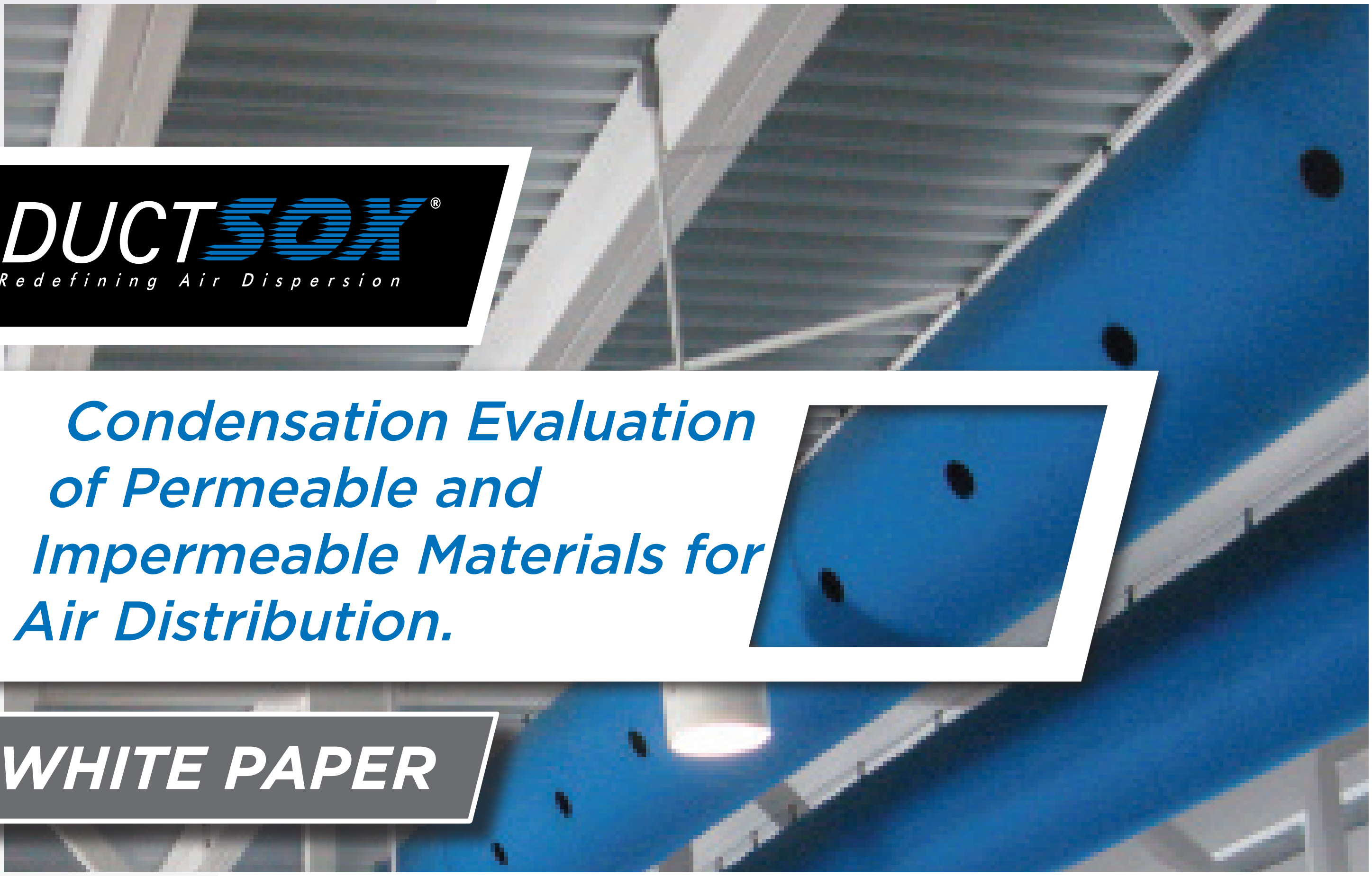
DUCTSOX®
Redefining Air Dispersion



Condensation Evaluation of Permeable and Impermeable Materials for Air Distribution.

WHITE PAPER

When specifying a duct system design, an important consideration is the potential of condensation on the exterior surfaces. As metal duct is most commonly used, single wall metal duct is applied where condensation is not an issue, and double wall or insulated metal duct would be used to prevent condensation or heat gain/loss. Designers of fabric duct systems also have options to control gathering of moisture and condensation on the outer walls of the ducts.

