TECHNICAL RESEARCH REPORT

Pressure

Design Methods for Fabric Duct Systems

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DUCTSOX®

Fabric Duct Pressure Explained

Metal ducts are commonly designed with either the equal friction method, static regain method, or the T-method.

Due to standards of fabric design, including consistent diameters and evenly dispersed airflow, a pressurized plenum concept is the best approach. This method best models pressure and air dispersion with fabric duct systems.

The use a constant duct diameter assists in installation and manufacturing processes. Additionally, the absense of reducing fittings reduces in duct airflow velocity, thereby reducing noise and frictional loss (energy).

Using proper methods can model pressure at any point within a fabric duct. The total pressure can be calculated by breaking it down into the three components: Inlet Static Pressure, Static Pressure Regain, and Friction Losses.

Please note: The charts and examples throughout this document are based on 5,000 cfm, ½” w.g. ISP and a 24” diameter fabric duct 100’ long.

INLET STATIC PRESSURE

The largest and most critical component to the operating pressure of a fabric duct system is the Inlet Static Pressure (ISP). This is the static pressure available at the inlet of the fabric duct or metal/fabric connection. The inflation and operation is dependant on the static pressure within the fabric duct system, not inlet velocity.

In some cases, the ISP may be External Static Pressure of the fan or unit if the transition to fabric is close to the outlet of the unit. Where the fabric duct inlet is some distance from the unit, the ISP is found by subtracting the frictional losses of duct and fittings from the external static pressure of the unit.

Based on our experience observed, the ISP approximately 80% of the time is ½” w.g. and between ¼” to 1-½” for the remaining 20%. The air outlet sizing details and throws can be designed with static pressure in mind. Projects utilizing fabric duct with static pressures greater than 1” w.g. tend to have increased energy usage and higher up-front costs of equipment without much change in function.

For ease of calculation and discussion, the ISP is a constant value along the entire length of duct as shown in Figure 1.

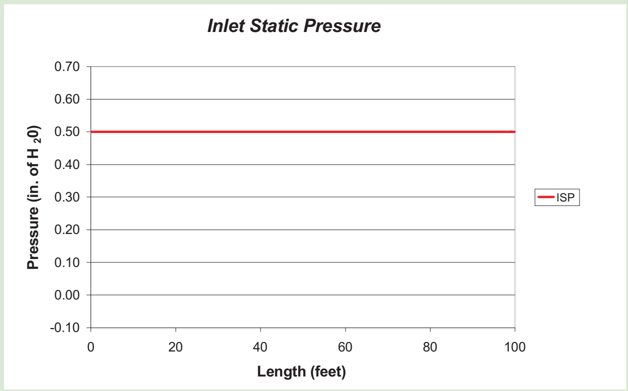

Figure 1: Inlet Static Pressure

STATIC PRESSURE REGAIN

As air is being dispersed to the space, Static Pressure Regain (SPR) builds along the entire lengh of the fabric duct. As cross sectional velocity reduces, Velocity Pressure (VP) decreases as charted in Figure 2. The VP is kinetic energy and slowly changes forms to a useful potential energy or SPR as the air travels down the constant diameter duct. Figure 3 displays the inverse relationship.

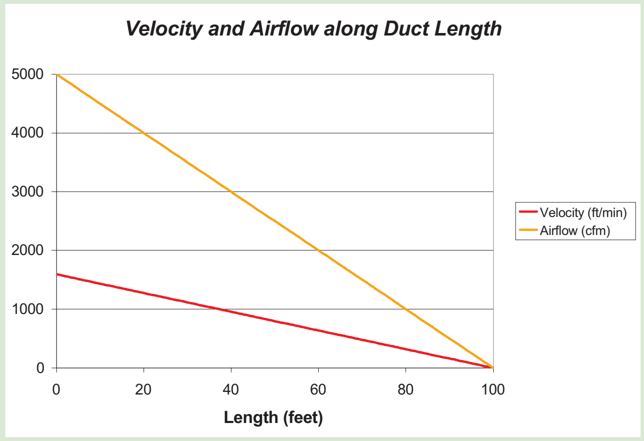

Figure 2: Airflow Velocity

For most systems, the pressure will be higher at the end-cap than at the inlet due to SPR. The total amount of SPR converted is equal to the VP at the inlet as shown by the equation:

