



Introduction

Industry Background

- Hot Mix Asphalt (HMA) facilities
 - ✓ Stationary
 - ✓ Some transportable
- HMA is combination of
 - ✓ Hot aggregate,
 - ✓ Hot liquid asphalt binder
 - ✓ Filler
- Recycled Hot Mix (RHM) is HMA with
 - ✓ Crumb rubber (rubberized asphalt concrete)
 - ✓ Reclaimed asphalt



Introduction

Industry Background

- Two basic processes
 - ✓ Batch
 - ✓ Continuous mix
- Batch change recipe based on customers order
- Continuous mix one recipe at a time stored for up to 7 days in insulated silo



Introduction

Permit Process Requirements

- District issues an “Authority to Construct”
- Inspection conducted
 - ✓ Usually includes a source test
- All conditions met “Permit to Operate” is issued



Emissions and Effects



HMA facilities emit pollutants such as PM, CO, NO_x, SO_x, VOCs and other toxic substances

NO_x and VOCs are Ozone (O₃) precursors each reacts with sunlight to form O₃

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Aggregate, Concrete Batching, and Hot Mix Asphalt Operations

HMA Emissions in CA

(OVER 125 Facilities)

| Typical HMA Pollutants | Emissions (tons/yr) |
|------------------------------------|---------------------|
| PM (total for all size categories) | 1500 |
| PM10 | 700 |
| PM2.5 | 400 |
| CO | 800 |
| NOx | 450 |
| Total Organic Compounds | 200 |
| Reactive Organic Gas | 200 |
| SOx | 100 |
| VOCs | 200 |

Emissions

Criteria and Precursor Pollutants

- ➡ Created during production, storage, and transport of HMA
- ➡ PM from aggregate



Emissions

Criteria and Precursor Pollutants (cont.)

- **PM, CO, NO_x, VOCs, and SO_x from fuel combustion and storage of asphalt binder and HMA**
- **Blue Smoke (VOCs) from production and loading**



NSPS – Standards of Performance HMA Facilities

(40 CFR Part 60 Subpart I)

Applies to HMA Facilities Comprised of:

- ✓ **Dryers**
- ✓ **Screening, Handling, Storing and Weighing Hot Aggregate Systems**
- ✓ **Loading, Transferring, and Storing Mineral Filler Systems**
- ✓ **Mixing HMA Systems**
- ✓ **Loading, Transfer, and Storage for APC Systems**

Applies to HMA Facilities that:

Commence Construction or Modification after June 11, 1973

Particulate Matter Standard

- ✓ **No discharge in excess of 90 mg/dscm (0.04 gr/dscf)**
- ✓ **Not to exceed 20 % Opacity or Greater**

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NSPS – Standard of Performance for Nonmetallic Mineral Processing Plants

(40 CFR Part 60 Subpart OOO)

HMA Facilities are also Regulated Under
Subpart OOO for Crushers & Grinding Mills

Process/Control

- ✓ How much aggregate is processed
- ✓ Moisture content of the processed material
- ✓ Control efficiency of the air pollution control equipment
- ✓ Opacity



Process

Composition of HMA

- ▶ Binder
- ▶ Filler
- ▶ Aggregate


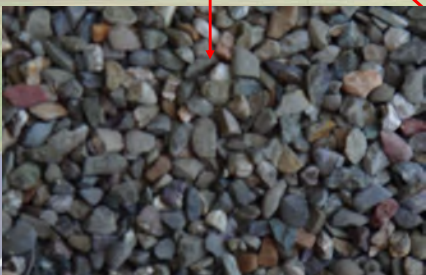



Diagram illustrating the composition of Hot Mix Asphalt (HMA). The components are Binder, Filler, and Aggregate. The binder is shown as a dark, viscous material. The aggregate is shown as a pile of dark, irregularly shaped stones. The filler is shown as a fine, dark material being poured into a container.

Process

Binder Composition

Binder Terms

- ▶ **Asphalt Binder**
 - ✓ Includes asphalt cement and any material added to modify properties
- ▶ **Bitumen**
 - ✓ Class of dark colored (solid, semi solid, or viscous)


