Fabric-Duct Design Accessories

A brief overview of some of the benefits of this often-overlooked ventilation option.

BY NICK KAUFMANN

Images courtesy of DuctSox Corp.

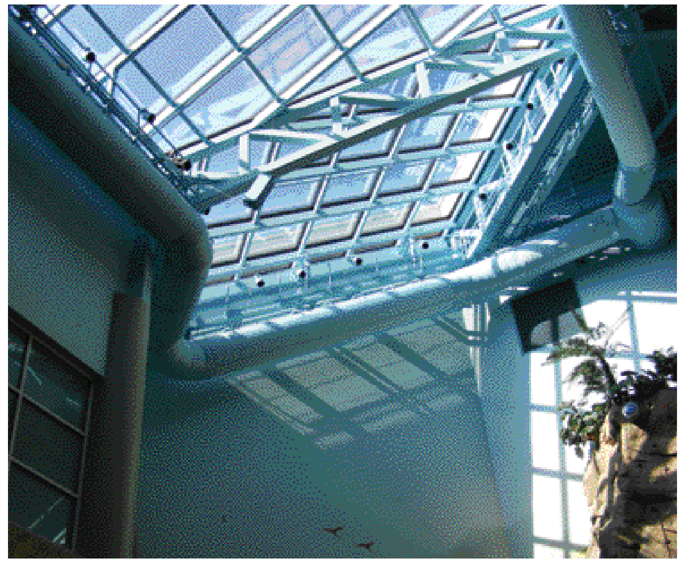

Figure 1 **Fabric duct has the same types of fittings as metal duct and can be designed to circumvent obstructions or navigate unusual angles.**

Despite it being a fast-growing ventilation category, many HVAC industry members mistakenly view fabric ductwork as a limited design with few capabilities other than just straight duct runs suspended by wire cable or ceiling track suspension systems in a gym or warehouse.

There are many myths about fabric duct, such as: it does not have the same array of fittings and accessories as metal; it looks wrinkled or deflated when the air-handling unit (AHU) shuts off; it is only a plan/spec product that is not inventoried and ready for quick delivery to smaller design/build projects; and it has no capabilities for high or directional throw. These and other misconceptions are untrue today, because fabric duct manufacturers have aggressively developed innovations and accessories that have catapulted fabric duct to nearly a 20% share of the open-architectural ceiling market.

Figure 2 **Just about any metal fitting shape can be made from fabric. A tee-shaped fitting for textile duct systems made out of fabric is shown here.**

It is safe to say that fabric duct now offers equal, if not greater, ductwork design flexibility than both spiral round and rectangular fabricated metal duct. In fact, the new design flexibility of fabric duct design has engineers and contractors specifying it in hospitals, schools, hotels, sports arenas, laboratories and data-center applications. The many innovations include: every imaginable fitting; directional air nozzles and air-flow adjustment devices; sound attenuators; in-duct tensioning systems that sport a perpetual inflated appearance; low-flow diffusers for laboratories, air-distribution models for poor-performing raised-floor applications; low-ceiling clearance models; and more.

Fittings

Any metal fitting can also be made with fabric. Few engineers and contractors are aware that elbows, tees, wyes, reducers and any unconventional radius or angle needed for a project can be custom-manufactured in textile equally as efficient and cost-effective as metal.

For example, the $133-million, 275,000-sq-ft Irving Convention Center in Irving, TX incorporates fabric ductwork with more fittings, offsets and other variances than most other facilities in the U.S. The exposition area features more than 1,200 linear ft of permeated textile duct with high throw orifices to reach the floor area 50 ft below.

It was a challenging design/build project for Fort Worth-based mechanical contractor Dynaten. Utility piping, electrical and structural steel presented a myriad of obstructions to circumvent.

However, Dynaten did not hesitate specifying with textile duct-fitting diameters of 22, 40, 44, 64 and 76 in., nearly all of which use a variety of custom-made elbows of 5 degrees, 15 degrees, 43 degrees and some other unconventional angles. Thus, the project totaled more than 24 elbows of different diameters, 14 offsets and a multitude of textile-to-textile adaptors to reroute ductwork while minimizing static pressure increases. Incidentally, friction loss in textile is considerably less at 0.04 in. w.g. vs. metal's 0.10 in. w.g., per 100 ft. In many projects, this affords smaller fan motor horsepower in equipment specifications, which in turn potentially reduces operational costs and expensive sizes.

