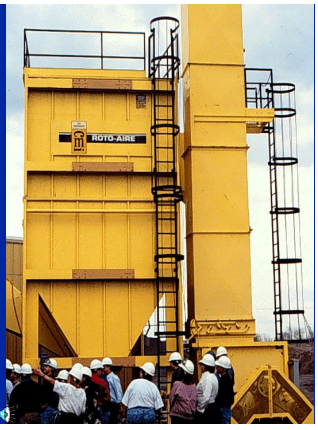
NACT 282 - Baghouses

National Training Program

NACT 282
Baghouses



Course Overview

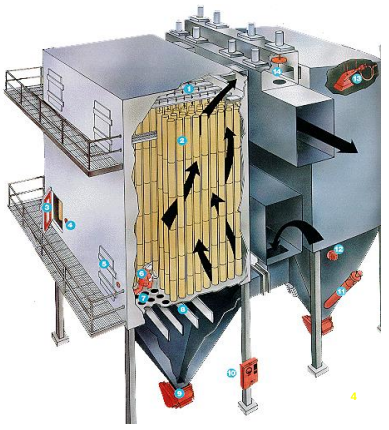
- What are we looking at?
- Why do we care?
- How does fabric filtration work?
- Types of baghouses
- Design and operation of baghouses
- Operation and maintenance problems
- Baghouse inspection

2

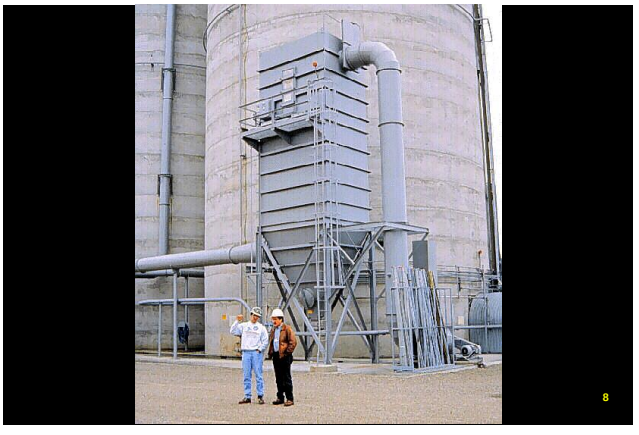
What Do They Look Like?

NACT 282 - Baghouses

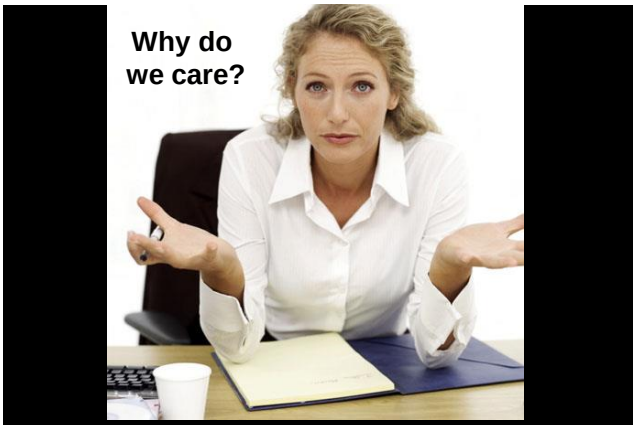
Generic Baghouse
(reverse air)



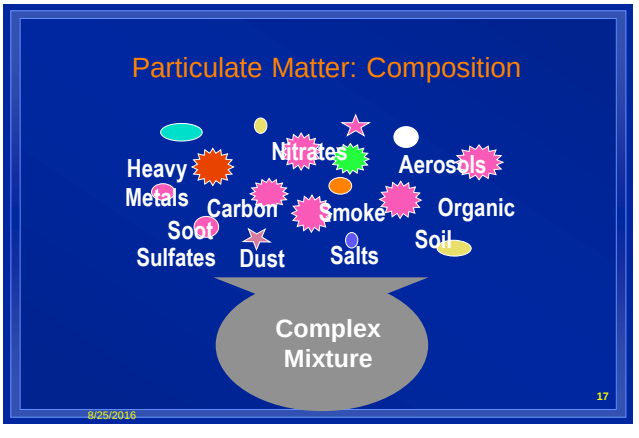
NACT 282 - Baghouses

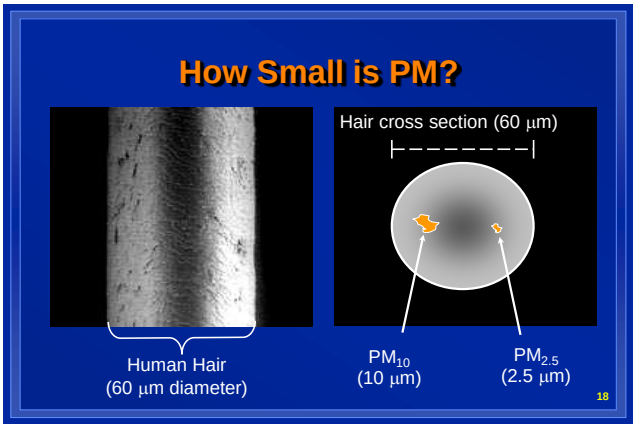


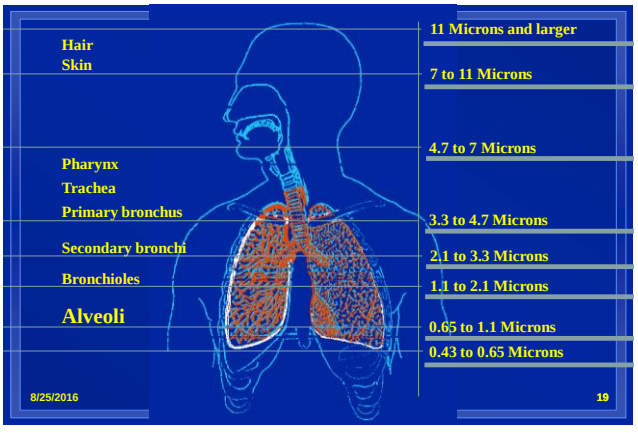
NACT 282 - Baghouses



NACT 282 - Baghouses




How Small is PM?
Hair cross section (60 μm)
Human Hair
(60 μm diameter)
PM10
(10 μm)
PM2.5
(2.5 μm)
18


Hair
Skin
Pharynx
Trachea
Primary bronchus
Secondary bronchi
Bronchioles
Alveoli
11 Microns and larger
7 to 11 Microns
4.7 to 7 Microns
3.3 to 4.7 Microns
2.1 to 3.3 Microns
1.1 to 2.1 Microns
0.65 to 1.1 Microns
0.43 to 0.65 Microns
8/25/2016
19


12,000

U.S. Mortality Figures In 2005

64,000 = Deaths from particulate air pollution

45,520 = Traffic accident fatalities

32,179 = AIDS deaths

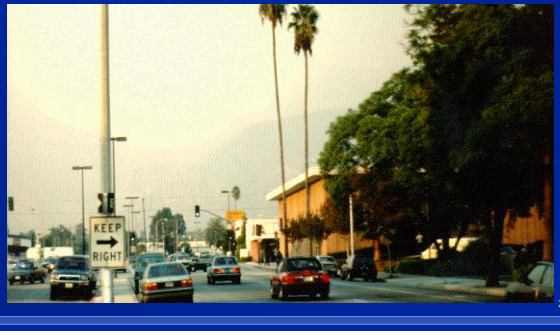
30,694 = Firearm fatalities

21

Los Angeles - Clear Day

22

Los Angeles - Smoggy Day



23

Most Polluted Regions In the U. S.*

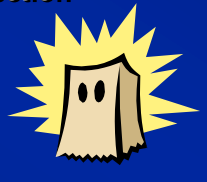
Ozone (SMOG)	Particulates
1. Los Angeles Region	1. Pittsburg
2. Bakersfield	2. Los Angeles Metro
3. Visalia/Tulare Co.	3. Fresno
4. Houston	4. Bakersfield/Kern Co.
5. Fresno/Madera	5. Birmingham, AL
6. Sacramento	6. Logan, UT
7. Dallas/Fort Worth	7. Salt Lake City
8. New York Metro	8. Sacramento
9. Washington, D.C. Metro	9. Detroit
10. Baton Rogue, LA	10. Washington, D.C. Metro

24

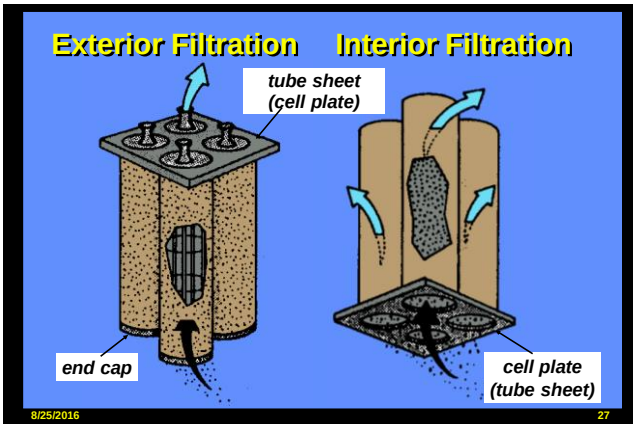
*American Lung Association "State of the Air" Report 5/08

Baghouses may be classified in several ways ....