Common fabrics are available in permeable or impermeable constructions. Impermeable fabrics typically are either manufactured as a solid film material or a woven construction with a coating on one or both sides. While the coating offers fabric stability for cutting and construction - it yields a defined barrier offering little thermal benefit. The temperature gradient from duct surface to room air is due to natural convection, therefore very narrow - as shown in Figure 1.

Permeable fabrics are generally a woven construction and are processed to a specific permeability. In theory, conditioned air passes through the fabric and creates a thin layer around the duct wall of tempered air. This boundary prevents the warm, moist room air from contacting the duct wall and generating condensate. With this concept in mind, the permeable fabric ducts can be considered a direct alternative to insulated or double wall metal ducts. Figure 2 reveals the expanded gradient for the permeable fabrics due to controlled outward airflow.

Figure 1

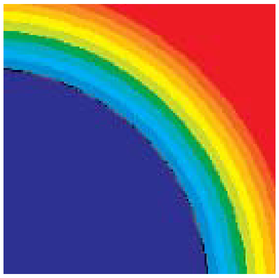


Figure 2

TEST APPARATUS AND PROCEDURE

To prove the theory, metal duct and several fabrics were tested at the Bioenvironmental and Structural Systems (BESS) Laboratory at the University of Illinois. Environmental chambers were designed to produce conditions yielding condensation on duct surfaces. The first chamber provided a constant air supply of 300 CFM (½" of H2O) at 55°F. The second chamber was used to model an unusual, but possible, hot and humid environment with temperature at 90°F and the relative humidity held between 92.5 - 98% throughout testing. The testing samples were 8" diameter and 30" long with no air outlets. Prior to testing, each sample was weighed in a plastic bag to determine dry weight.

The supply air looped back into the supply chamber once the air passed through the test duct section.

Once the sample was installed and chamber conditions achieved, testing was initiated and the chamber conditions were logged at 10, 20 and 30 minute intervals per sample. A total of 24 temperature readings were taken between 2 stations of 4 radial locations with three test points each - distanced 0 -¼", ½", and 1" away from the test sample surface (See Fig. 4). After the 30 minute test duration, each sample was returned to the plastic bag and weighed a second time to determine the weight gain due to condensate formation and retention.

The described test was performed on each of the following samples:

Figure 3

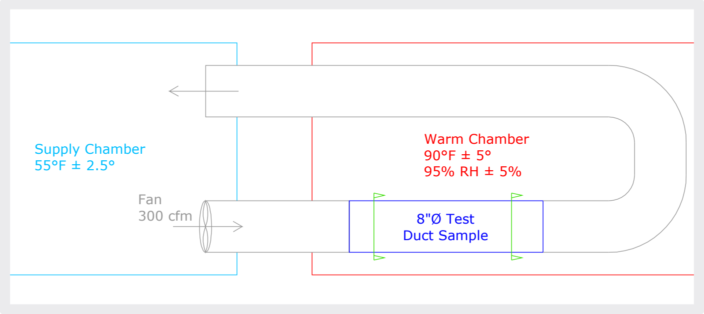
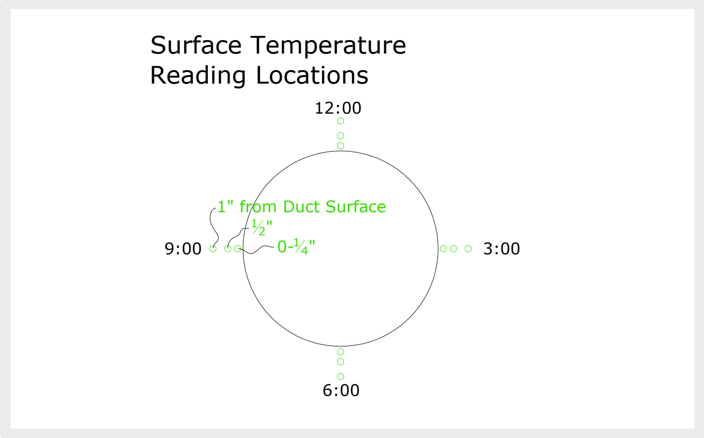