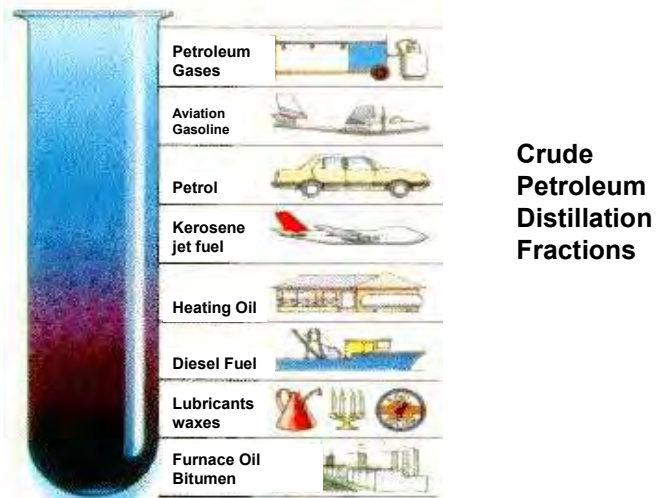


Diagram illustrating the binder composition. The binder is shown as a dark, viscous material. The terms Asphalt Binder and Bitumen are defined. Asphalt Binder includes asphalt cement and any material added to modify properties. Bitumen is a class of dark colored (solid, semi solid, or viscous) material.

Process Binder Composition



Process Asphalt Grading



➡ Two grading methods

✓ Viscosity Grading of Binder

✓ Superpave Performance Grade (PG)

Process

Viscosity Grading of Binder

- Viscosity test developed during the early part of the 20th century.

- ✓ AC

- Tests viscosity of binder to characterize viscosity as supplied (simulating condition before used)

- ✓ AR

- Tests viscosity of binder aged in a rolling thin-film oven (simulating HMA production)

Process

Viscosity Grading of Binder (cont'd.)

- PG (Superpave Performance Grade)

- ✓ Test developed in 1980-1990

- ✓ Based on performance of binder in relation to climate

- ✓ Temperature range is 115 to 180 F

- ✓ Address rutting, fatigue cracking, and thermal cracking



Process

Conventional HMA Binder

- Solid at room temperature
- 250 and 325 F from point of origin to the final destination
- Softening binder adds VOCs by
 1. Adding softer grade asphalt
 2. Adding lighter petroleum oils



Process

Typical Alternative Asphalt Binder

- Reclaimed asphalt pavement (RAP)
- Used tires (crumb rubber)
- Proprietary polymers
- Anti-stripping agents (hydrated lime)
- Recycled baghouse dust



Figure 2.16: RAP in Aggregate-Sized Chunks

Process

Polymer Modified Binders

- **proprietary blends added to bitumen**
- **Formula varies depending on desired result of end product**



Process

Filler

- **Dust added to asphalt binder and aggregate to improve adhesion**



Process

RECIPE FOR HOT MIX ASPHALT

Process



Hydrated Lime

- Caltrans requires a lime-slurry-marination (LSM) where climate promotes stripping
- Requires that mixture be stockpiled for 24 hours before use “marinated”

Process

Hydrated Lime

➡ Anti-stripping agent:

1. Added dry with binder
2. Added dry to wet or dry aggregate and “marinated” for several days
3. Added as lime slurry for immediate use or “marinated”



Process

Anti-stripping Agents

Illustration of binder with anti-stripping agent and without anti-stripping agent



Process

Alternative Binders

- Kept at temperatures higher than conventional binder
- Two types
 1. Polymer-modified asphalt cement
 2. Crumb rubber modified



Process



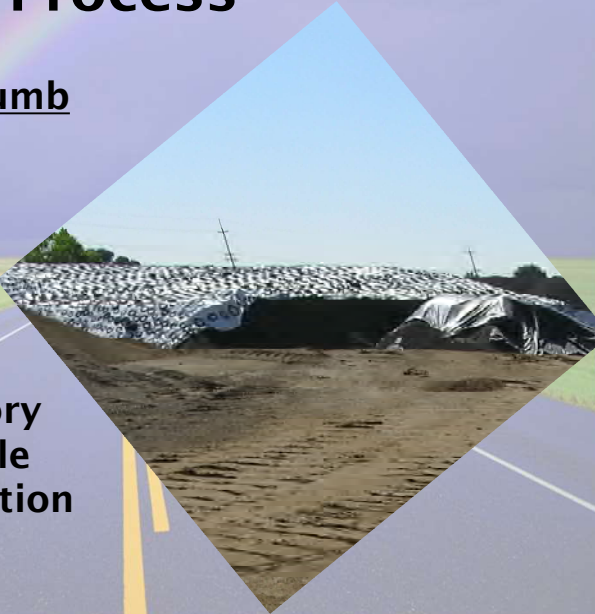
Crumb Rubber

- Added to binder to make crumb rubber modified (CRM)
- 75% scrap tire and 25% virgin rubber
- Non-hazardous hydrocarbon polymer
- Rubber-modified asphalt concrete (RAC)