- Method of dust collection
- Bag design
- Fan location
- Method of cleaning



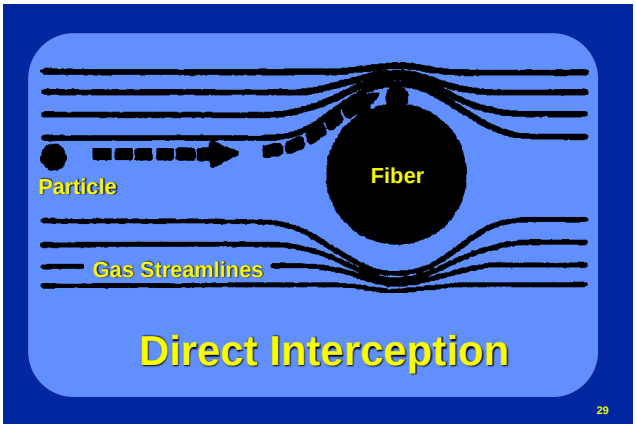
26

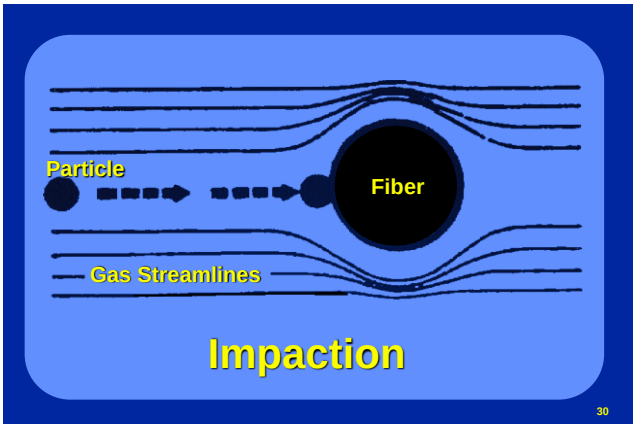


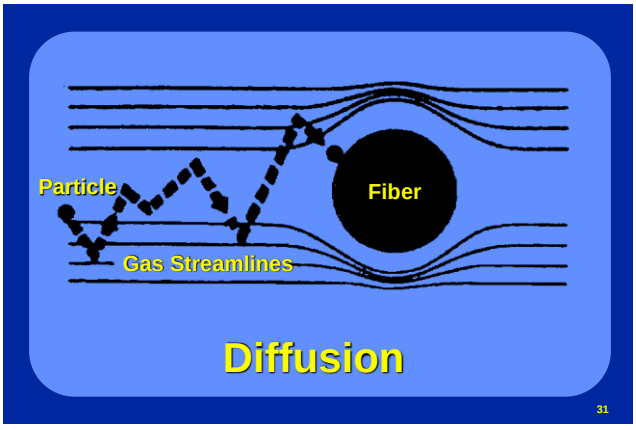
Particle Collection Mechanisms

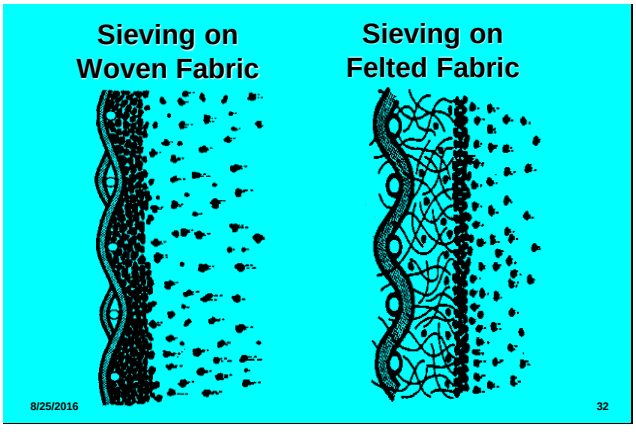
- Direct interception
- Impaction
- Diffusion
- Gravitational settling
- Agglomeration
- Electrostatic attraction

28




Particle
Fiber
Gas Streamlines
Impaction
30


Particle
Fiber
Gas Streamlines
Diffusion
31

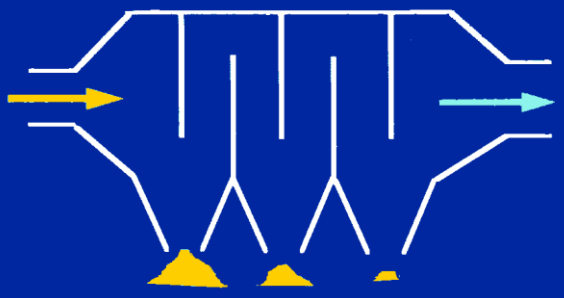

Sieving on Woven Fabric
Sieving on Felted Fabric
8/25/2016
32

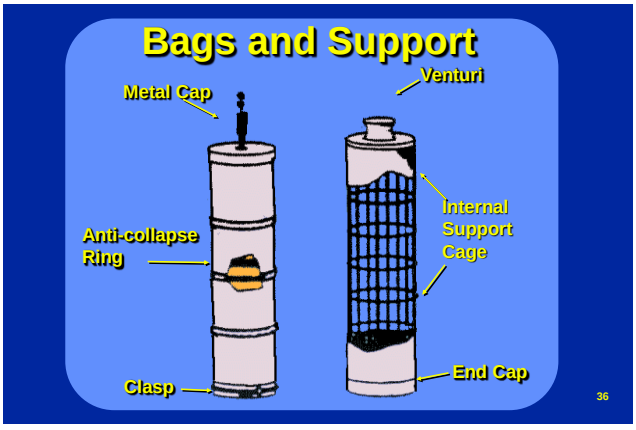
Other Mechanisms

- Gravitational settling
- Agglomeration
- Electrostatic attraction

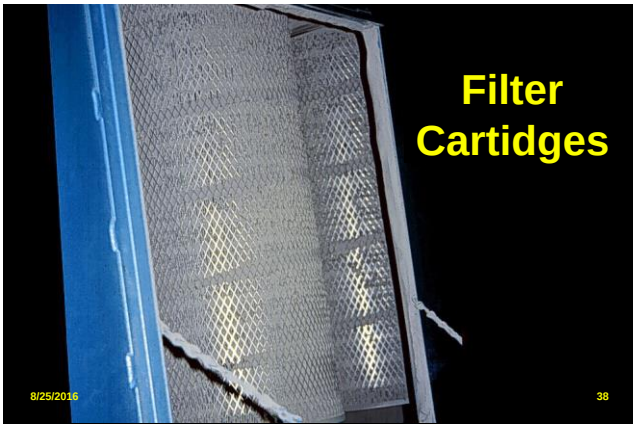
33

Settling Chamber

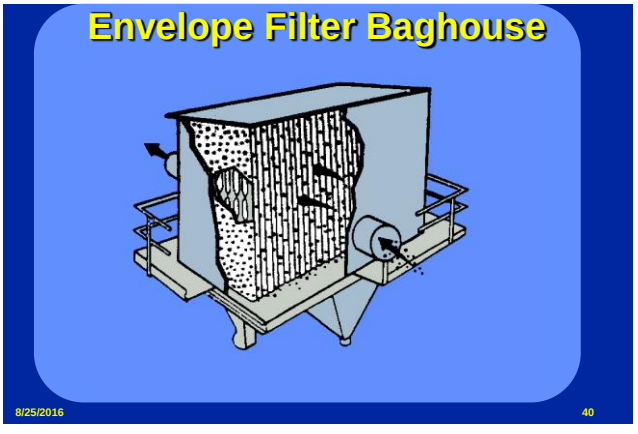



Bags and Support
Venturi
Metal Cap
Internal
Support
Cage
Anti-collapse
Ring
End Cap
Clasp
36


