DISPERSION CONVERSION

Data centers pose numerous ventilation challenges.

Data center ventilation strategies look to air displacement, not more cooling.

BY PHILIP SLOAN

Images courtesy of DuctSox Corp.

Ventilation in data centers is an ongoing efficiency and efficacy challenge for facility managers. In the data center industry's early days, getting enough cooling into server or electronics rooms required oversizing HVAC equipment, which affected efficiencies. Energy efficiency was sacrificed to guarantee the room was cold enough to offset equipment failures due to overheating.

Unfortunately, "over cooling" doesn't guarantee the air or ventilation will be drawn into the electronics racks adequately to prevent overheating, even though room ambient temperatures surpass American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 90.4, "*Energy Standard for Data Centers*" and TC9.9, "*Data Center Power Equipment Thermal Guideline and Best Practices.*"

Excessive velocities and turbulence can affect if and how ventilation is drawn into the racks by the small fans common in electronic equipment. Excessive velocities can also affect how the air is entrained and how it returns back to the HVAC cooling equipment. Frequently, in poor data center ventilation designs, warm air can potentially mix with cool air targeting the racks. This ultimately affects efficiency.

In conventional rooms, such as offices, classrooms and other commercial spaces, generally 1-ton of cooling can condition between 250-300 sq ft. In a data center, the same 1 ton of cooling can condition approximately 50-100 sq ft on average.

However, with many centers increasing load densities during the data center industry's ongoing trend toward higher kW equipment conversions, that 1-ton of cooling may no longer cover the same square footage. Subsequently, increasing air velocities exceeding 800 feet-per-minute (fpm) only makes the situation worse. Velocities more than 400 fpm in the cold aisle can create turbulence that upsets air infiltration into the equipment. In Figure 1 3A on page 15, (a side view cutaway of a

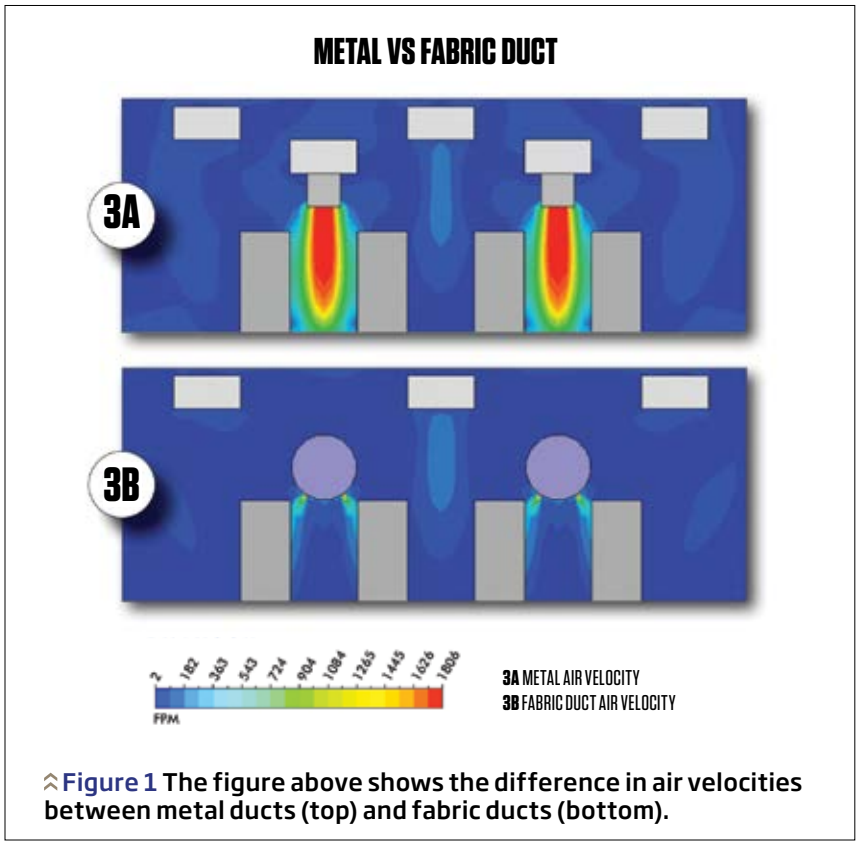


Figure 1 The figure above shows the difference in air velocities between metal ducts (top) and fabric ducts (bottom).