Process


Advantages of Crumb Rubber

- Waste reduction
- Less water
- Quiet
- Lasts Longer
- BUT No regulatory relief from visible emission evaluation (VEE)



Process

RECIPE FOR RAC



Process Reclaimed Asphalt Pavement

- **RAP is**
 - ✓ **Top layer of asphalt pavement removed**
- **Developed because of energy, economic, and environmental concerns**
- **RAP could be 30% of mix**
- **Increases asphalt lifetime**
- **May increase generation of Blue Smoke**



Process RAP

- **Production temp of virgin aggregate is 500-800 F**
- **RAP is heated through conductive heat transfer**
- **RHM is 350 F**



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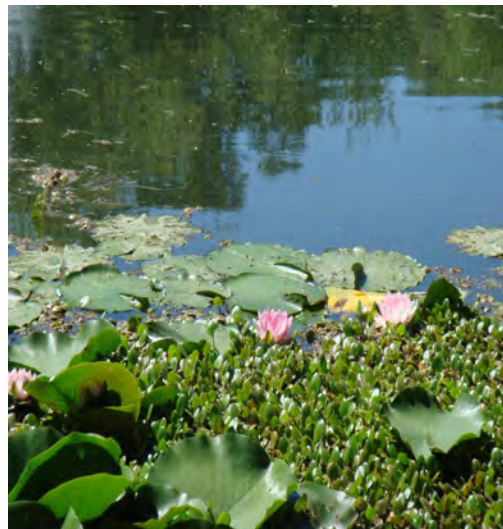
Aggregate, Concrete Batching, and Hot Mix Asphalt Operations

Process

RECIPE FOR RECYCLED HOT MIX

Process

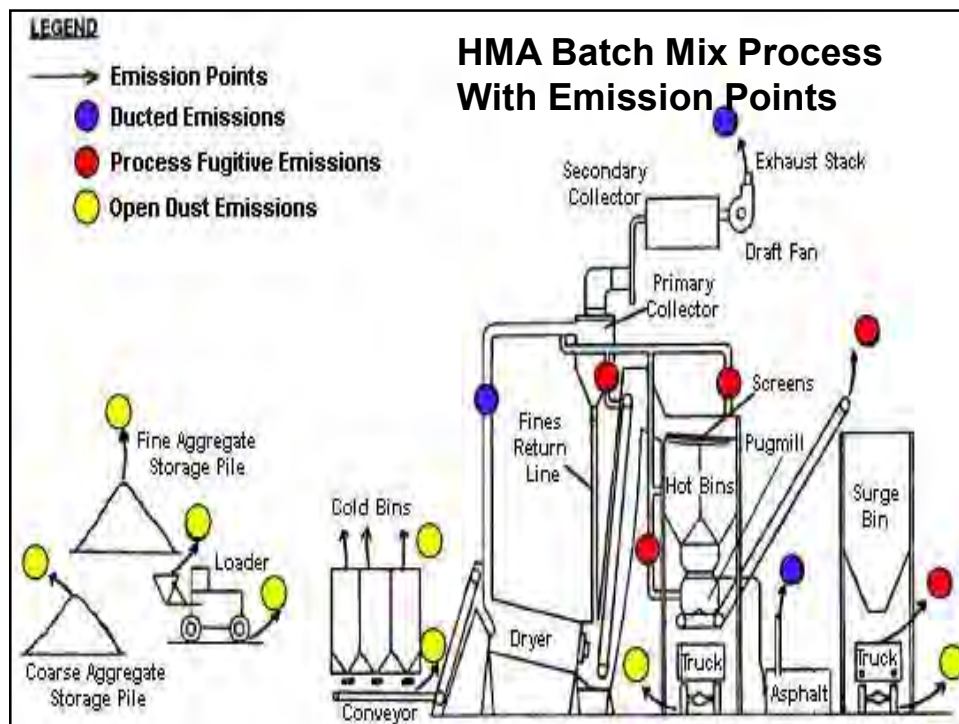
- ♦ Warm Mix Asphalt
- ♦ Advantages
 - ✓ Lower Production temp. 220 to 275 F
 - ✓ Less energy
 - ✓ Reduced cracking
- ♦ Disadvantages
 - ✓ Further testing to ensure QA/QC
 - ✓ Rutting
 - ✓ Workability
 - ✓ Longer setting=traffic delays





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Process Batch Facility

➤ Aggregate

- ✓ Stored in cold bins
- ✓ Moved by conveyor
- ✓ Sorted and weighted
- ✓ Dropped into dryer
- ✓ Elevated to top of batch tower and
- ✓ Separated

