Advancements in Particulate Emissions Control Technology for Industrial Sources

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Key Terms
ACFM

Actual Cubic Feet of gas per Minute

The volume of the gas flowing per unit of time at the operating temperature, pressure and composition.

(also measured in cubic meters per hour)
## Air-to-Cloth Ratio (Filter Rate)

<table>
<thead>
<tr>
<th>Type of Filter Cleaning System</th>
<th>Maximum Recommended Air-to-Cloth Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shaker</td>
<td>3.0</td>
</tr>
<tr>
<td>Reverse Air</td>
<td>3.0</td>
</tr>
<tr>
<td><strong>Pulse-Jet:</strong></td>
<td></td>
</tr>
<tr>
<td>A. Cylindrical Filter Bags</td>
<td>6.0</td>
</tr>
<tr>
<td>B. Pleated Filters (Non-Paper Media)</td>
<td>3.5</td>
</tr>
<tr>
<td>C. Pleated Filters (Paper Media)</td>
<td>2.0</td>
</tr>
</tbody>
</table>
Can velocity

In a pulse jet dust collector with the filter elements suspended from the tubesheet, Can Velocity is the upward air stream speed passing between the filters calculated at the horizontal cross-sectional plane of the collector housing at the bottom of the filters.
Grain loading

The amount of particulate by weight in a given volume of air, usually specified in grains/cubic foot (or grains/cubic meter).

1 lb (0.454 kg) = 7000 grains
1 kg = 15,432 grains
Collection efficiency

Efficiency = \frac{\text{Inlet Dust Load} - \text{Outlet Emission}}{\text{Inlet Dust Load}}

Example:

Inlet Dust Load = 15 Grains
Outlet Emission = 0.01 Grains

Efficiency = \frac{15 \text{ Grains} - 0.01 \text{ Grains}}{15 \text{ Grains}} = 99.93%
Inadequate Airflow

Reasons:

• Need to Increase from Designed Airflow
  • Added pick-up points

• Restricted Airflow

• Poorly designed pick-up hoods
Restricted Airflow from Plugged Bags
(Resulting in high differential pressure)

- Cleaning system not operating correctly
- Over/under cleaning filter bags
- Moisture
- Fine particulate
- High air-to-cloth ratio
- High can velocity
Restricted Airflow from Plugged Bags

- High grain loading
  - Incorrectly designed pick-up hood
- Oil carry-over from process
- Moisture / Oil in compressed air lines
- Failure to continuously discharge material
  - Purposely storing material in the hopper
  - Bridging / Material sticking to hopper sides
  - Inleakage
  - Airlock leaking
  - Baghouse / ductwork leaks
Restricted Airflow from Increased Static Pressure Across System

- Added ductwork and pick-up locations
- Closed damper
- Obstruction in ductwork
- Incorrect ductwork design
- High differential pressure (plugged bags)
Emissions at the Stack

Causes:

• Bleedthrough
  • Fine Particulate
  • High differential pressure
  • High air-to-cloth ratio
  • Over/under cleaning filter bags
Emissions at the Stack

Causes:

- Hole in the filter bag
- Abrasion
  - Inside the Bag
  - Outside the Bag
  - Inadequate Baffling
  - Poor Door Seal (Dirty Side)
- Physical damage
  - Flex Failure
  - External Puncture
Emissions at the Stack

Causes:

• Hole in the filter bag (continued)
  • Chemical attack
  • Thermal attack
  • Quality problem
Emissions at the Stack

• Poor bag fit to the tubesheet
  • Snapband
  • Clamp
  • Irregular shape / damage to tubesheet hole
• Fatigue crack in the tubesheet
• Housing leak
  • Door seal (clean side)
  • Corrosion / fatigue crack
What is ePTFE membrane?

A microporous membrane laminated to traditional filtration fabrics.

The ePTFE membrane consists of a web of overlapping fibrous strands that form millions of air passages, much smaller than the particulate, for an extremely porous filter surface.

Because the membrane is a PTFE derivative, its surface is slick; bag cleaning is more complete with less energy.
ePTFE filtration facts

• Average membrane pore size 0.5 - 1 micron, effective pore size much smaller

• Traditional woven/felts typically have a 20 micron pore size

• Can fit approximately 1000-2000 pores across the tip of a ball point pen

• 100 million pores per square centimeter
BHA-TEX®
magnified 2500x

Dot represents 1 micron particle

The web-like structure collects submicron particulate, yet allows air to pass through
Surface vs. Depth Filtration
Surface v. Depth Filtration

Best Available Technology
for Fine Particulate Collection
**Depth vs. surface filtration**

Conventional filters collect particulate in the depth of the fabric.

Dust gets trapped in the fabric.

Cross section view – standard felt bag (used)
**Depth vs. surface filtration**

An ePTFE laminated filter collects particulate on the surface of the membrane. Dust does not penetrate the fabric.

Cross section view – ePTFE laminated filter (used)
ePTFE Membrane Advantage
Why is ePTFE gaining popularity for filtration?