cold aisle between two racks of equipment) airflow from the metal duct/register systems push air down to the floor at rates surpassing 1,500 fpm. The surrounding decayed velocities still surpass 800 fpm, making it too turbulent for the racks to draw in the air. Instead of a uniform air dispersion, air bounces off the floor and rack facades to create turbulence.

Furthermore, the high velocity can create a vacuum effect where it pulls warmer air in from the hot aisles, which raises the total supply airflow's temperature and lowers efficiencies. Since a majority of the supply air in high velocity situations is not completely drawn into the front of the racks in the cold aisle, the air continually swirls and warms by picking up heat from other sources. Consequently, when and if it is eventually drawn into the racks, it is considerably warmer than its discharge temperature. This affects the room's energy efficiency and might add more electronic equipment wear-and-tear due to the increased temperature conditions that never satisfy ASHRAE standards or the electronics manufacturers' recommended cooling temperature requirements.

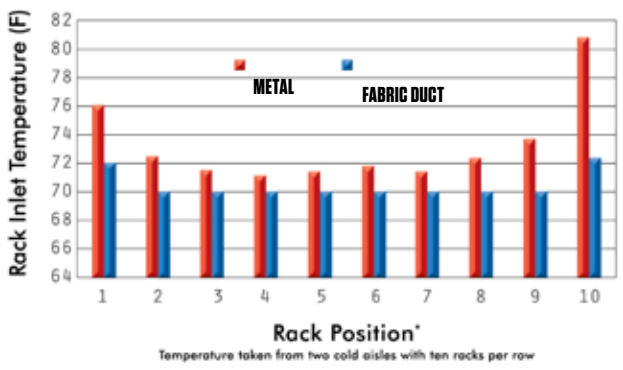
For this reason, many data center operators are looking to fabric HVAC air dispersion versus metal duct/register systems. Metal duct systems can have T&Bs (test and balance) performed, but their inherent design of registers every few feet inherently present turbulence. Though this can be throttled somewhat with dampers. Throttling registers can be problematic, especially when increased air volume is needed to cool the industry trend toward higher density equipment.

Unlike metal duct, fabric air dispersion design typically distributes air through fabric porosity, linear vents, or a combination of both. The result is less turbulence and more uniform air dispersion. In Figure 1 3B (above), the use of fabric air dispersion demonstrates slower velocities, but ample air volume. This type of

›› Efficiency and effective ventilation are critical for ducts in data centers.

air containment is significantly more efficient than high velocity methods and produces better Power Usage Effectiveness (PUE), an essential data center efficiency statistic. Slower velocities also eliminate the need for physical containment structures, which in turn produces lower construction costs.

A decade ago, some data center facility managers unhappy with metal duct performance began retrofitting metal air distribution with conventional fabric duct air dispersion, typically using a combination of porous fabric and linear vents that extend the length of the duct over a cold aisle. Involta LLC, which operates colocation data centers in Arizona, Pennsylvania, Ohio, Minnesota, Iowa and Idaho, is a prime example. Six years ago, in a trial location, the firm replaced metal duct with a retrofit of traditional fabric duct commonly used in a variety of applications such as retail, education and other commercial applications. The fabric duct reduced velocity, while not sacrificing volume. It dispersed by delivering approximately 15% of the air through the fabric's custom built-in porosity, while the remaining 85% was dispersed through a series of linear vents consisting of round 3 in.-diameter holes laser cut into positions approximately at 4, 5:30, 7:30 and 8-o'clock.



