The Café Delhi Heights chain uses fabric ducts for uniform distribution of conditioned air

Emerging Fabric Air Diffusion Trends in India

By Gurmeet Singh
Managing Director
VGI Power Systems, Delhi

and

John Lipscom
International Sales Manager
DuctSox Corporation, Peosta, Iowa, USA

Introduction

Fabric ductwork for HVAC applications is gaining an increasingly wider acceptance among Indian engineering firms and mechanical contractors. While this unique niche of the HVAC business is common in Europe and North America – the latter now uses fabric duct in more than 20% of the open architectural ceiling ductwork market - it has grown steadily in India.

Figure 1: Consultants are increasingly specifying fabric ducts for restaurants

For example, consulting engineering firms Tata Consulting Engineers, Mumbai; Aecom, New Delhi; and Sterling and Wilson, Mumbai are some of the prominent Indian firms using fabric duct air dispersion on projects ranging from hospitals, labs, manufacturing factories, retail stores, restaurants, offices and other commercial buildings. This inclusion in major construction projects is one reason the Indian fabric ductwork market grows fast every year. Another market driver is many Indian engineers'

About the Author

Gurmeet Singh is MD of VGI Power Systems Pvt. Ltd., a 15 year old player in the HVAC industry and a representative for DuctSox Corporation. VGI has expertise in two-stage cooling solutions and undertakes turnkey projects deploying cooling technologies, fabric duct air dispersion and HVLS fan solutions. VGI Group also handles facility management of various embassies and expat residences, involving the handling of MEP and civil work with full-time onsite teams.

John Lipscomb is the international sales manager for DuctSox, the leading player in fabric ductwork and accessories, which offers all types of fabric duct products including traditional overhead round models for industrial, commercial and institutional HVAC ventilation applications. Its recent product lines are Labsox®, KitchenSox® and UnderfloorSox* – textile air dispersion systems for critical environments including labs, kitchens and under floor air distribution.

continued on page 28

continued from page 26

acceptance of fabric duct as superior air distribution versus its metal counterpart.

Benefits of Fabric Air Dispersion

The superiority of fabric air dispersion over metal stems from its linear diffusion design that can run the entire length of a duct, versus metal registers positioned every five or 10 feet that deliver air in a drafty high air velocity. The linear vent strategy delivers an even dispersion without sacrificing throw distance. Fabric duct's vents can be engineered to any configurable arrays or orifice diameters ranging from 12 to 125 mm. Industrial models can include larger high-throw orifices or adjustable nozzles for directional airflow.

The addition of porous fabrics in commercial spaces increases indoor air comfort and energy savings in many cases. These linear vents can be distributed through factory-engineered porosities where approximately 15% of the air is dispersed through the fabric. The result is an even, gentler air dispersion to the occupants below.

Besides airflow superiority versus metal duct, there are other benefits, too:

Weight

Structurally light load-bearing roofs, for example, can withstand the suspension of almost any size or weight of fabric duct, because it is approximately 90% lighter than metal duct. Therefore, factories and other unbearably hot workspaces that would not be able to sustain the roof weight of hanging metal duct, can now be adapted to evaporative cooling with lightweight fabric air dispersion.

Labour Cost

Regardless of labour rates, fabric duct wins the battle of labour costs too. In most examples, the same diameter and length of fabric duct can be installed in 40 to 60% less time than metal, saving a large amount of construction cost on large projects.

Aesthetics

The sleek, streamlined dimensions of fabric duct versus the protruding ribs and diffuser registers of metal duct are embraced by architects when interior space aesthetics are important.

Condensation

India's hot, humid climate, especially in the south, typically creates condensation on metal air conditioning duct that drips onto anything below it. Consequently, metal duct job costs increase due to condensation. Besides a potential indoor rainforest, especially with the cooler air discharge of air conditioned spaces versus warmer temperatures of evaporative cooling, moisture can prematurely corrode metal. Porous fabric duct models help prevent condensation by forming a barrier around the duct, preventing moisture from settling on the surface.

Maintenance

Fabric duct can easily be unassembled, commercially laundered and re-hung in less than a day by unskilled labour. This is especially beneficial in food processing plants, restaurants and cleanroom production areas. Porous fabrics rarely get dust accumulations on their exterior surfaces because air continually blows through them.