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**Process
Cold Bins
Aggregate Stockpiles**



Process Cold Bins



**Process
Cold Bins and Conveyors**



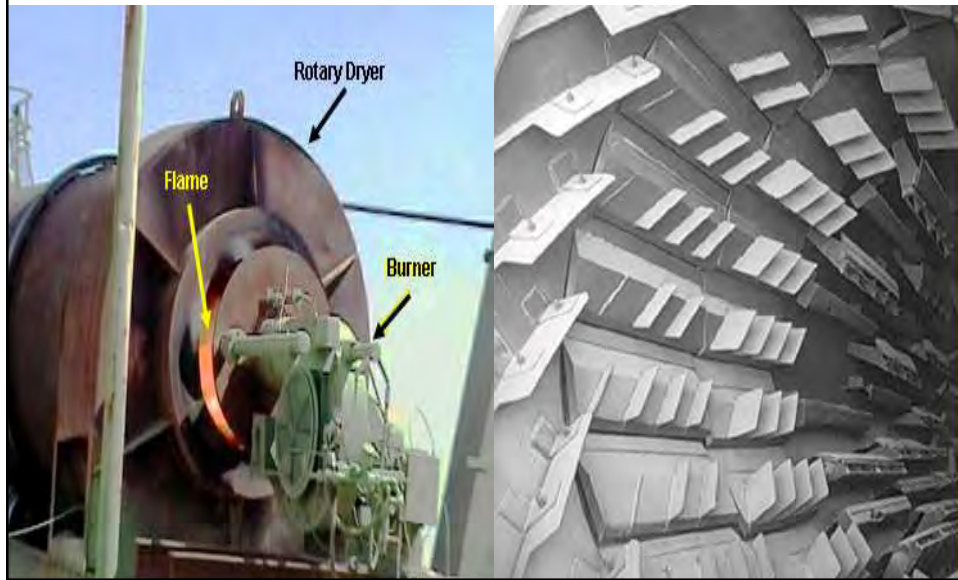
**Batch Process
Aggregate Dryer**