Like metal fittings, the production of a fabric fitting starts off as a flat pattern and is available in a 5-Gore elbow design instead of a mitered elbow, the latter of which induces more static pressure resulting in a reduced efficiency. Not all fabric duct manufacturers offer 5-Gore elbows.

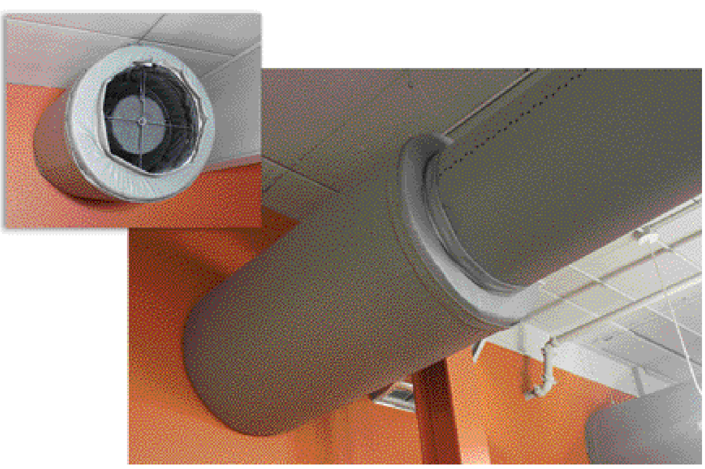

Figure 3 **The fabric sound attenuators abate noise generated from 14 AHUs ranging from 2,625–4,400 cfm.**

Sound attenuation

Up until 2016, perhaps the only accessory metal duct held over fabric duct was sound attenuation. Metal typically generates more air-flow noise and reverberates mechanical equipment sound more than fabric duct, so sound attenuation has not been a priority. However, in applications where mechanical noise reverberation might be an issue—such as offices, performance spaces, recording studios, etc.—the fabric duct industry has recently developed the first sound-attenuation device (see Figure 3). Fabric sound attenuators quiet AHU and variable-air volume (VAV) box operational and air-flow noise in the 500–2,000-Hz octave bands by 28–35 dB in offices, libraries, museums, classrooms and other sound-sensitive areas.

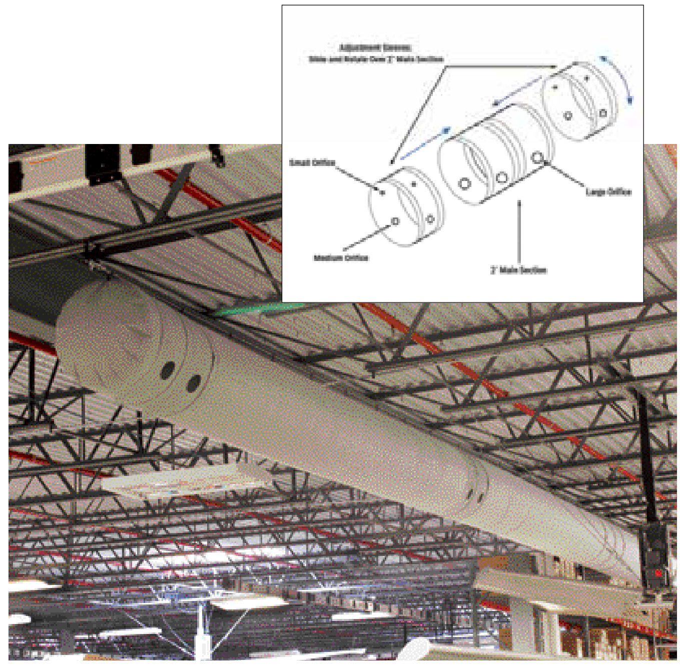

Figure 4 **Field-adjustable, modular and configurable fabric duct systems are ideal for smaller non-plan/spec projects of approximately 3,000-sq-ft or less.**

A case in point is Peosta, IA-based Mi-T-M, an international manufacturer of pressure washers, air compressors and many other industrial products. Mi-T-M's new 68,000-sq-ft offices needed mechanical noise abatement generated mainly by 14 AHUs ranging from 2,625–4,400-cfm. Using sound attenuators on each duct run, Mi-T-M's offices noise levels dropped 15 dB, an exponential calculation representing a decrease of more than 50%.