Providing Indoor Air Comfort for Indian Labour

Indian factories are taking advantage of evaporative cooling to create more humane working conditions and improve productivity. Therefore, it is no surprise that *The Economic Times* reports Forbes Marshall as one of the 10 best companies to work for in India. The steam engineering products manufacturer takes great care in the indoor air comfort of its employees, as typified by its new Chakan greenfield manufacturing facility near Pune. While some manufacturers offer little air comfort relief to workers, who many times succumb to production floor temperatures that can exceed 52°C, Forbes Marshall went to the expense of including evaporative cooling and fabric ductwork throughout the two greenfield plants. The project adds to Forbes Marshall's reputation as the 5th Best Workplace in India issued by the *Great Places to Work Institute* for 2013-2014.

Figure 2: Fabric duct in the paint area of a factory

The 108 x 122 meter boiler plant shed distributes 900,000 cfm of evaporative cooling through 20 runs of non-porous 64-inch diameter fabric duct that reduces to 48-inch diameter halfway through the runs. The accompanying 93 x 82 meter vendor park shed distributes 240,000 cfm of evaporative cooling through eight runs of non-porous 56-inch diameter fabric duct that reduces to 40-inch diameter halfway through the runs. Since fabric duct is easier to hang and, thus, safer than hoisting and securing heavier large diameter metal duct up to high ceilings, it helped contribute to the construction project's more than two million safe man-hours without any reportable incidents.

Tenneco, an India-based automotive shock absorber and emission control manufacturer has also used fabric duct. Its Bawal, Haryana manufacturing location uses 150,000 cfm of evaporative cooling and fabric ductwork to cool employees. This plant has one of the best productivity rates among Indian factories, without resorting to the 40% more expensive solution of conventional air conditioning equipment and metal ductwork. The cooler environment has generated productivity increases that keep the facility ahead of schedule even in the peak of summer. Six 25,000 cfm evaporative coolers supply their own respective 200 foot

continued on page 30

continued from page 28

Figure 3: A fabric duct in the Tenneco India plant at Bawal, Haryana

duct runs that are more cost-effective than metal duct. Estimates for running the necessary 1,200 linear feet of metal air distribution ductwork was not only more expensive, but required 12 to14 weeks of installation time. Additionally, hanging several tons of metal ductwork from the factory ceiling might have required a stronger roof support structure for the new 45,000 square foot factory.

Instead of 12 weeks, the six runs of 56-inch diameter round commercial-grade fabric duct were installed in six days. The blue streamlined fabric duct distributes 15% of its airstream through the fabric and the remaining 85% through a linear array of ½-inch diameter precision laser-cut vents. The air dispersion through the fabric eliminates settling dust and condensation; the latter also eliminates the need for maintenance-intensive protective exterior coatings or costly insulation concerns associated with metal duct. Each run is outfitted with a final filter that is zippered into the main duct runs, making replacement and cleaning easy.

Other Indian factories, such as ConAgra Foods and Nestle India, have incorporated fabric duct and evaporative cooling as well.

Trend in Restaurants and Sports Clubs

Restaurants are increasingly adding air conditioning in India. A case in point is the Cafe Delhi Heights chain of restaurants in the National Capital Region. The chain has simultaneously increased seating capacity and saved energy with the installation of fabric duct. The chain was spending more money on air conditioning to increase customer footfall and employee productivity. In some locations, it found customers grouping themselves around the restaurants' original metal duct registers. The solution was fabric duct and linear vents that disperse the air more evenly throughout the restaurants, so most customers are comfortable regardless of their seating position. The hot and cold spots have been reduced to even temperatures and a 25% customer increase.

Fabric duct also made it possible for sports clubs to incorporate air conditioning as well. An example is the exclusive 102-year old Delhi Gymkhana Club. The club recently converted its three squash courts to air conditioning. The wooden building's aged roof would not have been able to withstand the addition of a 27-foot long, 18-inch diameter metal duct run; however, lightweight fabric duct enabled the project. The white porous fabric also retains its aesthetic round shape and absorbs squash ball impacts without denting. Other sports clubs such as the Cricket Club of India, Mumbai, use fabric duct in spaces such as their badminton courts.