Cartridge
Filter Dust
Collector
8/25/2016
37


Filter
Cartidges
8/25/2016
38


Cartridge Filter Baghouse


Envelope Filter Baghouse
8/25/2016
40


PYZAM.com
Fan Location


Positive Pressure Baghouse
8/25/2016
42


Negative Pressure Baghouse
8/25/2016
43

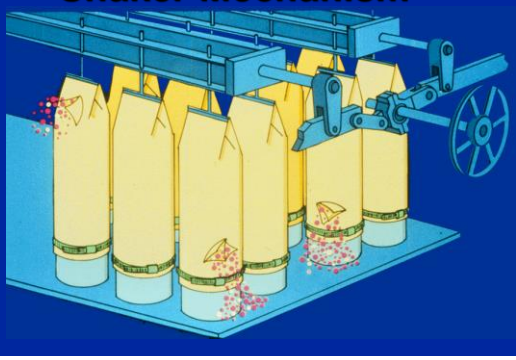

Cleaning Mechanism

Methods of Cleaning

- Shaking
- Reverse Air
- Pulse Jet
- Sonic

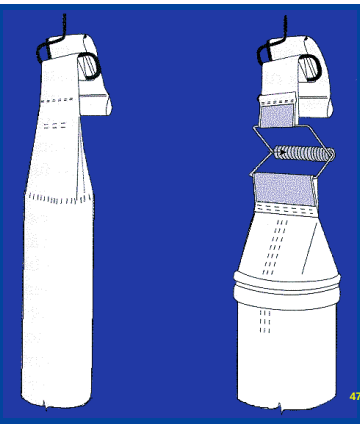
45

Shaker Mechanism



46

Shaker Bag with Torsion Spring



Courtesy BHA

47

Shaker Motor and Hangers

8/25/2016

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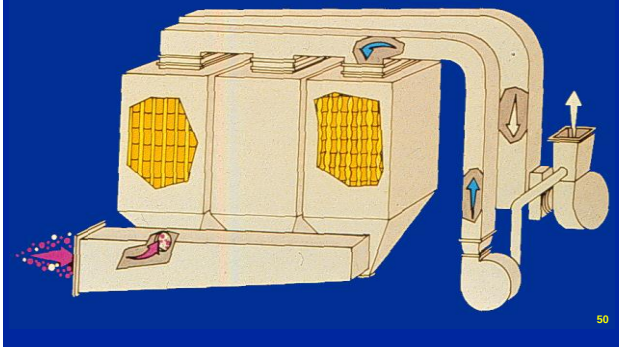
Shaker Cleaning System Problems

(Section 503.9)

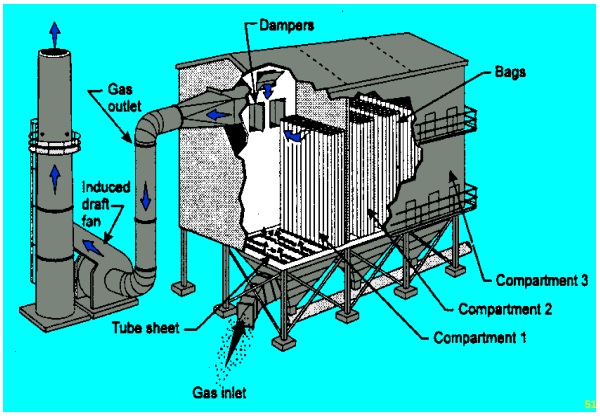
- Improper operation or failure of motors
- Inadequate maintenance of linkages
- Improper bag tension
- Hanging mechanism problems

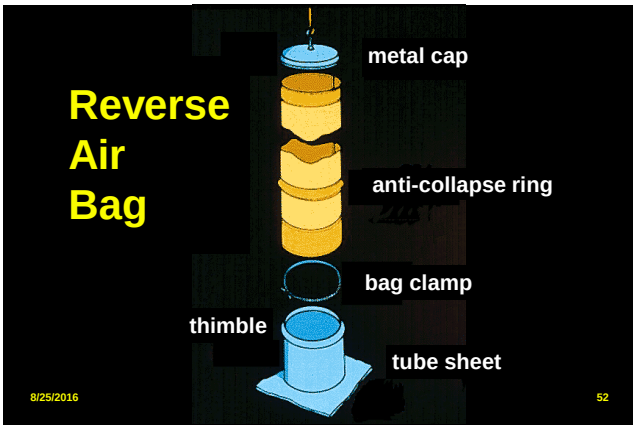
49

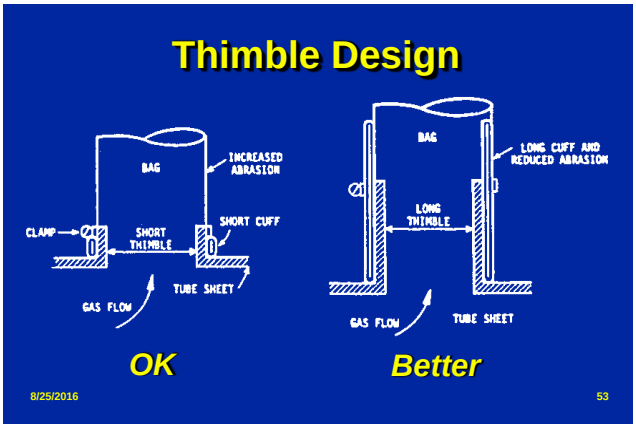
Reverse Air Baghouse

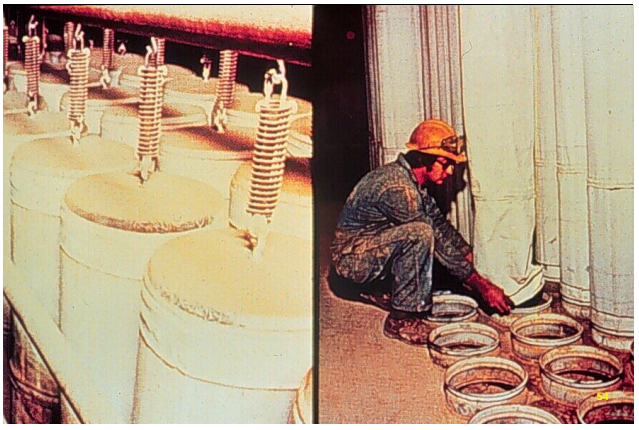


50

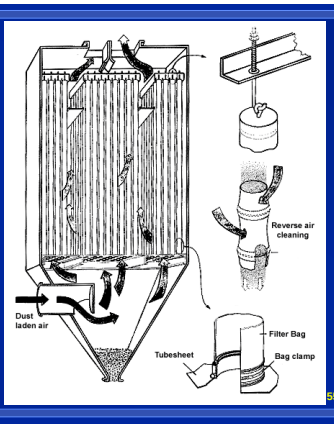

Dampers
Bags
Gas outlet
Induced draft fan
Compartment 3
Compartment 2
Compartment 1
Tube sheet
Gas inlet


Reverse Air Bag
metal cap
anti-collapse ring
bag clamp
thimble
tube sheet
8/25/2016
52


Thimble Design
BAG
INCREASED ABRASION
CLAMP
SHORT THIMBLE
SHORT CUFF
TUBE SHEET
GAS FLOW
OK
BAG
LONG CUFF AND REDUCED ABRASION
LONG THIMBLE
GAS FLOW
TUBE SHEET
Better
8/25/2016
53



Reverse Air Baghouse



55

Reverse air baghouse at lumber mill

56

Reverse Air Cleaning System

8/25/2016

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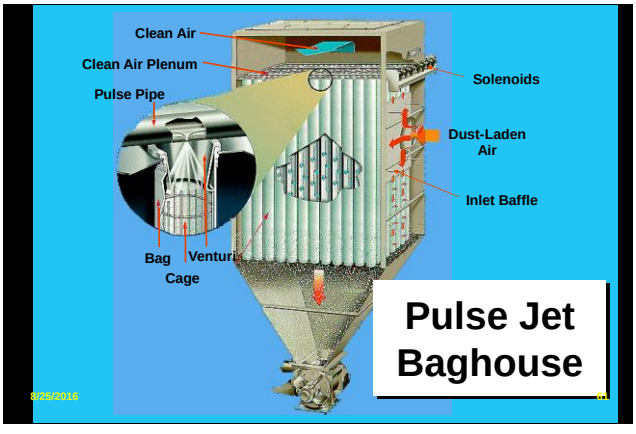
Reverse Air Cleaning System Problems

