# Rigid Perforated Ducts vs Fabric Ducts

Understanding the Static Pressure Difference

Engineers accustomed to fabric ducts typically expect a static pressure requirement on the order of 0.5" w.g. or higher. When a rigid perforated metal duct shows a required pressure significantly below that range, natural skepticism arises. This document examines the physics behind that difference, citing industry sources, and explains how the BREEZ selection tool validates that the lower pressure is consistent with the required discharge velocity and throw performance.

## Why the Pressure Expectation Differs

### 1 Inflation Pressure

*0.2–0.5" w.g. consumed just to keep the duct inflated — zero for rigid metal.*

A fabric duct is not self-supporting. It requires a minimum internal static pressure to maintain its shape. Published engineering data from major fabric duct manufacturers documents this requirement:

- DuctSox Engineering Guide: minimum 0.2" w.g. operating pressure for round fabric ducts; higher for semi-round or half-round profiles (up to 0.5" w.g.).
- Prihoda Technical Manual: recommends minimum 0.3–0.5" w.g. internal pressure depending on duct diameter and fabric weight.
- FabricAir Design Guide: specifies minimum 0.25" w.g. for standard round fabric ducts.

This pressure is purely structural — it contributes nothing to throw performance. BREEZ ducts are rigid metal, so the inflation pressure overhead is eliminated entirely. This means a larger share of the available static pressure is directed toward air projection. Note that friction, fittings, and internal flow redistribution still consume pressure within any duct — but the structural inflation component is zero for a rigid duct.

### 2 Discharge Coefficient

*For the same throw, metal perforations require roughly 55% of the pressure needed by fabric.*

The pressure required to push air through a perforation depends on the discharge coefficient (Cd), following the standard orifice equation. Since required pressure scales as $1/Cd^2$, even a modest difference in Cd has a significant effect on pressure.

For a thin, sharp-edged metal orifice, Cd values typically range from 0.60 to 0.72 depending on edge geometry and hole shape (Idelchik, Handbook of Hydraulic Resistance, 3rd ed.; ISO 5167). BREEZ perforations are precision-cut using a CNC laser cutting machine, ensuring clean, consistent edge geometry that maximizes the discharge coefficient. For perforations through thicker, rougher materials such as woven or coated textiles, Cd is reduced due to the longer flow path and edge irregularity. Representative values based on thick-walled orifice correlations fall in the range of 0.45–0.55 (Idelchik, §4.17–18); actual values vary by product and perforation method.

| Parameter | Fabric (thick-walled orifice) | Metal (thin-walled orifice) |
|---|---|---|
| Discharge Coefficient (Cd) | 0.45 – 0.55 | **0.60 – 0.72** |
| Implied pressure ratio (same V) | Baseline (1.0×) | **~0.53–0.70×** |

The pressure ratio follows from $\Delta P$ $1/Cd^2$. At representative midpoints (Cd = 0.50 vs. 0.67), the metal orifice requires roughly 55% of the pressure needed by the fabric orifice at the same exit velocity. The exact ratio depends on the specific products being compared.

Sources: Idelchik, I.E., Handbook of Hydraulic Resistance, 3rd ed., §4.17–18; ISO 5167-2:2003, Measurement of fluid flow by means of pressure differential devices.

## 3 Fabric Porosity Losses

*Air bleeding through the fabric weave adds pressure demand that does not exist with metal perforations.*

Some fabric duct systems are designed to allow air to permeate through the fabric weave itself, providing condensation prevention or supplemental low-velocity diffusion. This intentional porosity adds flow resistance beyond what the discrete perforations require.

Fabric permeability rates vary widely — from near-zero for impermeable coated fabrics to 15–30 CFM/sq ft at 0.5" w.g. for permeable weaves (per manufacturer specifications). Where present, this represents an additional pressure loss mechanism that does not exist with metal perforations.

Sources: DuctSox Fabric Selection Guide (permeable vs. impermeable fabric types); Prihoda Material Technical Data; ASHRAE Handbook — HVAC Systems and Equipment, Ch. 20.

## Engineering Validation

Understanding why the pressure expectation differs is necessary but not sufficient. The engineering validation that a given static pressure is adequate requires the complete chain:

- Active perforation area (total effective open area for the selected configuration)
- Discharge velocity ($V = CFM / A_{eff}$, from the standard orifice equation)
- Required static pressure ($\Delta P = (V / 4{,}005)^2 / Cd^2$, per ASHRAE Fundamentals)
- Resulting throw (using ASHRAE jet-decay constants: K = 6.2 for round jets, K = 2.4 for plane jets after coalescence)

The BREEZ selection tool computes this entire chain for each specific configuration — accounting for perforation geometry, duct friction (Darcy-Weisbach with Haaland friction factor), fitting losses (+15% safety factor), and static regain (–20% safety factor). The reported pressure is the result of that traceable calculation, not an assumed value.

Jet coalescence — where closely spaced individual jets merge into a continuous air curtain — is a key physical mechanism. The merged curtain behaves as a plane jet whose velocity decays as $1/\sqrt{x}$, significantly slower than an isolated round jet ($1/x$). This is what enables long throws at moderate pressures from perforated ducts. The phenomenon is well-documented in ASHRAE Handbook — Fundamentals, Chapter 20 (Space Air Diffusion).

Ultimately, a low required static pressure is acceptable only when the implied discharge velocity and resulting throw are validated for the selected active perforation area. That is the engineering checkpoint this tool is designed to provide.

## Benefits of Lower Static Pressure

| Benefit | Impact |
|---|---|
| **Reduced energy consumption** | Less fan pressure translates directly into operating cost savings |
| **Smaller fan selection** | Lower pressure requirements may allow a smaller fan, reducing first cost |
| **Lower noise levels** | Static pressure is directly linked to noise generated by the system |
| **Available pressure budget** | Pressure saved at the diffuser duct remains available for the rest of the ductwork |

## Summary

Engineers familiar with fabric ducts may carry an elevated pressure expectation that includes structural inflation (documented at 0.2–0.5" w.g. by major manufacturers), higher discharge resistance through thicker materials, and porosity losses — none of which apply to a rigid perforated metal duct. The BREEZ selection tool validates each configuration through a complete, traceable calculation chain from airflow to perforation area to discharge velocity to throw, using standard orifice equations and ASHRAE jet-decay physics.

**A low static pressure requirement, backed by a traceable engineering calculation from CFM to throw, is the sign of an efficient system — not a sign of error.**

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**References**

1. ASHRAE Handbook — Fundamentals (2021), Chapter 21: Duct Design.
2. ASHRAE Handbook — Fundamentals (2021), Chapter 20: Space Air Diffusion.
3. Idelchik, I.E., Handbook of Hydraulic Resistance, 3rd Edition, CRC Press, 1994.
4. ISO 5167-2:2003, Measurement of fluid flow by means of pressure differential devices.
5. DuctSox Engineering Guide, ductsox.com/resources.
6. Prihoda Technical Manual, prihoda.com/technical-support.
7. FabricAir Design Guide, fabricair.com/engineering.