Figure 4



MATERIAL	DESCRIPTION	WEIGHT*	POROSITY**
Metal Duct	Galvanized Steel (Std. 18 Ga.)		0
DuraTex	Polyester, Woven & Coated	5.75	0
TufTex	Polyester, Woven & Coated	8.2	0
Verona 1	Polyethylene, Woven & Calendered	6.75	1
Verona 2	Polyethylene, Woven & Calendered	6.75	2
Microbe-X	Polyester, Woven	3.2	6

*Material Weight/Area: ounces/yd2
**Porosity: CFM/ft2 at 0.5" w.g. static pressure

Results: Evaluations Included Three Methods

-Visual: Observation of Condensation
-Weight: Measuring Added Moisture Gains
-Temperature: Air Temperature Surrounding Test Samples

Weight

The weight gains were substantial on the impermeable fabrics due to the development of moisture on the outer duct surface as shown in Figure 5. The permeable fabrics picked up only a slight amount of moisture from the humidity.

Temperature

As predicted, permeable fabrics yielded a film or halo of conditioned air around the duct surface - preventing the warm, humid ambient air to contact the surface. This halo of conditioned air acts as a thermal barrier extending the temperature gradient. Results, shown in Figure 6, for the impermeable fabrics were slightly better than, but comparable to the single wall metal duct with temperatures near the duct surface being close to the ambient air. Comparing % difference yields clear graphical representation of the extended gradient.

Conclusions

While test conditions could apply only to extreme applications, building startup or during periods of shutdown - test results reveal a significant reduction in condensation on permeable fabrics. These consistent test conditions and various evaluations clearly identify concerns of condensation for impermeable materials (metal or impermeable fabrics). Fabric permeability rate has little effect - as tests results are similar from 1 cfm/ft2 to the 2 & 6 cfm/ft2 fabrics.

Results from visual inspections reveal the effects of exterior texture for impermeable materials. Smooth surfaced metal duct yielded drippage, while the woven exterior surface of DuraTex and TufTex (coated on inside only) produced only mist size droplets and no drippage.

For applications in which condensation is a concern, permeable fabrics yield the lowest possibility for condensation. For impermeable materials, a woven exterior finish reduces risks of drippage.

Visual: Condensation observation
(after the 30 minute test period)

Metal Duct	Water beads had formed on entire surface, droplets joined and dripped
DuraTex	Mist-like, miniature water droplets on surface, no dripping
TufTex	Mist-like, miniature water droplets on surface, no dripping
Verona	No Change
Microbe-X	No Change

Figure 5

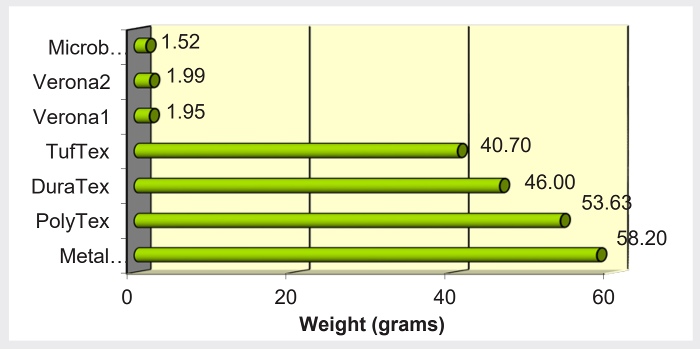
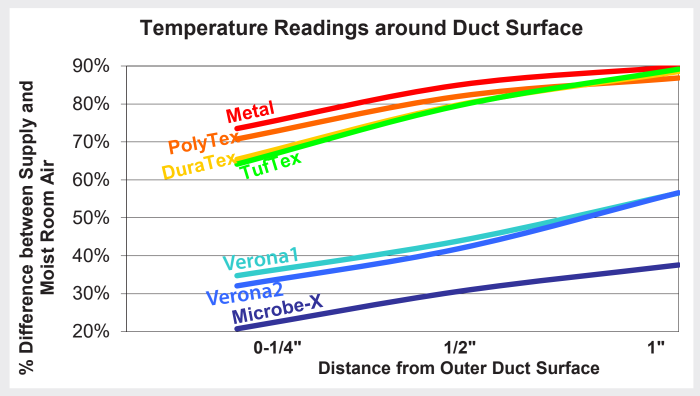


Figure 6



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