Field-adjustable modular/ configurable ducts

While the majority of fabric duct for open-architectural ceiling applications are typically plan-and-spec products, another new industry innovation is field-adjustable, modular and configurable fabric duct systems that are fully stocked and inventoried for three to five business days delivery. They are ideal for smaller non-plan/spec projects of approximately 3,000-sq-ft or less, such as retail strip center tenant improvement projects, commercial facility build-outs or floor plan reconfigurations, manufacturing/warehouse industrial plant retrofits, or any other open-ceiling architecture application. They offer equal, if not more, air-balancing flexibility, are 40%–80% quicker to install and 15%–50% less expensive than conventional metal duct/register systems.

The systems can be purchased in various sections and accessories through manufacturer representatives and are ideal for design/build contractors without engineering backgrounds. The systems consist of round 1.5-, 5- and 15-ft modular lengths of white polyester-woven, non-porous fabric ranging in five diameters of 12, 16, 20, 24 and 28 in. that accommodate up to 6,000 cfm per run. The system is balanced with a 2-ft-wide adjustable air outlet (AAO), or a four-orifice

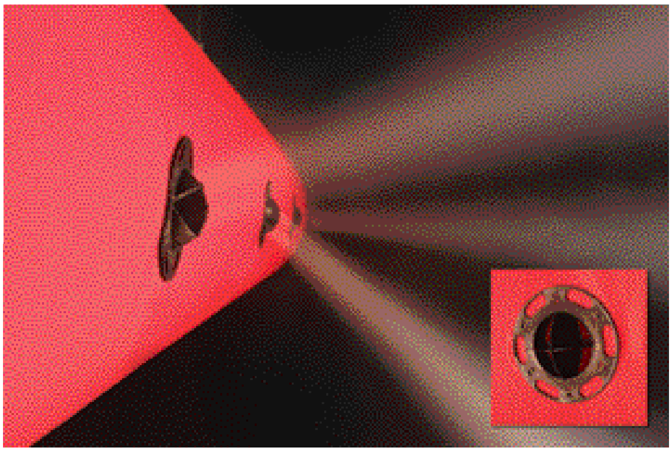

Figure 5 **Nozzles can be hand-rotated onsite into 10 different notched air-flow angle settings. The hemispheres have a throw range from 50–150 fpm and up to 10–70 ft, respectively.**

Figure 6 **The oval-shaped duct for low-clearance applications saves 13–27 in. of head room vs. round fabric or metal duct by spreading out air flow in a structure that ranges from 47–93 in. wide.**

component, which can be zippered anywhere into the duct run and offers a variety of throw distances, volume and directional capabilities comparable to metal duct/register systems (see Figure 4 inset). The AAO and elbow have dual zippers for adjustable mounting orientation. The AAO can produce 4 and 8 o'clock directional air flow or 2 and 10 o'clock if mounting orientation is adjusted.

Adjustable nozzles

Another recent innovation is the adjustable nozzle. Unlike vent orifices that are laser-cut into the fabric and offer no field adjustment capabilities, nozzles are field-adjustable (see Figure 5). They are constructed of a 360-degree rotatable hemispherical plastic diffuser secured inside a 2-in.-diameter (33-cfm, 0.5-in. w.g.) or 3-in.-diameter (66-cfm, 0.5-in. w.g.) grommet. They are designed to snap into the laser-cut orifice of a fabric duct trunk line.

Nozzles are ideal for any spot heating/cooling/ventilating applications, because they can be hand-rotated onsite into 10 different notched air-flow angle settings, including up, down, right or left as well as completely open or closed. The hemispheres have a throw range from 50–150 fpm and up to 10–70 ft, respectively.

Some applications for adjustable nozzles include:

→**Retail outlets**—for directing air flow away from temporary ceiling-hung signage or non-dehumidified air away from supermarket freezer aisles;

→**Industrial production lines**—adjusting air flow per employee or for quality-control process preferences or indoor air comfort; and

→**Natatoriums**—directing air flow and throw for complete window coverage and condensation control in difficult-to-reach corners.