- Enhanced fine particulate collection
- Superior clean-down of the filter after a cleaning cycle
- Longer bag life
- Lower differential pressure
- Resistance to moisture in the gas stream
## Reasons to Consider ePTFE Membrane

### Scrubbing
- SCR
- SNCR
- Lime injection

### Pressure drop management
- Load limited
- Helps avoid derates
- Decreased cleaning cycles
- Increased filter life

### Fuel changes
- Higher ash coal
- Coals producing finer ash

### Emissions
- PM 2.5
- Start-up emissions
- Regulatory
- Good neighbor


**ePTFE membrane advantages**

- Impact on sorbent usage / scrubbing
- Pressure drop management
  - Load limited plants
  - Scrubber upsets
  - Boiler tube leaks
  - ABS
- PM 2.5
- Fuel changes affect $\Delta P$

![Graph showing ePTFE membrane advantages](image-url)
The membrane advantage

**Test conditions:**
- New fabric
- 0.6 micron (average)
- 5:1 air-to-cloth ratio
- (1.52 m/min filter rate)
- 10 grains/ACFM grain loading

<table>
<thead>
<tr>
<th>Emissions gr/ACF</th>
<th>Standard filter media</th>
<th>BHA-TEX® filter media</th>
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<tbody>
<tr>
<td></td>
<td>0.0397 gr/ACF (92mg/m³)</td>
<td>0.0006 gr/ACF (1.3 mg/m³)</td>
</tr>
</tbody>
</table>
PulsePleat Filter Elements
Improve Fabric Filter Performance
Pleated Filter Elements Eliminate Bottom Bag Abrasion

Provide a large drop-out zone beneath the filters

Heavier particulate drops out

Before
Elements

PulsePleat Filter
High Differential Pressure / Loss of Airflow:

- High air to cloth ratio
- Fine particulate
- Poor cleaning mechanism efficiency

**Static Pressure vs. Air Volume**

14" (356mm)
12" (305mm)

Static Pressure

Air Volume

80±% of Designed Capacity
Designed Capacity

Difference Between Static Pressure of 2 Locations

imagination at work
PulsePleat Filters Reduce Differential Pressure

Increase surface filtration area... by as much as 2–3 times

Lower differential pressure... increased airflow

Lower emissions... double filtration efficiency
Aggressive Cleaning Cycles:
- Poor cleaning mechanism efficiency
- Inadequate pulse pressure
- High can velocity
- Accelerated filter bag fatigue and flex failure

PulsePleats Reduce Cleaning Frequency:
- Require 75 psi or less pulse pressure
- Reduced can velocity
- Staggered arrangement reduces can velocity
PulsePleats Cut Installation and Removal Time In Half

One piece unitary design
Lightweight and easy to handle

Top Load PulsePleat Filter

Bottom Load PulsePleat Filter
PulsePleat Operating Characteristics
Spunbond vs. Traditional Felts

Spunbond Polyester

Polyester Felt

Face view - magnified 100x
**Lower differential pressure**

**Differential Pressure**

- PE806/Membrane
- Spun Bonded
- Polyester Felt

Differential Pressure, mm w.g. (Inches w.g.)

- 130 mm (5.1"")
- 120 mm (4.7"")
- 110 mm (4.3"")
- 100 mm (3.9"")
- 90 mm (3.5"")
- 80 mm (3.2"")
- 70 mm (2.8"")
- 60 mm (2.4"")
- 50 mm (2.0"")

Dimensions: 612.0x792.0

[Image of graph with data points and labels]
*5:1 A/C Ratio (1.5:1), 0.5 micron particulate inlet loading: 30 grains/acf (69 g/m³)
Case Histories

- Bin vent - Silo collector
Filtration area comparison

Pulse-Jet with conventional bags
- 100 bags
- 6.25” x 120.00” bag size (159mm x 3050mm)
- 1640 ft² cloth area (152 m²)
- 6.1 air-to-cloth ratio
- 10,000 ft³/min (283 m³/min)
- 6-8” w.g. average differential pressure (152-203mm w.g.)
Filtration area comparison

Pulse-Jet with BHA

PulsePleat®
- 100 elements
- TA625 x 80.63” (2050mm)
- 5800 ft² cloth area (538 m²)
- 2.6 air-to-cloth ratio
- 15,000 ft³/min (425 m³/min)
- 3-4” w.g. average differential pressure (76-101mm w.g.)
Case History: Bin Vent Silo Collector

Problem:

With Filter Bags/Cages
- Rated 2,356 ACFM (4,003 m³/hr)
- 38 Bags, 475 ft² of media (4.5:1 A/C Ratio)
- DP 6+ in. w.g. (152+ mm w.g.)
- Short bag life
- Bottom bag abrasion
- Constant relief hatch blowing
- Heavy compressed air usage for pulsing
Case history: bin vent - silo collector

Solution:

With Pleated Filter Elements
- Air volume 2,356 ACFM (4,003 m³/hr)
- 38 Elements, 620 sq. ft of media (3.8:1)
- DP dropped 3 - 3.5” w.g. (40% reduction)
  (76 - 106 mm w.g.)
- Eliminated blown pressure hatch
- Eliminated bottom bag abrasion
- Reduced compressed air usage substantially
Questions?