Friction Loss and Static Regain

In constant diameter textile air dispersion systems

WHITE PAPER

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This white paper discusses a range of air pressure aspects as they relate to models of Textile Air Dispersion (TAD) systems with and without an internal frame.

The first air pressure aspect covered is the friction loss of the product. Then this paper discusses how the configuration of the product affects velocity pressure, static regain, and static pressure. Finally, how these different air pressure aspects affect the uniformity of the outlet air is discussed.

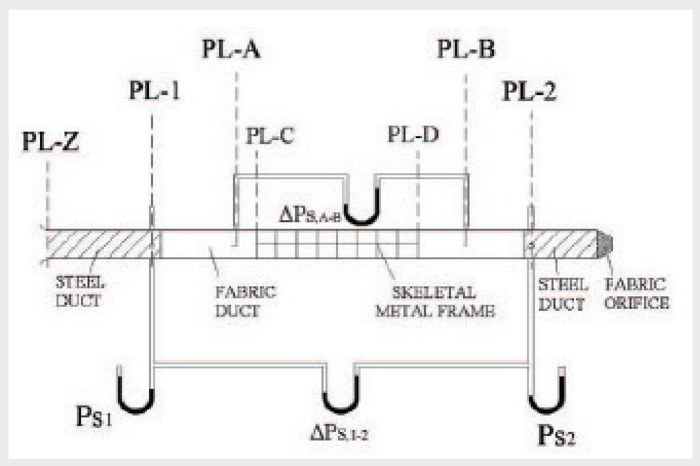
Textile Air Dispersion System Friction Loss

DuctSox, a manufacturer of TAD systems, led research at the Mechanical Engineering department of Tennessee Tech University (TTU). TTU is the same research lab trusted by ASHRAE to determine Pressure Loss data for ASHRAE's Duct Fitting Database. This research is the only Textile Air Dispersion System Pressure Loss data peer reviewed and published by ASHRAE.

The research resulted in pressure loss data of TAD systems with (Figure 1) and without the internal frame of DuctSox's SkeleCore™ FTS product.

This data reflects that TAD systems with an internal frame should be categorized with a Duct Roughness of "Medium rough" and a system without an internal frame should be categorized as "Medium smooth."

Figure 1



In a real-world scenario the pressure loss difference between these two types of systems is very small. For example, in Figure 2, if two systems, both 24" (610 mm) diameter, 50' (15.2 m) long, dispersing 100% of the airflow uniformly down the length, with an average inlet air velocity of 1800 feet per minute (9.1 m/s), the additional friction loss resulting from the internal frame is equivalent to the pressure loss for a five-gore elbow at the beginning of the system (0.02 inches of water (5 Pa) pressure loss).