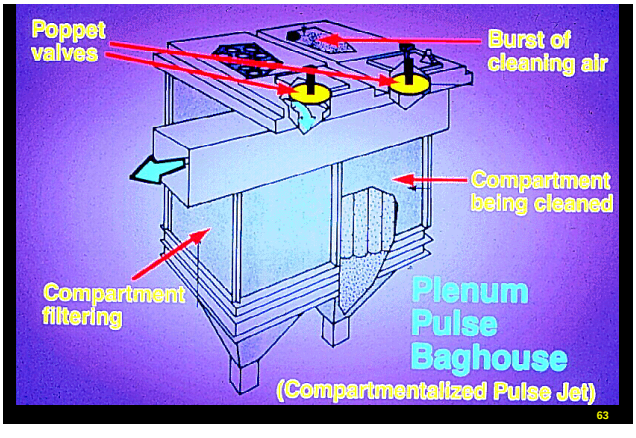
(Section 503.10)

- Inadequate reverse air flow
- Leakage through poorly sealed dampers
- Improper bag tension
- Corrosion

59


Pulse Jet
Cleaning
60


Clean Air
Clean Air Plenum
Pulse Pipe
Solenoids
Dust-Laden
Air
Inlet Baffle
Bag
Cage
Venturi
Pulse Jet
Baghouse
8/25/2016
61


Poppet
valves
Burst of
cleaning air
Compartment
being cleaned
Compartment
filtering
Plenum
Pulse
Baghouse
(Compartmentalized Pulse Jet)
63

NACT 282 - Baghouses

Pulse Jet Cleaning System Problems

(Section 503.11)

- Cage/bag misalignment
- Low compressed air pressure
- Contaminated compressed air
- Diaphragm valve leakage or freezing
- Loose, misaligned pulse pipe
- Timer or differential pressure sensor failure
- Excessive cleaning frequency

69

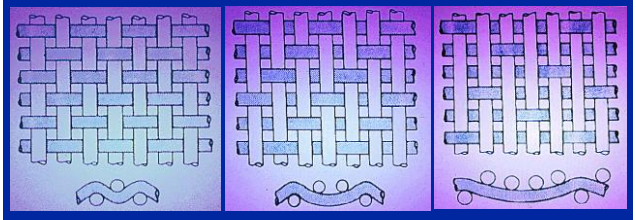
Acoustic Horn

Filter Media

- Woven
- Felted
- Membrane
- Sintered metal
- Ceramic

72

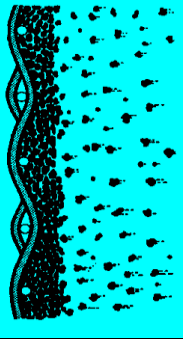
Fabric Weaves



Plain Twill Sateen

8/25/2016 73

Sieving on Woven Fabric



Sieving on Felted Fabric

74

Fabric Selection Factors

- Maximum Operating Temperature
- Melting Temperature
- Resistance to Corrosive Chemicals
- Flex and Abrasion Resistance
- Permeability (vs. blinding)
- Type of dust

75

Fabric Treatment Processes

- Calendaring
- Napping
- Singeing
- Glazing
- Coating
- Precoating

76

Applications for Different Types of Fabrics

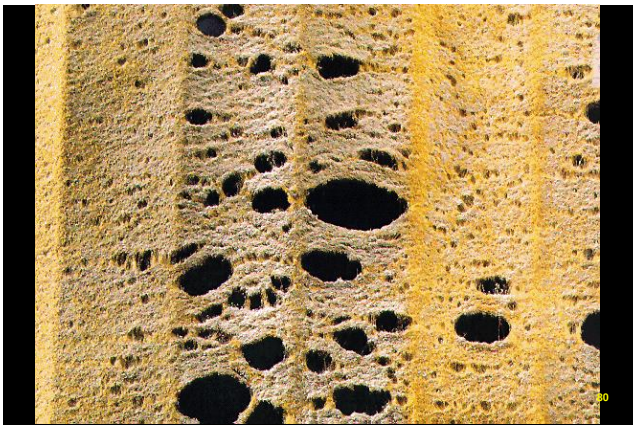
- Cotton - Simple applications
- Nylon - Abrasive dusts
- Polyester - Metal industries
- Nomex - Asphalt batch plants
- Teflon - Coal-fired boilers

77

Fabric Blinding

- Moisture in dust cake
- Lubricating oil (pulse jet)
- Submicron particles

78



What Is Going Into Your Baghouse?

- Dust Properties
- Gas Flow Rate
- Gas Temperature
- Chemical Composition

81

Design Considerations

- Pressure Drop
- Air-To-Cloth Ratio
- Collection Efficiency
- Fabric Type
- Cleaning
- Temperature Control
- Bag Spacing
- Compartment Design
- Space and Cost

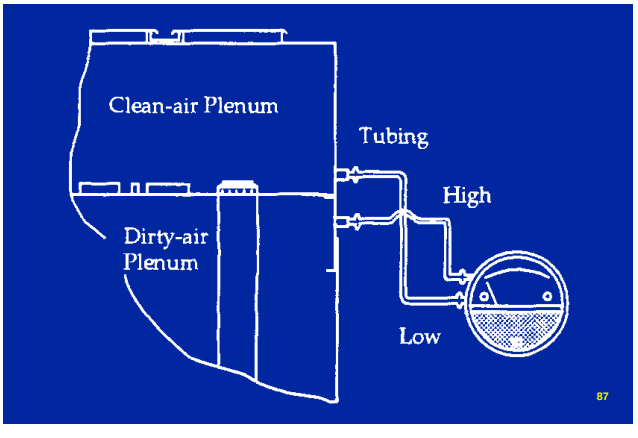
83

Pressure Drop (dp)

- Resistance To Airflow
- Inlet Pressure - Outlet Pressure
- Size of Fan
- Filter & Dust Cake

84

NACT 282 - Baghouses



Pressure Drop Across Filter

$$dp_f = k_1 v_f$$

dp_f = dp across clean fabric
k_1 = fabric resistance
v_f = filtration velocity

88

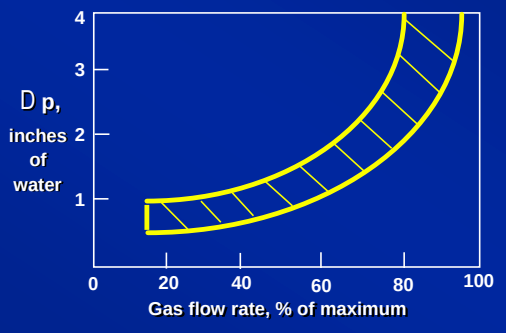
Pressure Drop Across Dust Cake

$$dp_c = k_2 c_i v_f^2 t$$

dp_c = dp across dust cake
k_2 = resistance of dust cake
v_f = filtration velocity
c_i = dust concentration loading
t = filtration time

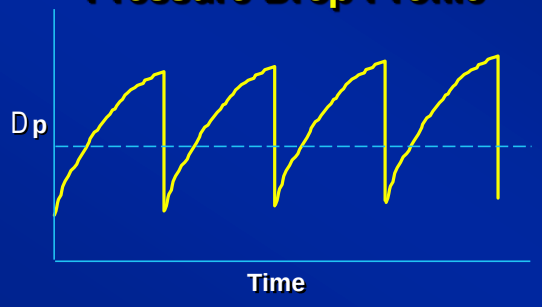
89

Static Pressure Drop vs. Gas Flow Rate



90

Pressure Drop Profile



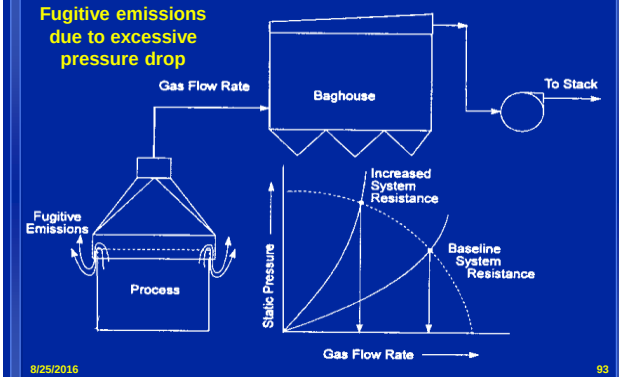
91

Problems Related to Pressure Drop

- *Pressure Drop Too High =*
  - bag blinding, blockage
  - increase in gas flow rate
  - fugitive emissions
- *Pressure Drop Too Low =*
  - bag failure
  - inleakage

