vary as the square of the volume, such that once any point is known then any other point can easily be calculated. While this is true for all combinations of system elements of the fixed variety, it is not true of many of the modern heating and air conditioning systems. The classic system curve assumes elements that are entirely fixed all the way from the fan to the discharge grill. All of the modern air conditioning and heating systems such as dual duct, constant volume reheat and variable volume all use mechanical dampering devices that are pressure controlled and do not behave according to the classic system laws.

A dual duct system, for example, is generally constant volume. Viewing this system from the fan end this means that no matter what pressure is generated by the fan, the constant volume box will only allow a certain quantity of air to pass. The advantage of this system is that as the modulating vanes change the mix of hot and cold air the same quantity of air is handled by the fan and enters the room. The constant volume boxes also eliminate the complicated job of balancing every branch in a multi-story installation. A system curve for a constant volume single duct reheat system would look like the vertical line B in Figure 6 although the system would only operate at one point. Most constant volume single duct reheat systems also can be represented by a similar curve. In such systems there is no real need to employ inlet dampers except as an initial balancing device or in systems that are designed for future expansion.

A variable volume system on the other hand operates entirely in the reverse. Instead of varying temperature by mixing air or reheating, temperature in a space is controlled by the volume of cool air introduced. In this system, variable boxes are allowed to modulate independently in each controlled space based on the heat load. For this reason a static pressure sensor is installed into the discharge duct to maintain that pressure. Actually a system curve representing this type of installation can be expressed as horizontal Line C in Figure 6 and they will actually operate along this system each day. It is normally not necessary to actually work with this type of system curve but its knowledge is helpful when relating back to varying fan capacities created by the internal inlet damper.

Visualize this system plotted across the varied characteristic curves created by the damper setting, illustrated in Figure 3 and 4. The role of a damper/fan combination in a VAV system becomes obvious as the variable volume boxes create the horizontal variable system. The variable damper settings provide a fan/damper combination that maintains the desired CFM and SP as required.

VI. Stability

Stability can be an important consideration when one is working with a fan inlet damper combination. Traditionally a backwardly inclined fan suffers from a problem of instability when operated to the left of its peak static pressure point. The New York Blower AcoustaFoil has eliminated the problem of instability through the use of blade design and the addition of its patented diverter. Because the AcoustaFoil Fan is stable throughout its entire operating range, there is no fear of creating a stability problem if the fan system and/or damper setting forced the fan to operate further to the left than designed. Stability also becomes an important consideration when one is looking for a wide range of flow rate since this will almost always force the fan to operate near the peak static point at some place in this range. The AcoustaFoil Fan can be installed with dampers with no fear that an unstable condition will result.