Engineering E-Update

Energy Considerations When Specifying Duct Silencers

Duane McLennan "sounds off" on the newest Noise Control Technology

September 9, 8:45AM by Duane McLennan

Combining “Noise Control” and “Green” into the same sentence has always been a longstanding goal of noise control manufacturers. There have been failed attempts over the years to provide silencers with green ratings, or which contain green products. These efforts have proven themselves neither useful nor recommended for use in duct systems. The latest example of this would be using natural cotton fiber as an acoustic media, which we will discuss at length in later articles. For this article, we’d like to take a quick step back and look at how silencers are currently being applied and how it relates to energy consumption and what is perceived, vs. what is actually happening in the duct system.

Adding a silencer to a system

The goal of adding a silencer to a system is to create a productive and appropriate acoustic environment for the occupants in accordance with the intended use of the space. Achieving this goal tends to be at odds with other goals such as minimizing the amount of ductwork, reducing the size of the air handling system. The later into the design process the acoustics are taken into account the more difficult the challenge can become. No matter how much thread you use, it isn’t possible to turn a sow’s ear into a silk purse. With many ways to use Duct Silencers and Attenuators, our goal as product designers and application specialists is to maximize our acoustic attenuation and minimize pressure drop. As acoustic performance increases, so does the product pressure drop. This balancing act is what makes silencer selection such a science and highlights the critical need for intuitive silencer selection software like Price All-In-One. In addition to determining the performance requirements of the required product, one has to consider how the design of the system will affect the installed performance.

As a rule of thumb, silencers are to be installed with no less than 3-5 duct diameters of straight duct before and after the unit. This requirement ensures that the on-site installed will be similar to the conditions the unit was actually tested under. When choosing the installed position for a silencer in the ductwork this suggestion should be taken into account at all times. The silencer attenuation will not likely be degraded by less than ideal installed conditions, however the pressure drop can be adversely affected leading to greater energy consumption on the system. Below are the Approximate Silencer System Effect Factors provided by ASHRAE and an example of how to use them.

Approximate Silencer System Effect Factors

Silencer Condition	Pressure Drop Factor
Inlet (within 3 to 4 duct diameters)	
Straight unobstructed duct (#1)	1.0
Free air/plenum with smooth inlet (#2)	1.05
Free air/plenum with sharp inlet (#3)	1.1 to 1.30
Radius elbow (with turning vanes) (#4)	1.05
Radius elbow (no turning vanes) (#5)	1.1
Miter elbow (#6)	1.3
Fan (#7)	1.1 to 1.3
Outlet (within 3 to 4 duct diameters)	
Straight unobstructed duct (#8)	1.0
Duct doubles area abruptly (#9)	1.4
Abrupt expansion/plenum (#10)	2.0
Radius elbow (with turning vanes) (#11)	1.5
Radius elbow (no turning vanes) (#12)	1.9
Miter elbow (#13)	2.0
Fan (#14)	1.2 to 1.4

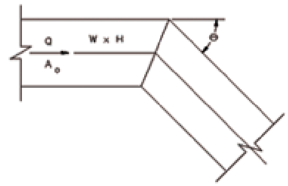
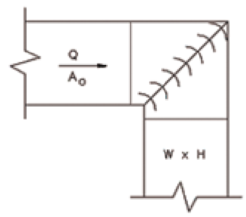
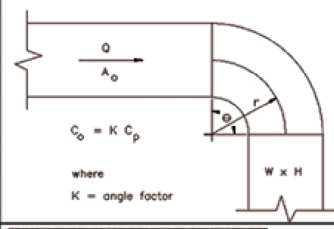
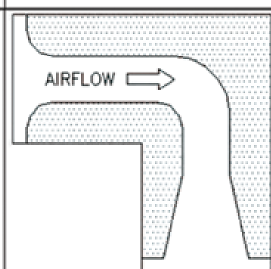
* Silencer pressure drop (including system effects) = silencer pressure drop per test code x pressure drop factor (inlet) x pressure drop factor (outlet).

Source: ASHRAE 2003 Application Handbook

Actual Pressure Drop = Cataloged Pressure Drop X Inlet Pressure Drop Factor X Outlet Pressure Drop Factor
Pressure Drop of the RM Silencer = 0.21 in w.g.
Inlet correction factor for a miter elbow = 1.3
Outlet correction factor for an abrupt doubling of duct area = 1.4
Therefore: Actual pressure drop = 0.21 X 1.3 X 1.4 = 0.38 in. w.g.

