Dust Collection - Design and Maintenance

Presented by:

Eric Stefan
What is “Dust”?  

A dust particle is a fine particle that is released and/or transported into the air either through entrainment with a product, displacement of air because of a product, in conveying air and/or in other processing equipment.

Why is “Dust” a Problem?

• Product degradation or loss  
• Health issue for workers  
• Safety issue for assets and facilities  
• Sanitation and infestation control  
• Maintenance  
• Equipment life expectancy  
• Retention of valuable product

Where is “Dust” a Problem?

Anywhere in a facility – product transfer, pit dumping, loadout, tunnels, head house, aeration, even in the offices.
Dry-Type Collectors

• Cyclone Collector

• Baghouse Filter
Things that affect cyclone efficiencies

- Particle Size of product
- Air volume entering the cyclone
- Quality of fabrication
- Quality of installation
- 90% - 99% efficient
Importance of proper installation

Wrong
Here the trunk elbow turns the stock opposite to rotation in collector.

Right
See the difference…. elbow throws stock to outer wall of collector.
Baghouse Filters

“VR”

“S”

“M”

“CR”
Baghouse Filter

- Utilizes fabric socks/media
- Very efficient, up to 99.99% on particles in airstream that are submicron size
- Filter bags and “dust” cake on surface of media act to separate particles from incoming dirty airstream, from clean air exiting baghouse to atmosphere.
Bag Cleaning Systems:
Reverse-pulse (pulse-wave or pulse-jet)

- High Pressure Low Volume
  - 80 to 100 psig air at low volume
  - Cleaning air supplied by “house” compressed air system
  - Oil and moisture contamination from “house” compressed air system are common.
Bag Cleaning Systems: Reverse-pulse (pulse-wave or pulse-jet)

• **Medium Pressure**
  – 10-15 psig at moderate to high air volume
  – Use of positive displacement blower to supply air.
  – Air supply is local to inlet of PD blower; oil and moisture contamination not typically a problem.
Bag Cleaning Systems:
Reverse-pulse (pulse-wave or pulse-jet)

- Low Pressure
  - 30-100” w.c.
  - Use of fan to deliver high volume of air at low pressure.
Baghouse Filters
Air Inlet Configuration

- Properly designed and applied air inlet serves many functions:
  - Allow airstream with particles to enter baghouse without damage to bags.
  - Allow adequate area for stock to enter baghouse without choking.
  - Allows for particles to drop from airstream to filter discharge.
Baghouse Filter Configuration

Type of Air Inlet

• High Air Inlet(s)
  – for medium and light dust loading.
  – Include deflectors to reduce bag wear from incoming particles in airstream to filter.
  – Used in general dust collection or handling air from air outlets of cyclone collectors.
Baghouse Filter Configuration
Type of Air Inlet

- Cyclonic/Material handling inlet(s)
  - Ideal for Heavy-Loading or material conveying.
  - Inlet has tangential entry into section below filter bag section.
  - Typical to a heavy loaded negative lift; ie. Hammermill lift.
Baghouse Filter Configuration

Type of Air Inlet

• Low air inlet(s)
  – Airstream(s) introduced into filter below bags
  – Not recommended due to potential for air turbulence in filter upon dirty air entry.
  • Baffle to deflect airstream downward may aid in reducing this potential.
Follow a few basic principles

- Obtain the Velocity of the air
- Obtain the Area of the duct/pipe at the point of measurement
- Multiply Velocity x Area to determine Volume

Basic Formula

\[ Q = VA \]

\( Q = \text{ACFM (Volume of Air)} \)
\( V = \text{Velocity (in feet per minute)} \)
\( A = \text{Tube internal cross-section area (in square feet)} \)
Typical Air Measurement Reading Points
Why “downstream” of fitting?

- Air after an elbow, fitting, damper, etc... becomes turbulent.
- Allows air to become “laminar” and more even inside the tubing/ducting/pipe
- Makes measurements more accurate

Velocity Pressure

TP (Total Pressure) – SP (Static Pressure) = VP (Velocity Pressure)

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Velocity = 4005 x √VP
Finding Velocity

**Example 1:**
- VP reading = 1.0
- Velocity = 4005 FPM

**Example 2:**
- VP reading = 1.75
- Velocity = 5298 FPM

**Example 3:**
- VP reading = 3.60
- Velocity = 7599 FPM

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Finding Volume

\( Q = V \times A \)

**Example 1:**
- Velocity = 4005 FPM
- Tube = 12" OD (.7854 sq ft)
- Volume = 3145 CFM

**Example 2:**
- Velocity = 5298 FPM
- Tube = 12" OD (.7854 sq ft)
- Volume = 4161 CFM

**Example 3:**
- Velocity = 7599 FPM
- Tube = 12" OD (.7854 sq ft)
- Volume = 5968 CFM

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Air to Cloth Ratio

• Establishes design capacity of a baghouse
• Term refers to ratio of air quantity (cubic feet per minute or cfm) to the amount of media surface area within filter (square ft.)