Low-ceiling clearance

Low-ceiling clearances in offices or industrial production floors with overhead conveyers or frequent reconfigurations with high-rise machinery are a prime target for applications requiring minimal duct heights of 11–22 in., but high cfm. This innovation saves 13–27 in. of head room vs. round fabric or metal duct by spreading out air flow in a structure that ranges from 47–93 in. wide (see Figure 6).

The oval duct retains an inflated shape even during idle air-handling periods with patent-pending polyester ropes and supportive fiberglass rods for structural integrity. Six 3/16-in.-diameter ropes are sewn into the fabric interior at 9- to 14-in. increments, which also present an aesthetic pleated effect. The oval-shaped duct offers a variety of air-dispersion options, such as air porous fabric, linear vents, nozzles and orifices.

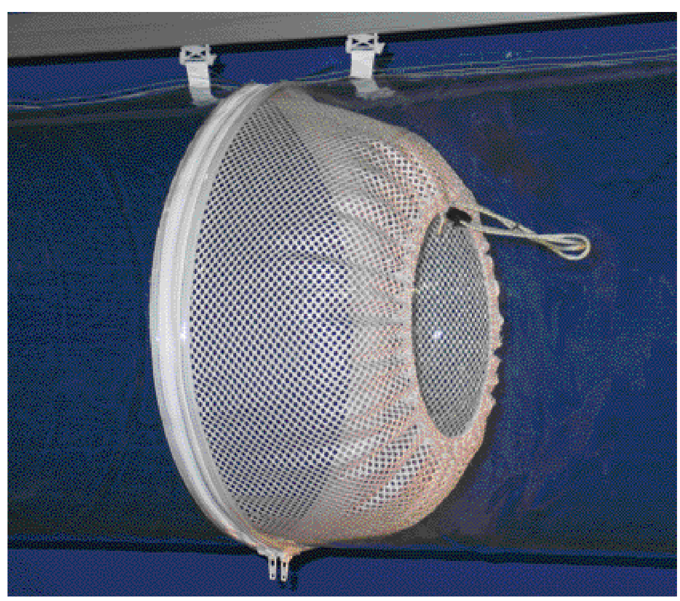

Figure 7 **The AFD is designed for balancing air flow anywhere throughout a duct run, but is generally factory-set for the inlet to quell turbulence caused by the air handler or its connecting ductwork/elbows.**

Figure 8 An in-duct tensioning system combines tensioning baskets and internal hoops to offer a perpetual inflated duct appearance.

The air-flow device

Another fabric-duct industry innovation is the adjustable flow device (AFD), a polyester-based factory-set or field-adjustable hemmed drawstring aperture (see Figure 7). The AFD is designed for balancing air flow anywhere throughout a duct run, but is generally factory-set for the inlet to quell turbulence caused by the air handler or its connecting ductwork/elbows. It can be zippered into any part of the duct run where sections are adjoined with zippers. The AFD is available in sizes that fit duct diameters ranging from 6–84 in. The AFD offers variable resistance to balance static regain, balance air flow to branches from trunk lines, straighten turbulence early in the supply run and reduce abrupt startups. When factory-set, AFDs included in the fabric-duct system design should not require field-balancing.

An AFD can be also be a helpful retrofit tool when balancing a duct run with air flow and velocity originally designed for a certain length that has been shortened, such as a space with a newly constructed wall. The original end cap can be relocated and zippered into the new termination point followed by zippering in an AFD to balance the duct run's new length.

Hoops, baskets and cylindrical tensioning

Perhaps fabric duct's only disadvantage vs. metal duct is a deflated or wrinkled appearance during AHU inactivity or roll-out and popping noises during equipment startup. Fabric duct manufacturers have countered this with three suspension devices grouped under the description of cylindrical in-duct tensioning systems (CIDTS) to maintain an inflated appearance, regardless of AHU operation. The good, better, best approaches are hoops, tensioning baskets and cylindrical tensioning frameworks (see Figure 8 inset).