92

Fugitive emissions due to excessive pressure drop



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Air-to-Cloth Ratio

$$v_f = Q/A$$

- v_f = filtration velocity
- Q = volumetric air flow rate
- A = area of cloth filter

p 300-32

94

Cleaning Method	Air-To-Cloth Ratio	
	$(cm^3/sec)/cm^2$	$(ft^3/min)/ft^2$
Shaker	< 3:1	< 6:1
Reverse Air	< 2:1	< 4:1
Pulse Jet	2.5:1 to 7.5:1	<15:1

p 300-33

95

Importance of A/C Ratio

- *A/C Too High:*
  - fan works harder
  - increased abrasion
  - blinding
  - breakdown of dust cake
- *A/C Too Low:*
  - smaller BH required

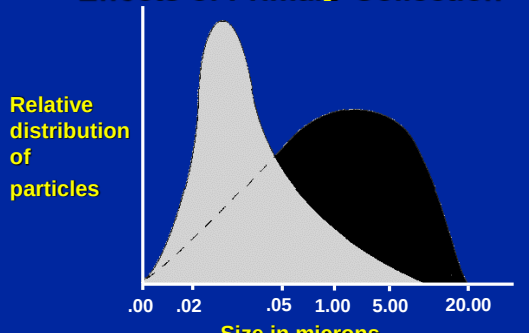
96

Controlling Gas Entry

- Precleaner
- Baffle Plate
- Inlet Diffuser
- Inlet Location
- Thimble Design
- Bypass

97

Effects of Primary Collection



98

Cyclones

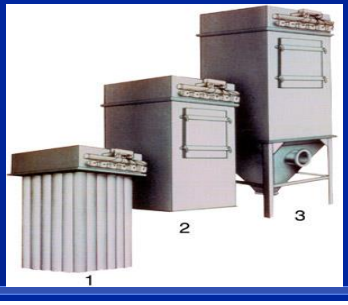
Baghouse with Cyclonic Inlet

100

Industry Description
Bin Vent Filter

101

Industry Description
Bin Vent Filter



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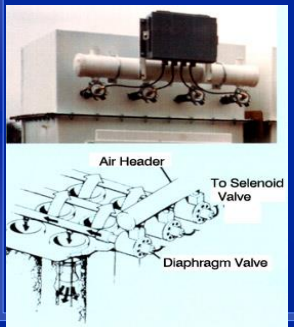
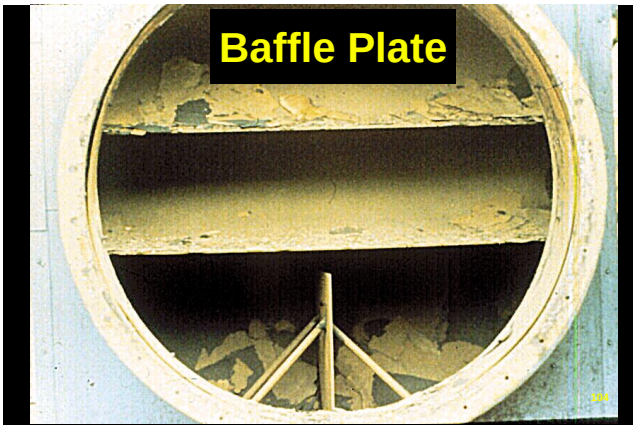
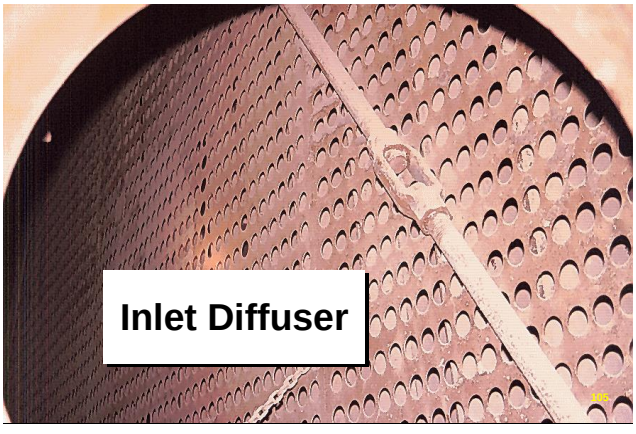
Bin Vent Filter

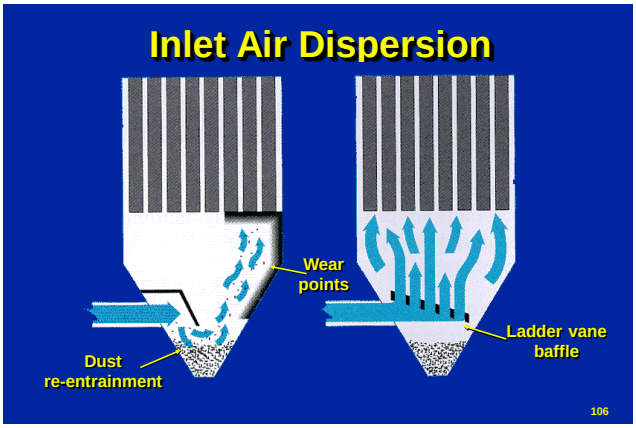


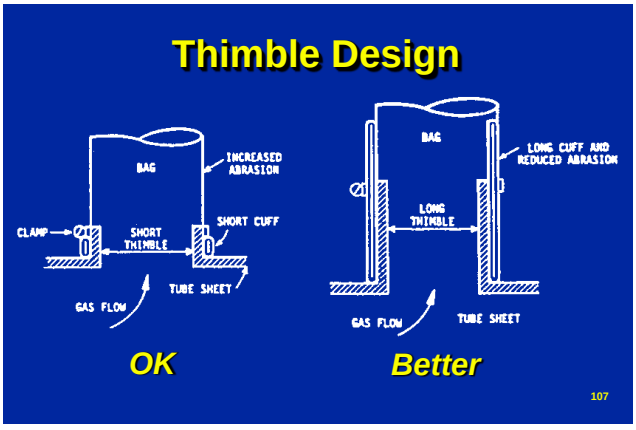
Baffle Plate

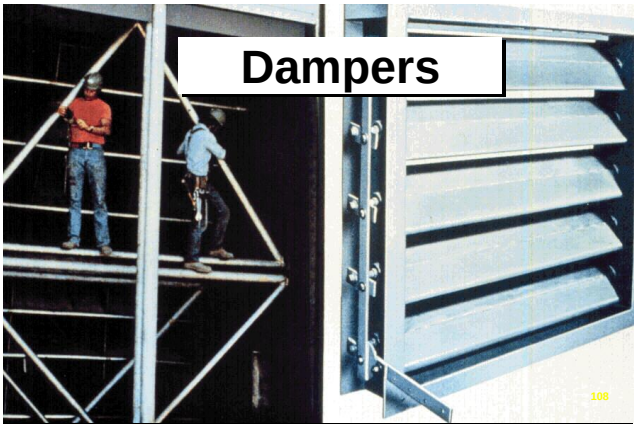


Inlet Diffuser




Inlet Air Dispersion
Wear points
Ladder vane baffle
Dust re-entrainment
106


Thimble Design
BAG
INCREASED ABRASION
CLAMP
SHORT THIMBLE
SHORT CUFF
TUBE SHEET
GAS FLOW
OK
BAG
LONG CUFF AND REDUCED ABRASION
LONG THIMBLE
GAS FLOW
TUBE SHEET
Better
107


Dampers
108

Gas Temperature Effects

- *High Operating Temp. =*
  - fabric breakdown
- *Low Operating Temp. =*
  - condensation
  - blinding, chemical attack
- *Inlet - Outlet Temp. Too High =*
  - inleakage