Figure 2

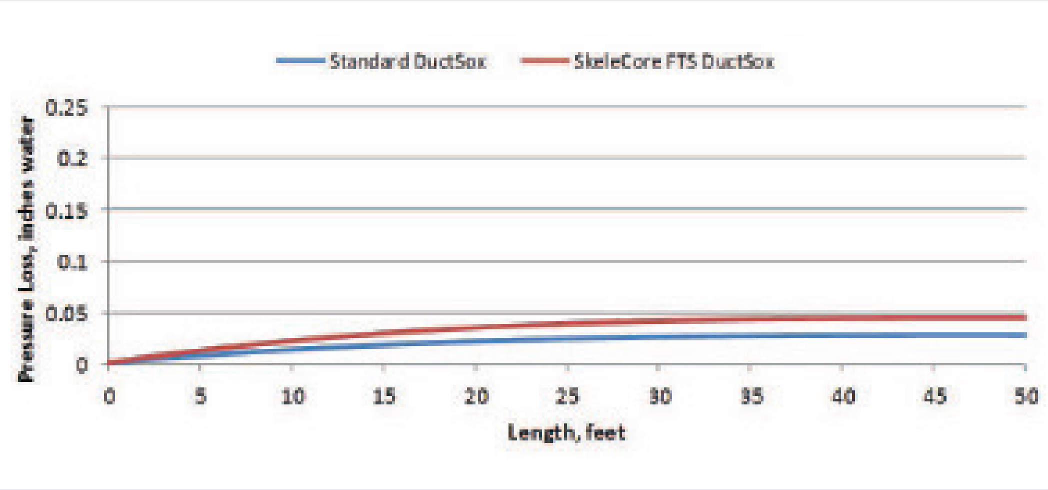
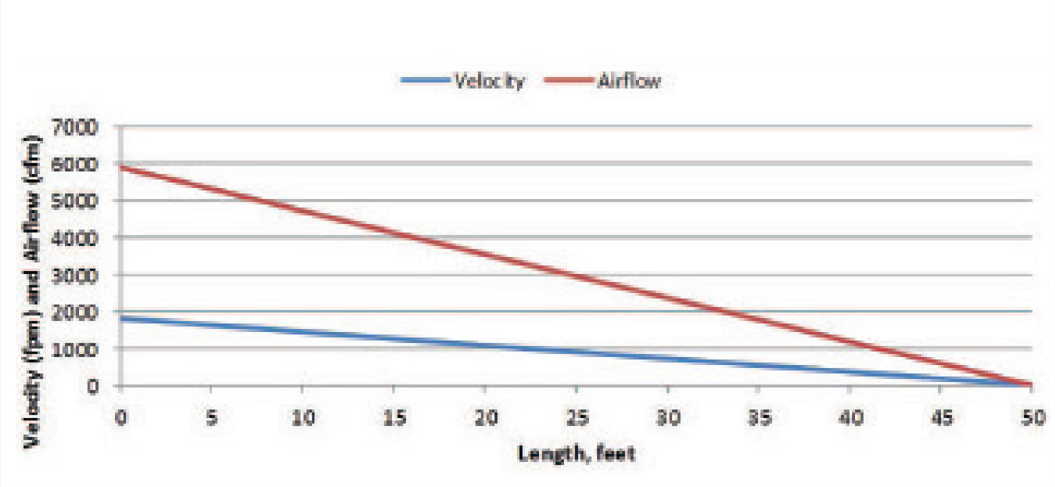


Figure 3



Textile Air Dispersion System Velocity Pressure, Static Regain, and Static Pressure

The largest and most critical component to the operating pressure of a textile air dispersion system is the static pressure at the inlet of the system. This static pressure is provided by the HVAC unit. The inflation and operation of a textile air dispersion system is dependent on static pressure, not inlet velocity.

As air is being dispersed to the space, the airflow and velocity at subsequent downstream locations continues to decrease as shown in Figure 3.

The VP is kinetic energy and slowly changes forms to a useful potential energy or Static Pressure Regain (SPR) as the air travels down the constant diameter duct. Figure 4 displays the inverse relationship.

For most systems, the pressure will be higher at the endcap than at the inlet due to SPR. The total amount of SPR converted is equal to the VP at the inlet as shown by Equations 1 & 2 for air at standard conditions:

SPR = Inlet VP = (V / 4005)2

(1) I-P

where

Inlet VP = velocity pressure, in. of water

V = inlet velocity, fpm

SPR = Inlet VP = 0.602 V

(2) SI

where

Inlet VP = velocity pressure, Pa

V = inlet velocity, m/s

Figure 4

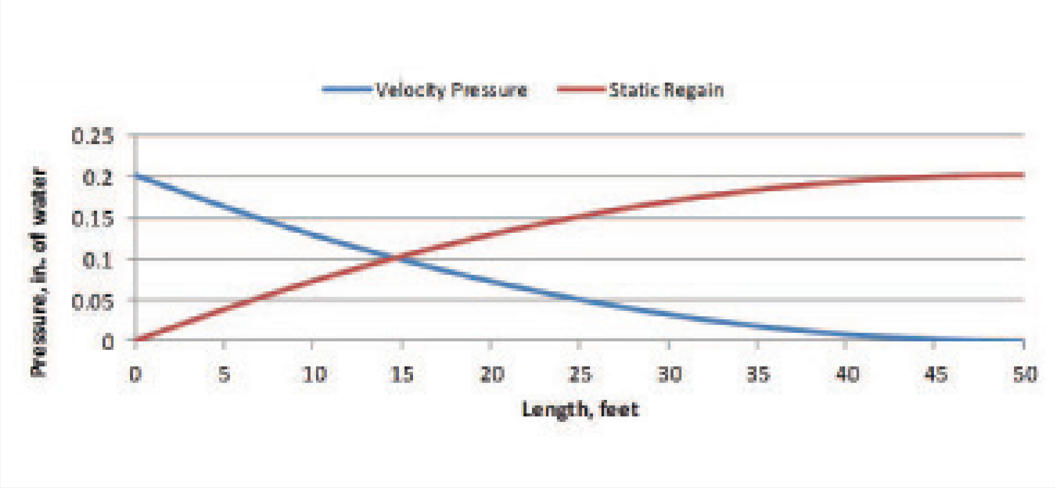
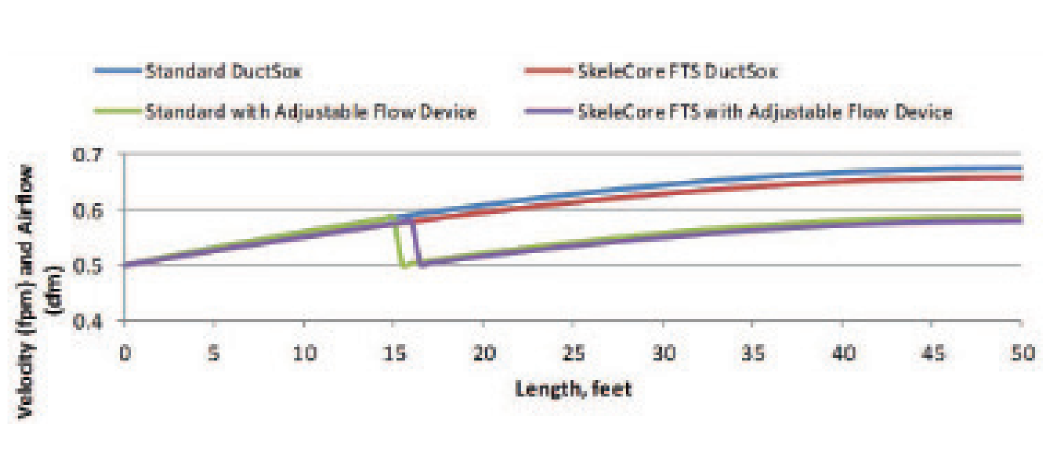


Figure 5



Combination of Air Pressure Effects

In TAD systems, the accumulation of static pressure regain is a common occurrence due to constant diameter sizing. It happens to influence static air pressure more than friction loss does. After combining effects of static regain and friction loss, the pressure along the length of duct is still uneven and higher near the endcap. An internal damper (an Adjustable Flow Device, AFD, in this example) is used to adjust the static pressure and reduce the pressure difference.

The airflow being dispersed is directly related to the static pressure at the outlet. Uneven static pressures result in uneven airflow to the space. Without an AFD, the airflows commonly vary 10% to 20% from inlet to endcap of a straight system. With proper use of the AFD, the variation of airflow is greatly reduced and is typically 3% to 6%. For example, Figure 5 shows an improvement in airflow from 11% to 5% by the insertion of an AFD at the 15' (4.6 m) mark.

The additional Pressure Loss due to increased Frictional Loss of an internal metal frame system simply results in less pressure loss being designed into the internal damper. In the example above, an internal damper is designed with a pressure loss of 0.08" for a system with an internal metal frame and 0.09" for a system without.

Conclusion

TAD system friction loss is categorized with a Duct Roughness of "Medium rough" and a TAD system without an internal frame is categorized as "Medium smooth."

TAD systems have a unique static pressure curve due to the fact that most systems are designed with a constant diameter from beginning to end, as the velocity decreases, the static pressure increases.

TAD systems, as with standard metal duct and diffuser systems, rely on pressure loss and Static Regain for uniform air dispersion.

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