Trend of Open Ceiling Architecture

Open architectural ceilings are a major design initiative and are an emerging trend in India versus suspended, T-bar or grid ceilings. One reason is reduced construction costs. A project can save construction costs by eliminating the suspended ceiling altogether in favor of an open architecture appearance. Besides construction costs, operational savings can be attained by mounting the ductwork seven-feet high to disperse air closer to the occupied area.

For example, Speedways, the Amritsar-based Hero two-wheeler dealership chain, has found fabric duct aesthetic as well as cost-saving. It is converting dealerships to air conditioning with fabric duct installed either under suspended ceilings or resorting to quarter or half-recessed strategy. New dealerships will have open architectural ceilings to save construction costs. To add to the aesthetics, Hero has silk-screened its corporate logo on the fabric to help its branding.

In-Duct Tensioning for Supply and Return

One of the few disadvantages of fabric duct is its limp wrinkled or deflated appearance when air handlers are idle. This disadvantage, especially in commercial spaces where aesthetics is as important as performance, prompted the development of the in-duct tensioning system that holds the duct fabric taut with a perpetually-inflated, wrinkle free appearance. This type of suspension's first generation featured 360^0 internal metal hoops every five feet that maintain the duct roundness and minimize

Figure 4: Conventional fabric duct without in-duct tensioning in a restaurant

Figure 5: In-duct tensioning system in a restaurant

continued on page 32

continued from page 30

sagging and wrinkles. The hoops, which are supported by vertical cables tied into a horizontal cable suspension or U-track run, hold the fabric ductwork open regardless of air handler operation.

The second generation of duct tensioning system featured 360° cylindrical supports attached to a central skeletal spine with a tensioning ratchet device. Instead of just internal hoops, the six-foot long tensioning spine spreads the front and back support hoops away from each other via an accessible adjustment nut. This not only keeps an inflated appearance, but also smoothes the fabric to eliminate any wrinkling, thus giving a streamlined appearance.

Besides aesthetics, the new suspension/retention systems also have extended warranties. The fabric is the same quality, but the absence of hundreds and sometimes thousands of inflate/deflate movement cycles minimizes fabric fatigue. Thus, the fabric remains in a static position throughout its lifecycle. While many manufacturers offer warranties of up to 10 years on fabric with the older suspension systems, the new suspension/retention systems have extended warranties of up to 20 years, depending on the fabric and the suspension/retention system.

In-duct tensioning systems have turned fabric duct design upside down. Previously engineers would choose the fabric, color, orifices, etc., first and the suspension last, because the suspension system consisted simply of cables or track. Now designers are choosing the suspension system type first because it affects the entire project's aesthetics and performance.

While in-duct tensioning devices were developed for aesthetics, the Indian engineering culture has found it invaluable for return air duct runs. Fabric duct is typically used only in supply air because return or exhaust ductwork would collapse due to a vacuum. However, Indian engineers have found the new in-duct tensioning systems as invaluable for keeping fabric return duct open and an inexpensive and quicker-to-install solution. The Hero showrooms are tapping into this trend.

A typical application is mounting a fabric supply duct on one side of a space and a fabric return duct with in-duct tensioning on the opposite side. This configuration helps draw the supply air across the entire space and eliminate stratification for pure air dispersion. Vents are placed linearly toward the top apex of the duct to draw the warmest air in the room. Using the in-duct tensioning system in the supply duct is optional for aesthetics, or it can be value-engineered without it.

Engineering Challenges that Cannot be Solved with Metal Ducts

The ventilation challenges many laboratories face are excessive velocities, vibration and noise from conventional HVAC supply air ceiling diffusers. Typical velocities upwards of 100 fpm or more are very high and cause turbulence that disrupts exhaust fume hood capture, and research-skewing wide temperature swings and drafts. This HVAC ventilation dysfunction can many times be resolved with better diffusion. Fume hoods need fairly calm environmental conditions from which to draw and capture surrounding air. These turbulences are many times caused by a nearby four-way metal diffuser's excessive air velocities; however, substituting fabric diffusers can reduce the fpm without sacrificing cfm.