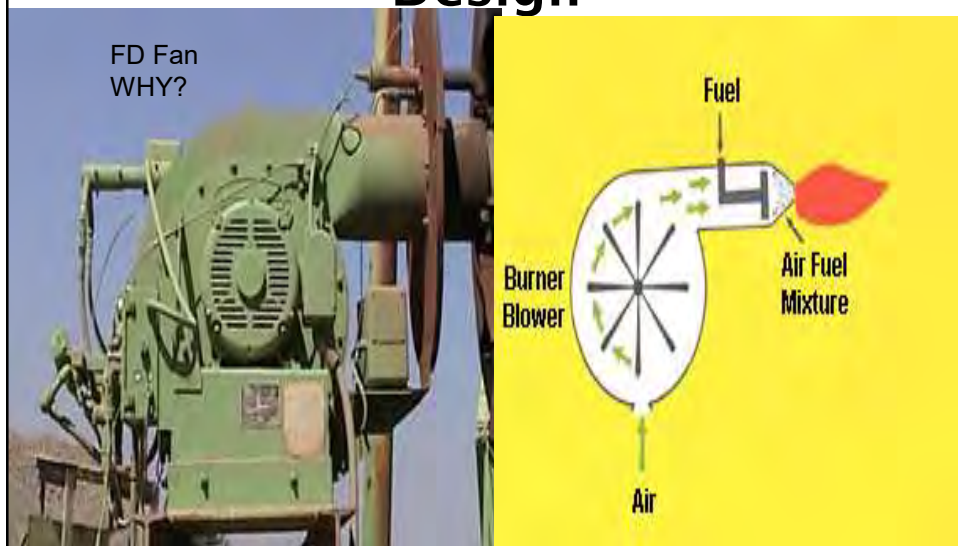
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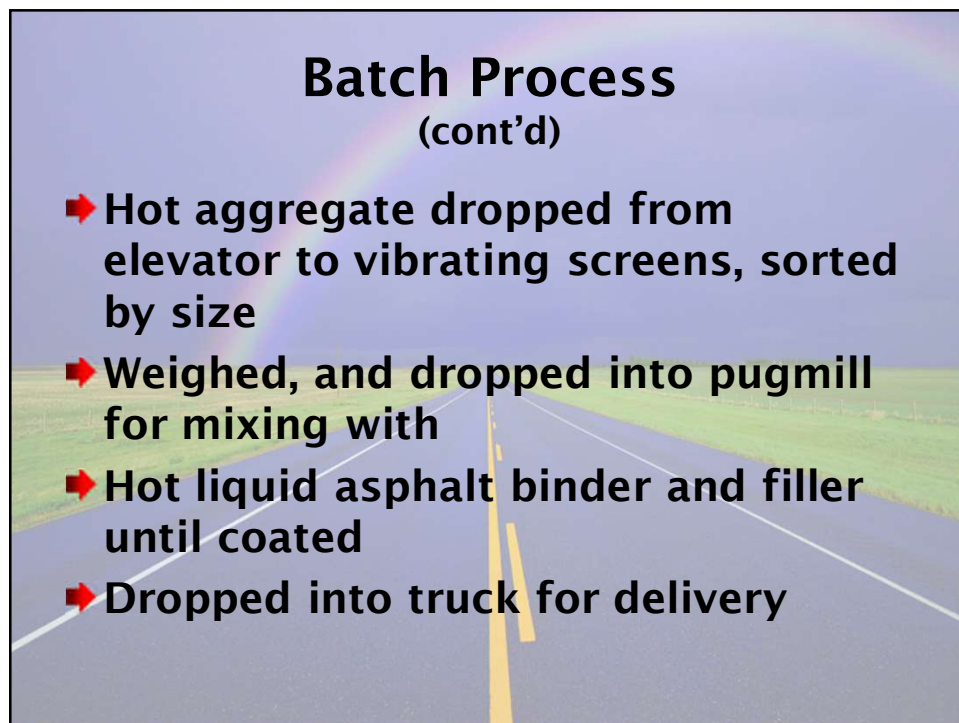
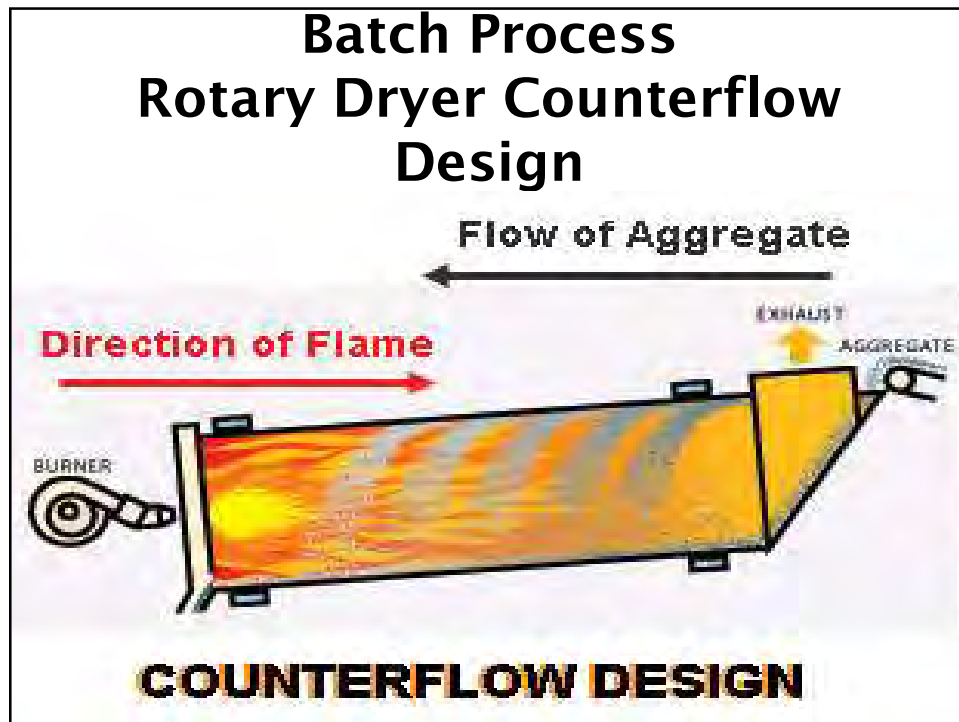
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Batch Process Rotary Dryer