Some balancers and commissioning engineers I have spoken to are of the opinion that silencer cataloged pressure drop ratings are just plain out to lunch, and have absolutely no bearing in the real world. As silencer product developers, we have an obligation to provide the best information available and do so in strict adherence to applicable test standards (ASTM E-477-06a). During the development of the Price line of silencers, some products proved more challenging than others in this regard. Our Rectangular Elbow Duct Silencers were initially based upon typical industry standard designs, however required significant Computational Fluid Dynamics analysis to compliment our actual testing as we were unable to reproduce the catalogued results published in the industry. We now fully understand the frustrations of the balancers.

A comparison of pressure drop for various elbow configurations at 1500 fpm face velocity is shown.

Elbow Fitting		Pressure Drop (in WG)
Rectangular Mitered Elbow without turning vanes (CR3-6)		0.17
Rectangular Mitered Elbow with Turning Vanes (CR3-12)		0.05
Smooth Radius Elbow without Turning Vanes (CR3-1)		0.02
Lowest Pressure Drop Rectangular Elbow Silencer (ERM48/1A)		0.22

Claims of an elbow silencer having pressure drop comparable to a smooth radius elbow would be questionable at best and need to be substantiated and proven.

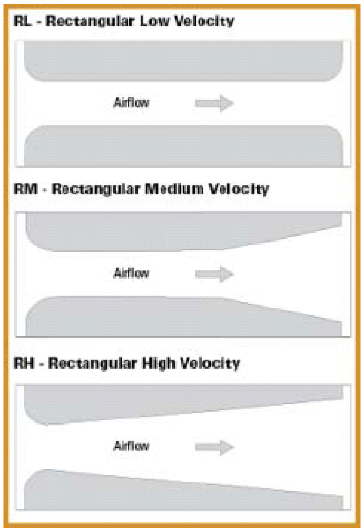
So what does all this have to do with Energy Considerations?

The proper application of silencers and credible test data are key to achieving the net energy requirements of the project. A silencer that has been properly selected and located will in turn use less energy than one applied without consideration to the installed location or derived from questionable catalogue data. Not having to “crank up the fan” will help maintain the intended energy consumption signature for the overall design, and eliminate costly changes during commissioning.

A Few More Rules of Thumb to Ponder…

- 1. When using rectangular straight through silencers, try to stay under 2500 FPM
- 2. When using rectangular elbow silencers, try to stay under 1500 FPM
- 3. Maintain at least 3 duct diameters of straight duct at the inlet of the silencer
- 4. Maintain at least 5 or more duct diameters of straight duct at the discharge of the silencer
- 5. Seek the assistance of your chosen noise control specialists when venturing outside of these parameters

Product Training Tip



Over the years, the silencer manufacturers have developed some fairly standard silencer geometries to deal with the pressure drop vs. insertion loss equation. Backed by testing and development, these designs can be applied on an application specific basis selecting the appropriate unit for the project achieving both the required acoustic performance at a reasonable installed pressure drop. These designs are labeled based on a specific velocity profile, however can be applied to a broader range of velocities when taking into consideration an acceptable pressure drop.

What are some of the typical silencer geometries?

Low Velocity – rounded nose-in / nose-out design

The low velocity design can also be looked at as the high pressure drop design. This geometry provides a very high level of acoustic performance, but as velocities extend past about 1000 FPM we find that the pressure drop levels begin to become undesirable for most applications.

Medium Velocity – rounded nose-in / tapered tail out design

The medium velocity design is the best all around performer available in the silencer market. It's straight through parallel entrance provides a high level of insertion loss, while it's tapered tail discharge works to keep the pressure drops as low as possible. With this model, we can work through a wide range of applications from 0-2000 FPM with a reasonable amount of pressure drop for most applications.

High Velocity – rounded nose-in / full length tapered tail out design

The high velocity design allows us to get up into the 2000-2500 FPM range with our standard product offering while providing excellent sound attenuation and lower pressure drops than the other 2 designs. We also use this design in lower velocity applications that require extremely low pressure drops, sometimes as low as 200 FPM.