109

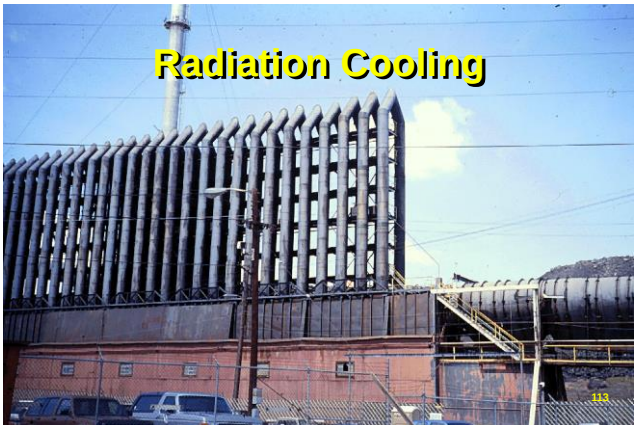
Temperature Control

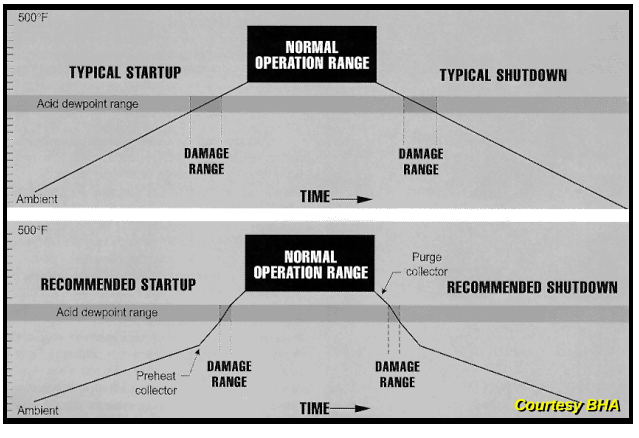
- Gas Cooling
  - Dilution
  - Radiation
  - Evaporative Cooling
- Preheating
- Insulation
- Minimize Inleakage

110

Insulated Baghouses

111


Radiation Cooling

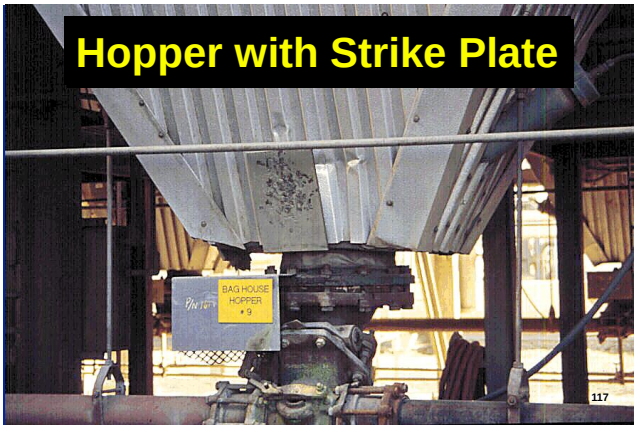

500°F
NORMAL OPERATION RANGE
TYPICAL STARTUP
TYPICAL SHUTDOWN
Acid dewpoint range
DAMAGE RANGE
DAMAGE RANGE
Ambient
TIME
500°F
NORMAL OPERATION RANGE
Purge collector
RECOMMENDED STARTUP
RECOMMENDED SHUTDOWN
Acid dewpoint range
Preheat collector
DAMAGE RANGE
DAMAGE RANGE
Ambient
TIME
Courtesy BHA

Hoppers and Dust Handling Equipment

(Section 303.5)

116

Hopper with Strike Plate

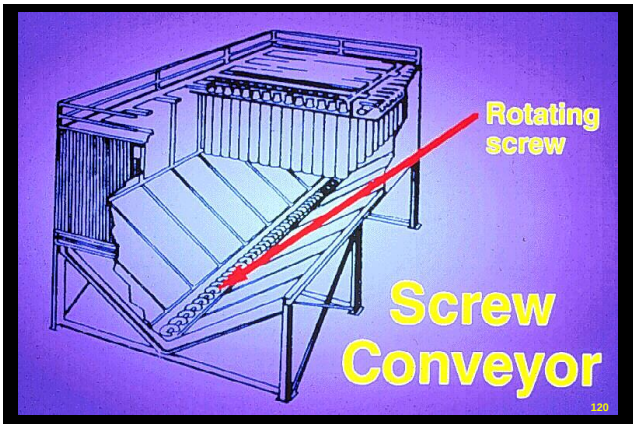


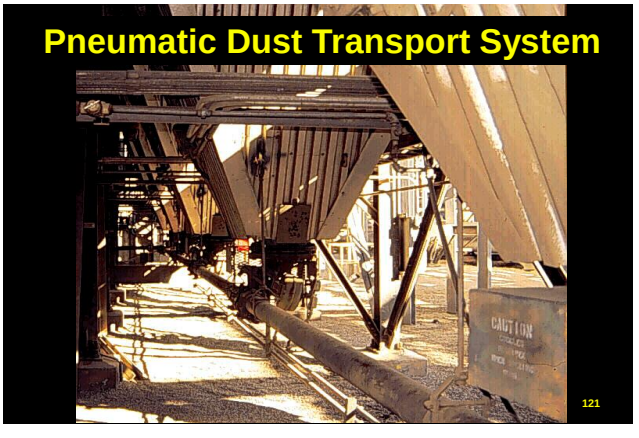
117

Hopper with Compressed Air Cleaner

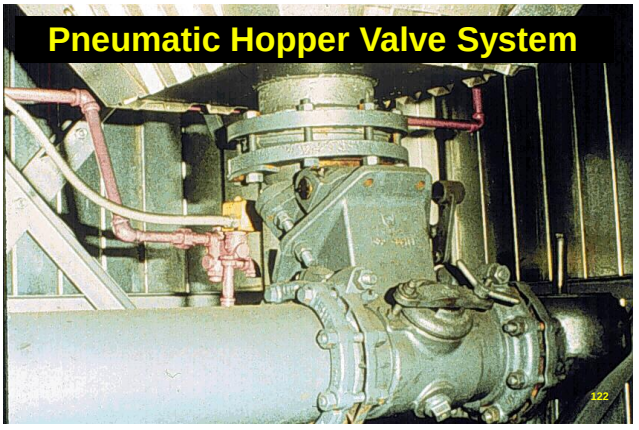
118


Hopper Level Indicator System
119

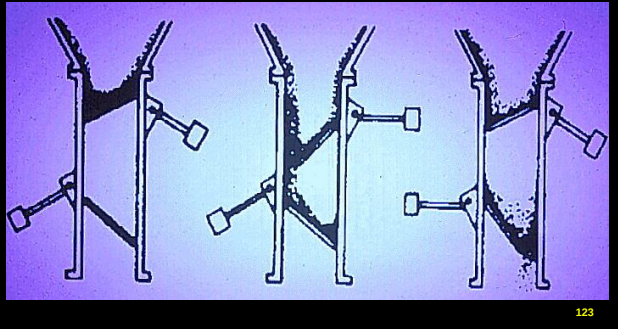

Rotating screw
Screw Conveyor
120


Pneumatic Dust Transport System
121

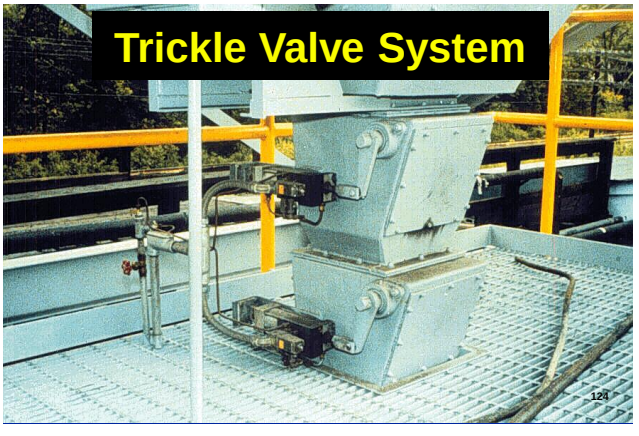
Pneumatic Hopper Valve System



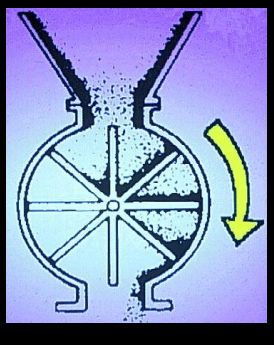
Trickle Valve System



Trickle Valve System

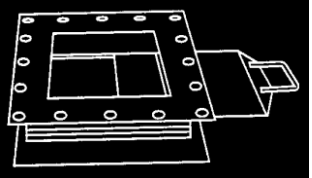


Rotary Airlock Valve



125

Slide Gates



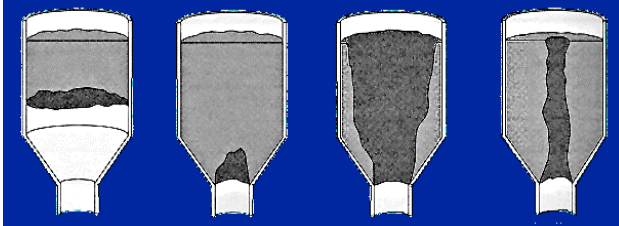
126

Dust Discharge Problems

- Inleakage
- Corrosion
- Change Process Temp.
- Dust Buildup
- Pluggage
- Fugitive Emissions