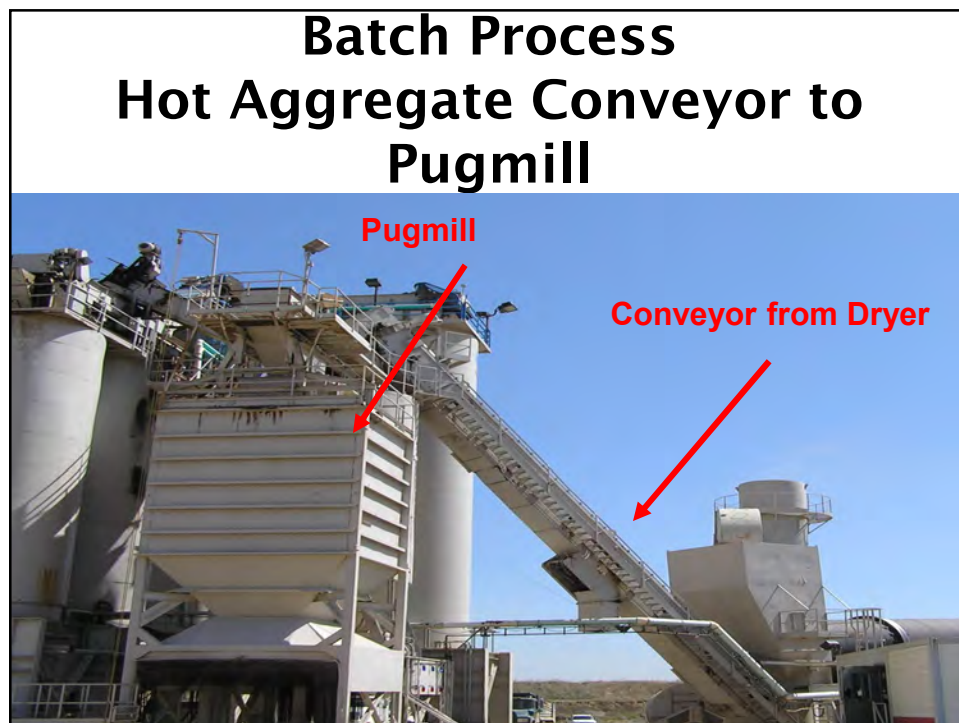
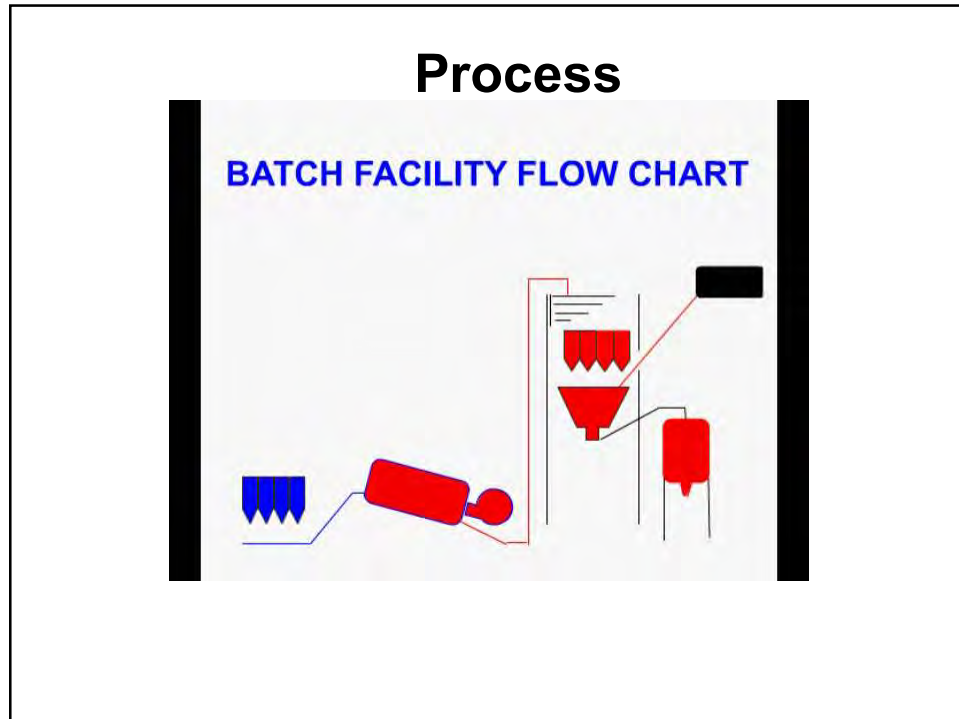
Process Combustion and Basic Burner Design