Internal 360-degree metal hoops inserted every 5 ft to maintain duct roundness is one way to avoid this issue. The hoops, which are supported by vertical cables tied into a horizontal cable suspension or U-track run, hold the fabric ductwork open and taut, regardless of air-handler runtimes.

Another method is a combination of tensioning baskets and internal hoops. It is suspended from either a cable or track suspension system. The tensioning locks, which connect the tensioning baskets to the suspension system, tighten and lock the fabric externally into a taut, smooth appearance.

> **Many critical environments, such as laboratories and clean rooms, suffer poor exhaust fume-hood capture and exhaust performance due to excessive HVAC supply-air diffuser velocities.**

The premium method is 360-degree cylindrical supports attached to a central skeletal spine with a tensioning ratchet device. Instead of just internal hoops, the 6-ft-long tensioning spine's adjustment nut is ratcheted onsite to spread the front and back support hoops apart. It is the most aesthetic method, because it keeps an inflated appearance and also smoothes the fabric to eliminate any wrinkling, thus giving a more streamlined appearance, regardless of AHU run times. This method has been recently enhanced to include large 50–84-in.-diameters to accommodate huge spaces such as arenas.

CIDTS have also caused a revolution in fabric duct design. Ten years ago, a consulting engineer and architect would design a system by first picking the fabric type, color, air dispersion and then choose the suspension system (typically a cable or track system) last, but the opposite has occurred today. Now, the suspension system is the first choice because of aesthetics, followed by the selection of other variables.

Fabric duct advantages

According to a 10-month-long study performed by the Iowa State University's Mechanical Engineering Dept., titled "Thermal Comparison Between Ceiling Diffusers and Fabric Ductwork Diffusers for Green Buildings," proved fabric duct has a 24.5-% efficiency differential, because it heats rooms faster and more uniformly to satisfy temperature setpoints when compared to metal duct/diffusers. This results in reduced mechanical equipment runtime, thus saving energy in the process. The study is available for free at www3.me.iastate.edu/bglab. Additional advantages include:

- 90% lighter than metal, which can result in lighter weight structural steel in facilities for an overall building construction savings. Lightweight also promotes more employee safety, especially with high ceilings;
- Linear-vent air dispersion distributes air more evenly than metal register/diffusers every 5–10 ft for better energy efficiency. Linear air dispersion (and porosity, if used) provides better air comfort with less drafts;
- 40%–60% faster and less expensive to install in labor;
- More streamlined and aesthetic than metal;
- Easily cleaned with quick disassembly and commercial laundering;
- Less expensive than metal in material costs;
- Will not get dented from errant objects in athletic facilities.

Diffusers for critical environments

Many critical environments, such as laboratories and clean rooms, suffer poor exhaust fume-hood capture and exhaust performance due to excessive HVAC supply-air diffuser velocities. Besides poor fume-hood performance, excessive velocities also cause noise (vibration) or fluctuating temperatures that disrupt sensitive activities, especially in labs. Instead of reducing air-flow volume, which typically is not effective, viable or compliant with codes, this common HVAC ventilation dysfunction can many times be resolved with better diffusion.

To reduce drafts while maintaining the designed supply/exhaust air volume ratio, fabric duct manufacturers have innovated drop-in diffusers that essentially replace 2 x 2-ft or 2 x 4-ft metal four-way ceiling diffusers. Typically, they consist of an easily removable (for cleaning) fabric face capable of dispersing up to 1,000 cfm, however the diverging, yet uniform, air-flow pattern reduces drafting noticeably below industry-standard critical environment diffusers. The fabric is available in engineered porosities that evenly disperse without drafts and disruptions to draft-hood capture. Fabrics are also available in micro-perforated polyester designs that reduce product maintenance. These micro-orifices do not capture and retain

›› Figure 9 A science building at the University of Toronto replaced its original metal diffusers with fabric diffusers for even air flow and slower velocities, while still maintaining the needed cfms to condition the lab spaces.

particulates like woven porous fabrics that may need periodic laundering depending on the application and HVAC filtration method.

The fabric duct industry continues to innovate and continues to be a choice for applications such as the burgeoning data-processing center market and other critical-cooling applications for computer, server and electronic equipment rooms. The future looks bright for fabric duct as it steadily gains market share from metal duct in open-architectural ceiling designs.

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