127

Types of Hopper Blockage



Arching *Bridging* *Buildup* *Ratholing*

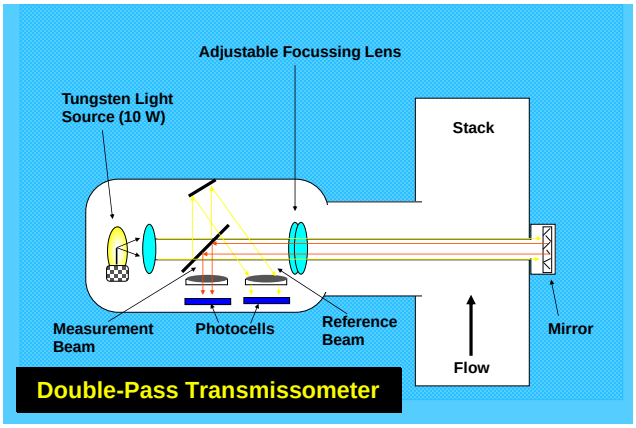
How Do We Monitor Compliance

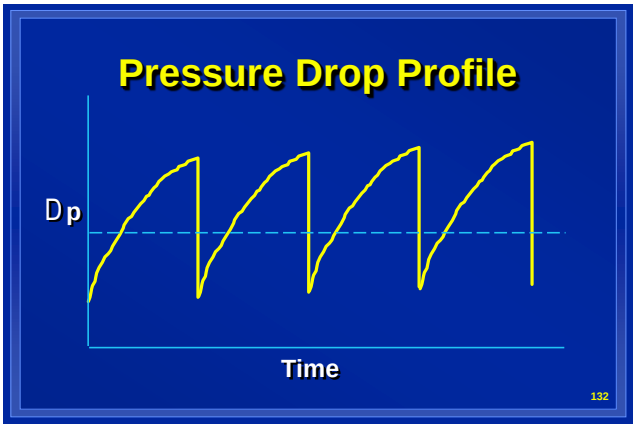
Performance Monitoring

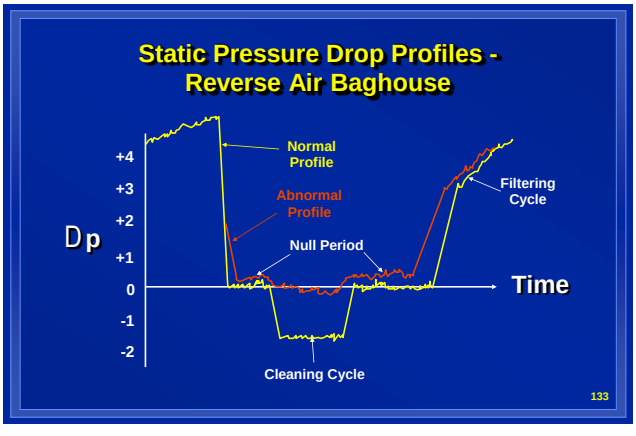
(Section 501, 502)

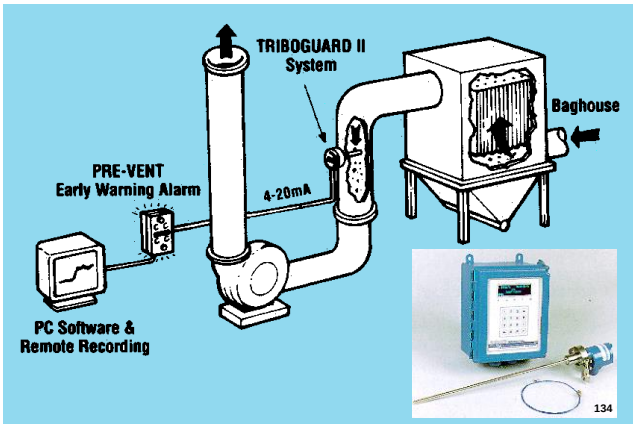
- Opacity
- Triboelectric & Tribokinetic Devices
- Light Modulation
- Pressure Drop
- Temperature
- Bag Failure Patterns
- Clean-side deposits

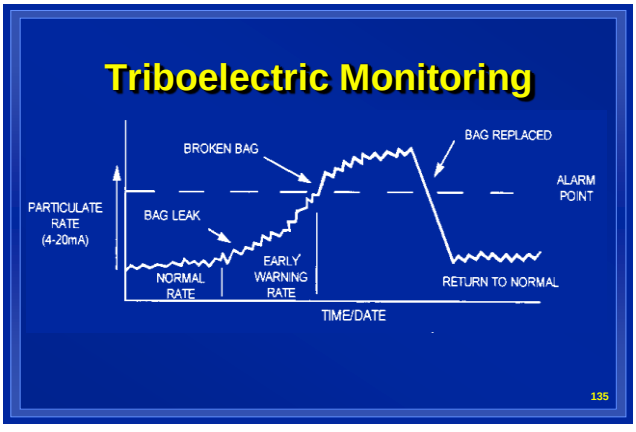
130

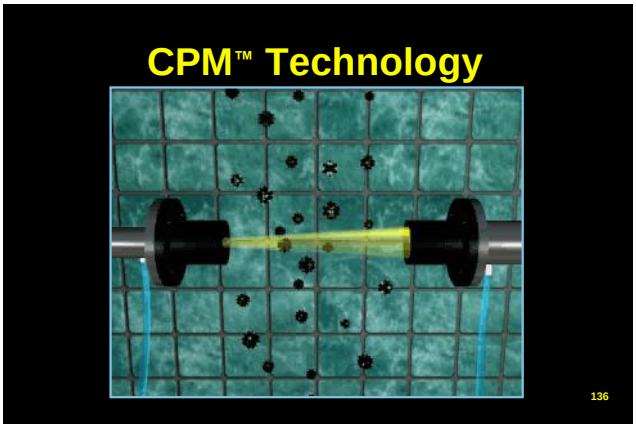

Adjustable Focussing Lens
Tungsten Light Source (10 W)
Stack
Measurement Beam
Photocells
Reference Beam
Mirror
Flow
Double-Pass Transmissometer

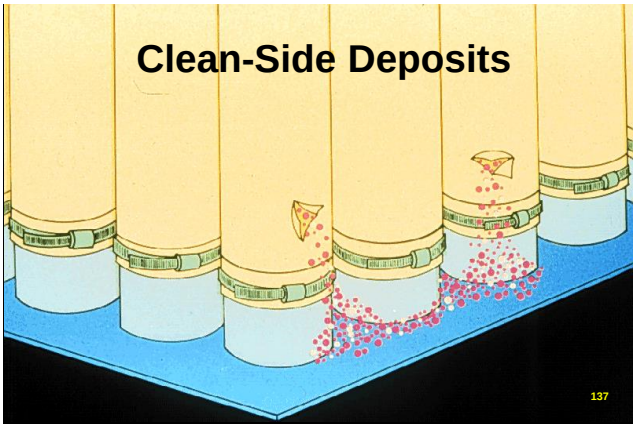

Pressure Drop Profile
Dp
Time
132

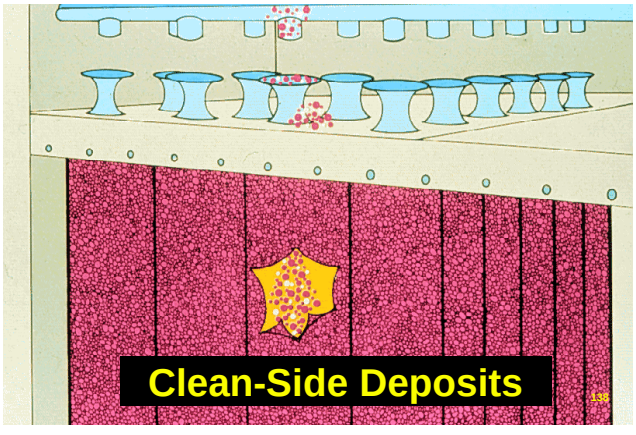

Static Pressure Drop Profiles - Reverse Air Baghouse
+4
+3
+2
+1
0
-1
-2
Dp
Normal Profile
Abnormal Profile
Null Period
Filtering Cycle
Time
Cleaning Cycle
133