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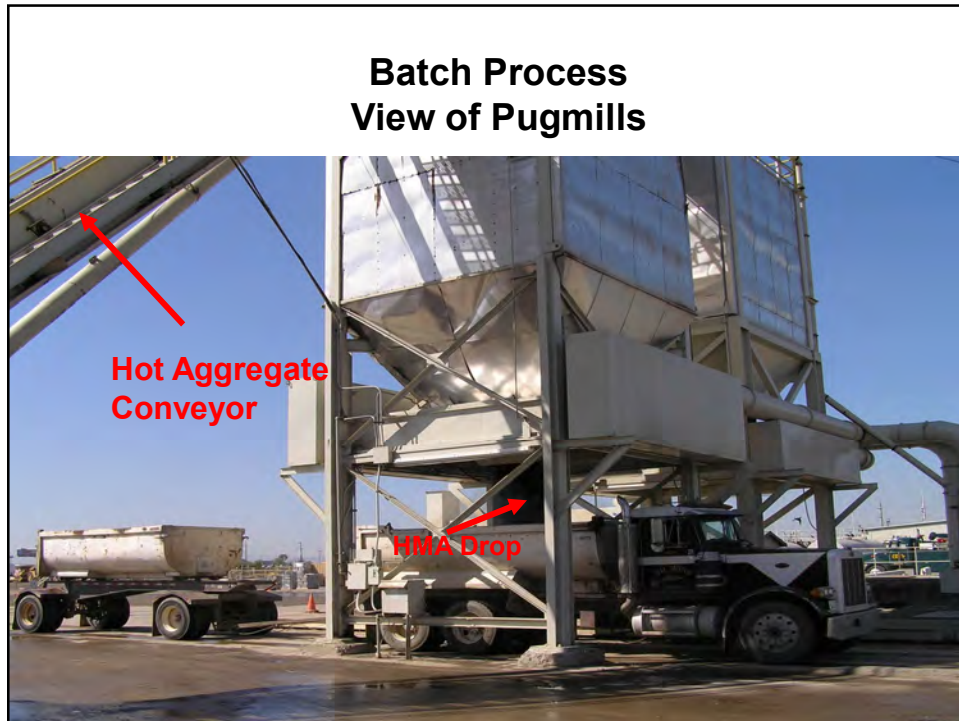
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Batch Mix Process without Pugmill

- Newer design
- All ingredients are mixed together in the drum and sent to silos
- Better controls

**Batch Process Rotary
Dryer/Mixer Combined**



**View of Batch Operated Double
Drum Mixer Down for
Maintenance**



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Inside View of Double Drum Mixer

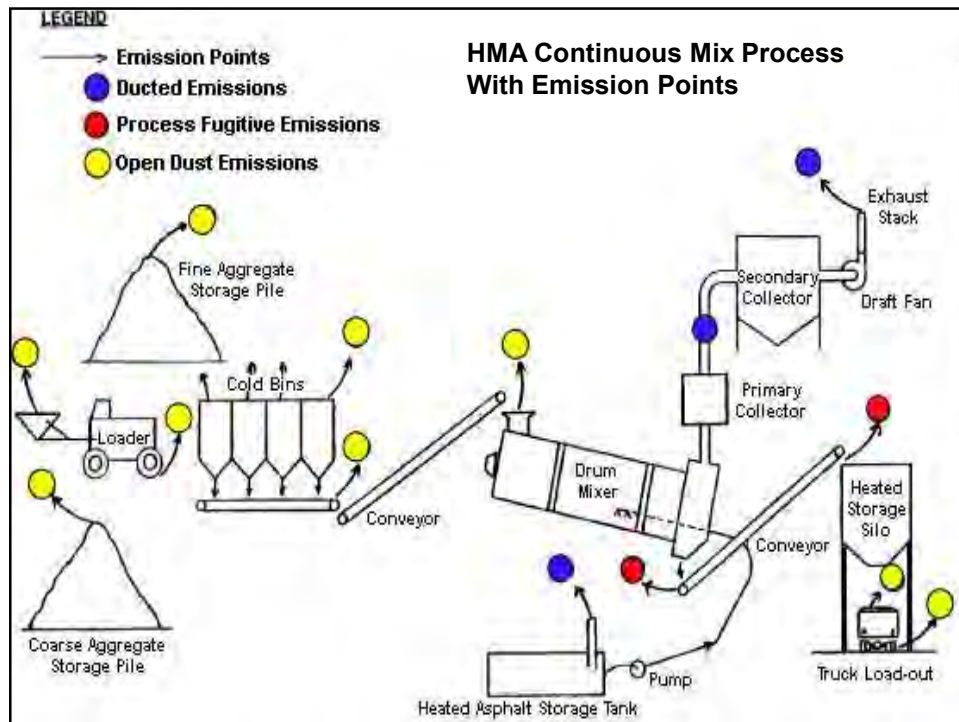


Continuous Mix Process



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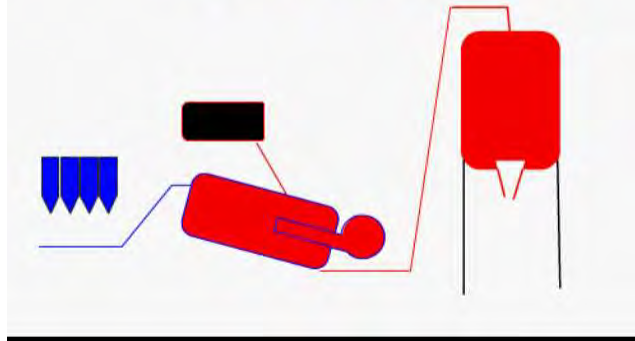
Process Continuous Mix Facility Characteristics