$$\text{SPR} = \text{Inlet VP} = (\text{Inlet Velocity} / 4005)^2$$

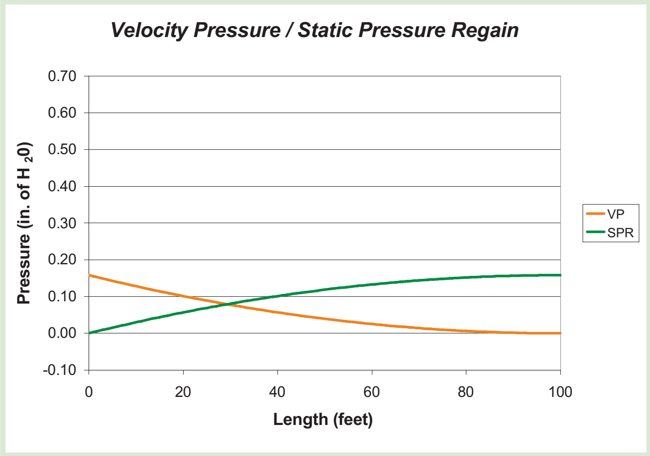

Figure 3: Velocity Pressure and Static Pressure Regain

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FRICTION LOSSES

Similar to metal ducts, fabric duct systems have friction losses (FL) along straight sections of duct and fittings. The losses, however, are much less than an alternate traditional metal layout. The FL are directly related to the duct diameter and cross sectional velocity. As the air is dispersed along the constant diameter duct length, the cross sectional velocity is decreasing and thus the FL decrease as well, as shown in Figure 4.

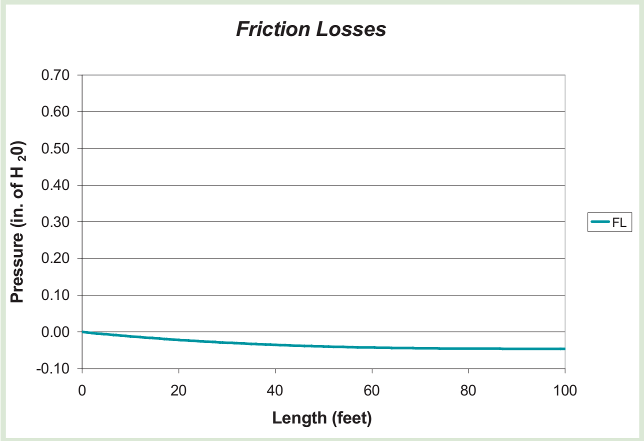

Figure 4: Frictional Losses

To estimate the FL of a straight section of fabric duct that is equally dispersing air:

1. Find the FL of the straight section of duct with 100% of airflow along the entire length. You can either use an air duct calculator or commonly used equations for metal duct.
2. Take 35% of the FL for that particular length of duct. This is a close approximation of the total FL over the entire length of fabric duct.

For example, a 24” diameter duct conveying 5000 cfm of air will have a friction loss of 0.14” SP per 100’ of duct. The fabric duct that is equally dispersing air over 100’ would have a friction loss of approximately 0.05” SP.

CONCLUSIONS

Components used for system design:

The Average Pressure (AP) is the average static pressure from inlet to endcap and is utilized for calculating the air dispersion through fabric, linear vents, and orifices. The AP of a fabric duct with equal air dispersion can be approximated by the equation:

$$AP = ISP + .65 * (VP - FL)$$

Example:

*AP = .50 + .65 * (.16 - .05)*
AP = .57” w.g.

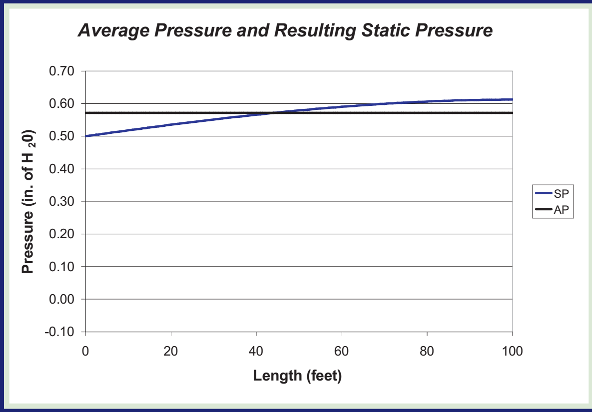

Figure 5: Average Pressure

If the ISP and SPR are added and FL subtracted, the resulting number will be the accumulated static pressure at the endcap. In most cases, the maximum static pressure of the system.

$$\text{Endcap SP} = ISP + SPR - FL$$

Example

Endcap SP = .50 + .16 - .05
Endcap SP = .61” w.g.

This calculation is important for understanding the variance in pressure from inlet to endcap which equates to a variance in airflow as well. Fabric duct manufacturers should have some means of balancing the static pressure and airflow. DuctSox has an Adjustable Flow Device or AFD to accomplish this. The internal fitting can vary the resistance to airflow and aid in balancing the static pressure within the fabric duct from inlet to endcap. For more information on the AFD and its benefits in fabric ducts, refer to the “AFD: Device of Many Functions” White Paper on www.ductsox.com.

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