Figure 6: Air flow in a lab with LabSox fabric duct

A case in point is the Indian Institute of Technology Kanpur campus. A science building lab was experiencing excessive air velocity of more than 200 fpm through 2 x 4 foot conventional HVAC ceiling diffusers. Engineers recommended 2 x 4 foot fabric diffusers as drop-in replacements for the lab's eight 2 x 4 foot conventional diffusers. Subsequently, skewed instrumentation and experiments from excessive flow were corrected with an air velocity reduction to 30 fpm through the fabric.

A fabric diffuser can reduce localized drafts by half or more, but still allow the necessary air volume to balance the space. Further, specifying a directional pattern, such as surround or radial flow, also offers more airflow control. In similar situations, reducing airflow volume is not viable, because lab supply air volume designs are closely tied to ensuring proper room pressurization

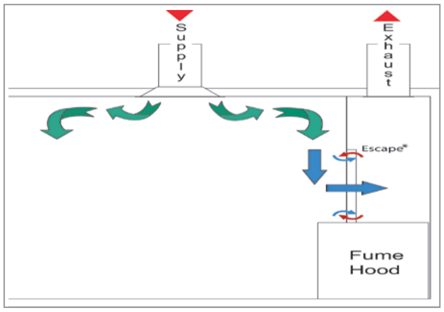

Figure 7: Air diffusion in a lab with metal duct

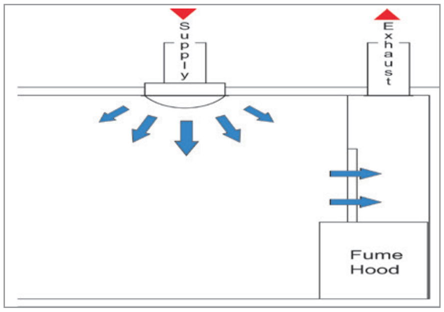

Figure 8: Diffusion with a fabric duct

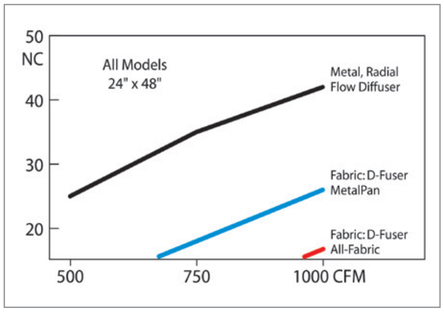

Figure 9: Noise level in lab with metal and fabric ducts

continued on page 34

continued from page 32

How Fabric Works as an Air Diffuser

Fabric diffusers disperse airflow better than their conventional metal four-way radial counterparts that do not work particularly well in commercial kitchens because of their inherent high velocities and diffusion characteristics. Four-way radial diffusers induce drafts that mix airflow well, but are noisy and yield drafts that projects air outwards, which may impact nearby sensitive capture hoods. Laminar flow diffusers, which typically have a flat face and no directional louvers, can be directed downward and only generate a column of air with an even more vertical descent to the floor. Both options could cause a concern near the cooking hood's drawing area.

Comparatively, fabric diffusers disperse the air slowly with a wider pattern that mixes with ambient air more efficiently. This generates minimal turbulence and keeps air movement below the 70 fpm velocity at the lip of the hood, allowing it to draw according to its intended design. Essentially, the airflow dispersion pattern of the surround flow fabric diffusers has bridged the gap between the laminar and radial airflow patterns.

(ASHRAE-recommended negative pressure for labs). Throttling down individual diffusers may throw off the pressure balance. This can draw more air from other environments, such as through doors, or just push airflow to other inline diffusers and create excessive ventilation elsewhere.

These fabric diffusers typically consist of an easily removable fabric face capable of dispersing up to 1,000 cfm. However, the diverging, yet uniform, airflow 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 particulates like woven porous fabrics that may need periodic laundering, depending on the application and HVAC filtration method.

The drop-in replacement process is eased with a metal pan, a fabric-faced back panel in suspended ceilings. Other product options for finished ceilings include a similar product with a textile backpan, a half-round shape to extend the dispersion surface, or a quarter-round to offset against the 90^0 angle created by a wall and ceiling joint. For open ceiling laboratories, a typical cylindrical shape can also yield good results.

Conclusion

As engineers and contractors discover the many benefits of fabric versus metal ductwork, the former will increasingly be considered a feasible option on many projects. The result will be a better value in installation and material costs as well as energy savings for building owners. For the occupants, there will be better indoor comfort and increased productivity.