• Air Volume (CFM)
  Cloth Area (SQ.FT.)
Air to Cloth Ratio
Rule of Thumb for design A/C Ratio

9-10:1 Ratio
• Elevator, Cleaning House, General Suction.

5:1 Ratio
• Filter / Receiver

7:1 Ratio
• Filter used as secondary collector on Pneumatic Conveying Systems, Bulk Flour Storage, Hot, Moist, Humid Airsystems (Negative Pneumatic Lift Systems)
Can-Velocity of a baghouse

- Can Velocity is measured in feet per minute (fpm).
- Determined by dividing the volume of dust-laden air entering the baghouse chamber by the net flow area available in the airflow direction.
- Net flow area determined by subtracting total axial cross-sectional area of bags from total cross-sectional area of bag chamber.

**Air Volume (cfm)**

Net flow area of filter housing

Net flow area

= Total cross-section area of bags minus total cross-section area of bag chamber
Can-Velocity of a baghouse

“Rule of Thumb” for Can-velocity

• Varies with application, but can generally assume a can-velocity at 300 fpm or below to be acceptable.
• Dusts with bulk density 25-50 lbs/ft³

Example:

• 5ft. Diameter housing with 19.6 sq.ft. net flow area, handling 6,000 cfm = 306 fpm Can-velocity.
Can Velocity Example Problem

- Can Velocity = \( Q / (H - B) \)
- Filter handling 2,550 CFM = \( Q \)
- Cross Sectional area of the housing = \( H \)
- Cross Sectional area of the Bags = \( B \)
- \( 2,550 / (11.1 - 2.6) = 300 \text{ FPM} \)

Housing = 40” x 40”

25 bags (4.5” OD x 96” long) = 2.6 ft²
# Minimum Duct Design Velocities

<table>
<thead>
<tr>
<th>Nature of Contaminant</th>
<th>Examples</th>
<th>Minimum Design Velocity, fpm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vapors, gases, smoke</td>
<td>All vapors, gases, smoke</td>
<td>1000 - 2000</td>
</tr>
<tr>
<td>Fumes</td>
<td>Welding</td>
<td>2000 - 2500</td>
</tr>
<tr>
<td>Very fine light dust</td>
<td>Fine rubber dust, cotton dust, bakelite molding powder dust, jute lint, cotton dust, shavings (light), soap dust, leather shavings</td>
<td>3000 - 4000</td>
</tr>
</tbody>
</table>
Good Velocity, Good Volume, Good Design

Dust is in suspension; System is balanced.
Kice Industries, Inc.

Good Velocity, Good Volume, Good Design

CORRECT MANIFOLD DESIGN

Dust is in suspension; System is balanced.

WITH THE DESIGN OF A MANIFOLD SYSTEM FOR A SUCTION SYSTEM, THE AIR VELOCITY (FPM) INSIDE THE MANIFOLD WILL BE ENOUGH TO KEEP THE DUST/PRODUCT MOVING THROUGH THE DUCT AND ELIMINATE PILES AND CHOKES.
Bad Velocity, Good Volume, Bad Design

Dust is dropping out (in locations);
System is balanced (at end of system).

BY USING A STRAIGHT DUCT DESIGN WITH SEVERAL PICKUP POINTS THE VELOCITY (FPM) OF THE AIR IN THE DUCT WILL BE LOW AND DUST/PRODUCT WILL FALL OUT OF THE AIR STREAM AND PILE UP.
Dust is NOT in suspension; System is NOT balanced. Air taking path of least resistance.
Dust is in suspension (but at higher velocity); System is not balanced.
# Tube Data Chart

<table>
<thead>
<tr>
<th>TUBE</th>
<th>AREA</th>
<th>VELOCITY - FEET PER MIN.</th>
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<tr>
<td></td>
<td></td>
<td>3500 @ .81 wg</td>
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<tr>
<td></td>
<td>O.D.</td>
<td>I.D.</td>
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<tr>
<td>1 1/2</td>
<td>1 3/8</td>
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<td>2</td>
<td>1 7/8</td>
<td>2.76</td>
</tr>
<tr>
<td>2 1/2</td>
<td>2 3/8</td>
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<td>74.66</td>
</tr>
<tr>
<td>12</td>
<td>11 3/4</td>
<td>108.43</td>
</tr>
</tbody>
</table>
Example Design

System 2

750 CPM
6" OD
4,000 FPM
1" s.p.

100'
1- 90 degree
1- 45 degree

System 1

209'
4 - 90 degree

520 CPM
5" OD
4,000 FPM
10" s.p.

System 3

50'
1,270 CPM
8" OD
3,755 FPM
1.2" s.p.

50'
1,600 CPM
9" OD
3,621 FPM
1" s.p.

1,600 CPM
18.2" w.c.

12.2" s.p.

330 CPM
4" OD
3.5" s.p.
Thank You For Your Time

Questions ?