SIZING DAMPERS

APPLICATION NOTE LC-127

Dampers must be sized correctly for an HVAC system to work correctly. Installing dampers of the same size as the ductwork, while common practice, may not allow for optimal performance. For best control, the damper should have a large rotation. The following procedure can be used to size dampers for use with TSI controllers.

Step 1. Determine Duct Area Needed for Maximum Flow

TSI recommends sizing dampers by targeting a specific velocity range. Ductwork is commonly sized for a maximum velocity of 2,000 to 2,800 fpm (feet per minute). Duct velocities greater than this often are plagued by flow noise. To determine the size duct required for a given flow rate, use the formula:

$$Area = \frac{Flow}{Velocity} = \frac{Flow(cfm)}{2{,}000 fpm}$$

simply divide the flow rate by the desired duct velocity to obtain the cross-sectional area of the duct. For example, the cross sectional area for a 1,000 cfm flow rate is $\frac{1{,}000\ cfm}{2{,}000\ fpm}$ = 0.5 ft^2.

Step 2. Convert Maximum Flow Duct Area to Duct Size

But 0.5 ft^2 is not a duct size. The diameter of a round duct is related to its cross-sectional area by the formula

$$Area = \frac{\pi}{4 \cdot 144} Diameter^2$$

where Area is in units of $feet^2$

diameter is in units of inches

π=3.14

4 and 144 are constants or conversion factors

Solving for diameter gives $Diameter = \sqrt{\frac{4 \cdot 144}{\pi} Area}$.

The area of a rectangular duct is determined as

$$Area = \frac{Length \cdot Width}{144}$$

where Area is in units of feet^2

length and width are in units of inches

and 144 is a conversion factor

Continuing the example, the $Diameter = \sqrt{\frac{4 \cdot 144}{\pi} 0.5}$ = 9.6 inches. Since round ductwork is commonly available in even sizes, round up to 10 inches.

Step 3. Verify Velocity at Minimum Flow

If measurement of the controlled flow is required, the minimum duct velocity also must be checked; duct velocities are normally held above 400 fpm when using pressure-based flow measurements like pitot arrays to help ensure accuracy. Using the area formula, first calculate the area of the damper selected previously. Then, use this area to determine the duct velocity at minimum flow rate.

From the example, a 10 inch damper will give an area of $\frac{\pi}{4 \cdot 144} 10^2$ =0.545 ft^2. If the minimum flow rate is 250 cfm, then the duct velocity will be $\frac{250cfm}{0.545ft^2}$ =460 fpm. Since this velocity is above 400 fpm, a 10 inch damper will be sufficient. If the minimum flow rate is below 400 fpm, decrease the damper size until the duct velocity is sufficient.

This process has the potential to require a number of iterations. Instead, minimum and maximum flow rates for common round duct sizes are listed in Table 1.

Damper Diameter (in)	Recommended Flows			
	Duct Area (ft^2)	Min CFM (400 fpm)	Max CFM (2,000 fpm)	Max CFM (2,800 fpm)
6	0.196	79	393	550
8	0.349	140	698	977
10	0.545	218	1090	1526
12	0.785	314	1570	2198
14	1.069	427	2,137	2,992
16	1.396	558	2,791	3,907

Table 1. Flow rates for common round duct sizes.

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