TRIBOGUARD II
System
Baghouse
PRE-VENT
Early Warning Alarm
4-20mA
PC Software &
Remote Recording
134


Triboelectric Monitoring
BROKEN BAG
BAG REPLACED
ALARM
POINT
PARTICULATE
RATE
(4-20mA)
BAG LEAK
EARLY
WARNING
RATE
NORMAL
RATE
RETURN TO NORMAL
TIME/DATE
135


CPM™ Technology
136


Clean-Side Deposits
137


Clean-Side Deposits
138


Fluorescent Dye Leak Detection
139


Maintenance
Daily
Weekly
Monthly
140


141


Inversion Bag Cleaning Device
142

Inspection Elements

- Pre-Inspection
- On-Site Inspection
- Post-Inspection

144

Permit Conditions

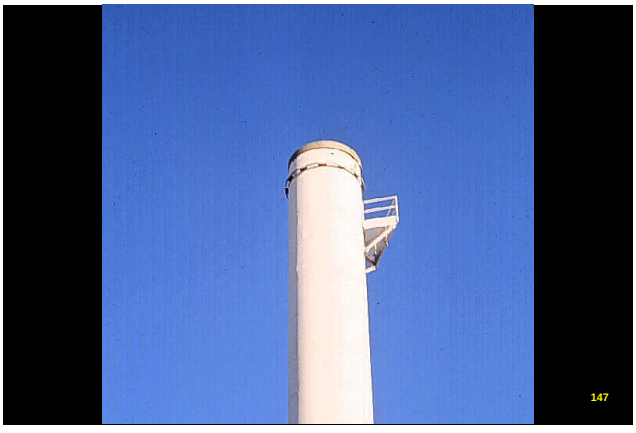
- Opacity Limits
- Process Weight Limits
- Ranges of Inlet and Outlet Temps.
- Process Rate
- Recordkeeping Requirements
- CEMS Requirements
- Minimum / Maximum Pressure Drop

145

Air Pollution Control System Points of Inspection

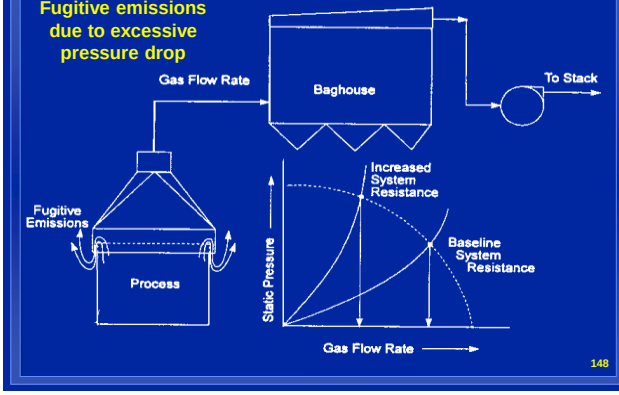
- Capture (System Entrance/Exit)
- Transport
- Air Mover
- Control Device
- Instrumentation
- Subsystem(s)
- Records

146

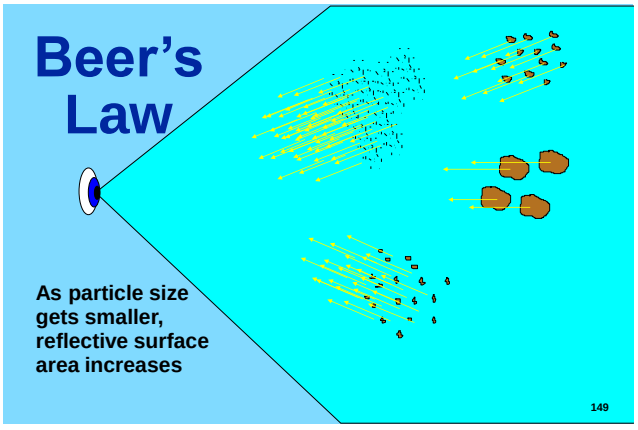


147

Fugitive emissions due to excessive pressure drop



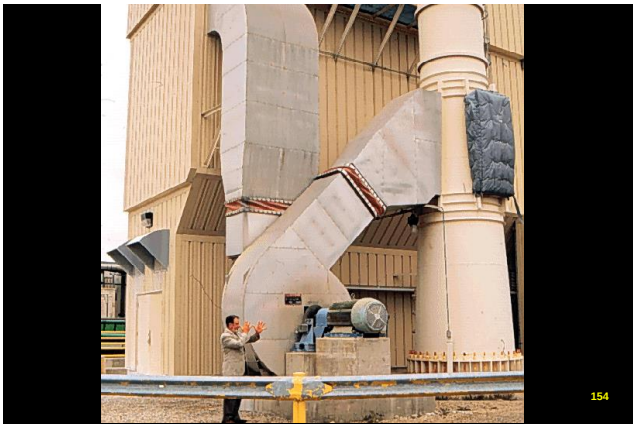
148


Beer's Law
As particle size gets smaller, reflective surface area increases
149


150


151

NACT 282 - Baghouses

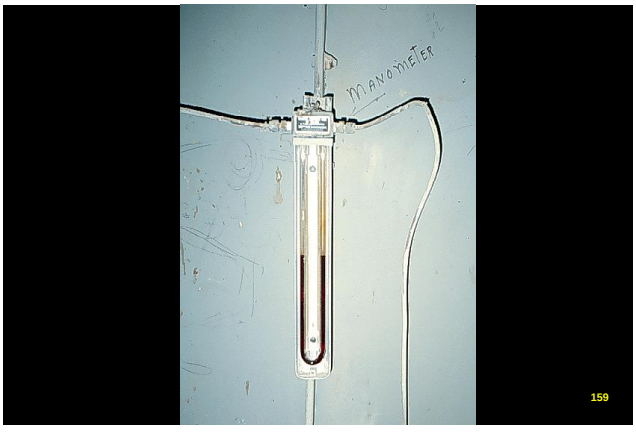


NACT 282 - Baghouses

Instrumentation

- Flow Meters
- Thermocouples
- Pressure Gauges
- Transmissometers / CEMs
- Hopper Level Indicators
- Compressed Air Pressure Gauges

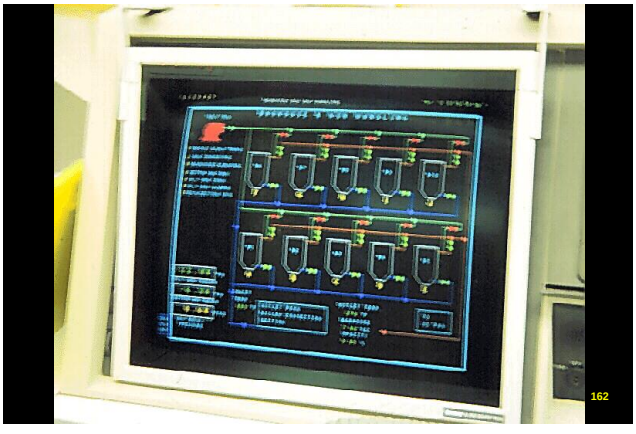
158



159

160

NACT 282 - Baghouses

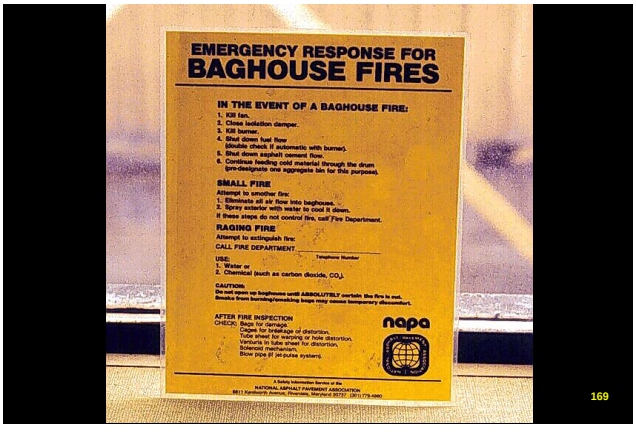


General Safety Policies

- Anticipate hazards before leaving for inspection site
- Have all necessary personal protective equipment
- Be aware of and conform to all applicable plant and agency safety policies
- Do one thing at a time
- Don't work alone

166

NACT 282 - Baghouses



NACT 282 - Baghouses