‹‹ Figure 2 A temperature performance comparison of metal and fabric ducts.

While decidedly more effective in performance and less expensive than metal duct, the conventional fabric duct model slowed velocity, but lacked enough direction adjustability when needed. Seeing the potential for optimum air dispersion with fabric duct, the company recently collaborated with a fabric duct manufacturer for a new generation of fabric duct designed specifically for data center cooling. The result is a round fabric duct that exhibits the best of both worlds: reduced velocity but field adjustability with nozzles for targeting spot cooling. Located above the cold aisles, the bottom of the 14-in.-diameter fabric duct is porous to provide reduced velocity and ample volume, but also has field-adjustable nozzles for directing air exactly where it is needed. The nozzles traverse the length of the fabric. Each nozzle can be adjusted for direction and airflow velocity at areas needing additional volume.

Involta's Marion, IA, facility was one of the company's first deployments of this new generation of porous fabric duct. The air dispersion systems distribute large volumes of air into data center cold aisles, but with velocities under 400 fpm. The deployment was also combined with mechanical equipment modifications of variable frequency drives (VFD) on air handlers. The VFDs allowed a 40% volume reduction, but maintained the same cooling temperatures due to better air dispersion, according to the company's Chief Security Officer Jeff Thorsteinson. Combined with some server and storage device change outs, the Marion facility HVAC retrofit reduced electric utility costs by 80,000 kWhr/month.

The company has since committed the same air diffusion concept in retrofitting existing facilities, as well as its new data center build-outs, such as a 40,000 sq ft location in Northpointe Industrial Park, Freeport, PA.

This current total HVAC design goes beyond Marion's data center-specific fabric dispersion systems and mechanical system VFDs. Additionally, it uses microchannel condensers and the CRACs (computer room air conditioning) are combined with a plenum designed by the project's general contractor, Rinderknecht Associates, that supplies the

straight fabric dispersion runs. Another plenum above the supply ducts draws warm, rising return air from the hot aisles back into the CRACs for conditioning and recirculation. Furthermore, when outdoor temperature and relative humidity are conducive to data center set points, the building automation system switches the system over to free cooling.

The Northpointe location is recording an impressive 1.3 PUE, which places it in the top 5% of efficient multi-tenant data centers nationwide. The design also provides more uniform temperatures throughout the cold aisle than conventional ventilation. In a perfect world, a data center cold aisle would remain the same temperature from top to bottom and from end to end. But temperature fluctuations can vary as broadly as 10°F with poor ventilation designs. Consequently, some sections of racks might be subjected to acceptable 72°F, but other sections may receive air at 82°F or higher, which isn't acceptable or compliant with ASHRAE standards. In Figure 2 (on page 16) using fabric air dispersion to place the air into the cold aisle shows a difference of less than 5°F throughout the aisle.

Besides a performance advantage, fabric air dispersion in the data center environment has several other benefits, such as:

→No risk of condensation;
→Lower cost than metal duct systems;
→Simplified design that installs up to 60% faster than metal duct;
→Little or no server time disruption in retrofit situations;
→Minimal construction dust and dirt during retrofits;
→Anti-static fabric prevents static electricity build-ups;
→Scalability allows quick additions within minutes to accommodate future cold aisle commissioning;
→Capable of commercial laundering.

For the service contractor already maintaining refrigeration and air conditioning equipment for data center clients, these new fabric air dispersion discoveries combined with other HVAC innovations for data center ventilation offer additional opportunities to streamline client efficiencies. If Northpointe is a model, this design can provide new projects and retrofits with HVAC efficiencies that are well beyond ASHRAE 90.4 and data center industry norms.

Retrofitting a data center's ventilation system using fabric air dispersion designed for the application's special ventilation needs can result in additional business. It can also make a happy customer when utility bills are greatly reduced and the retrofit work garners a short payback.

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