1. HMA is continuously produced
2. No batch towers to segregate hot aggregate
3. Insulated heated storage silos are used instead of surge bins to store HMA
4. Production is horizontal verses vertical

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Process

**CONTINUOUS MIX FACILITY
FLOW CHART**



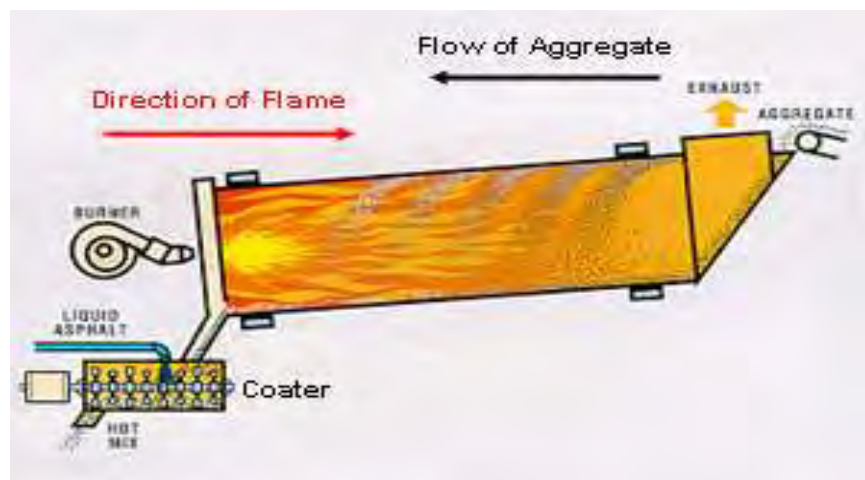
Process
HMA Drum Design



Process Drum Design

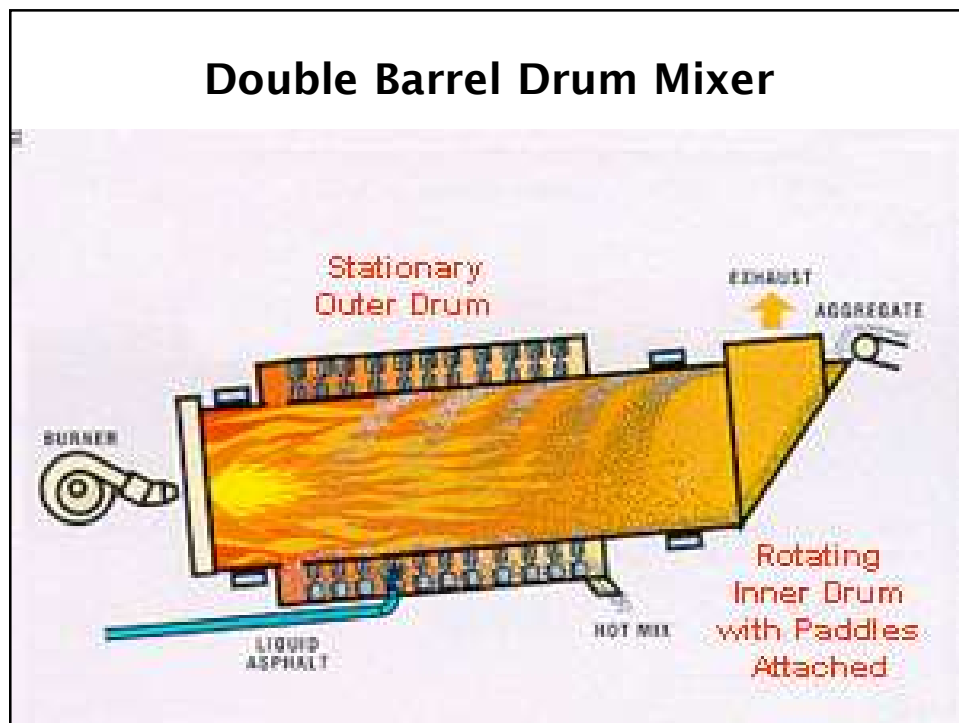
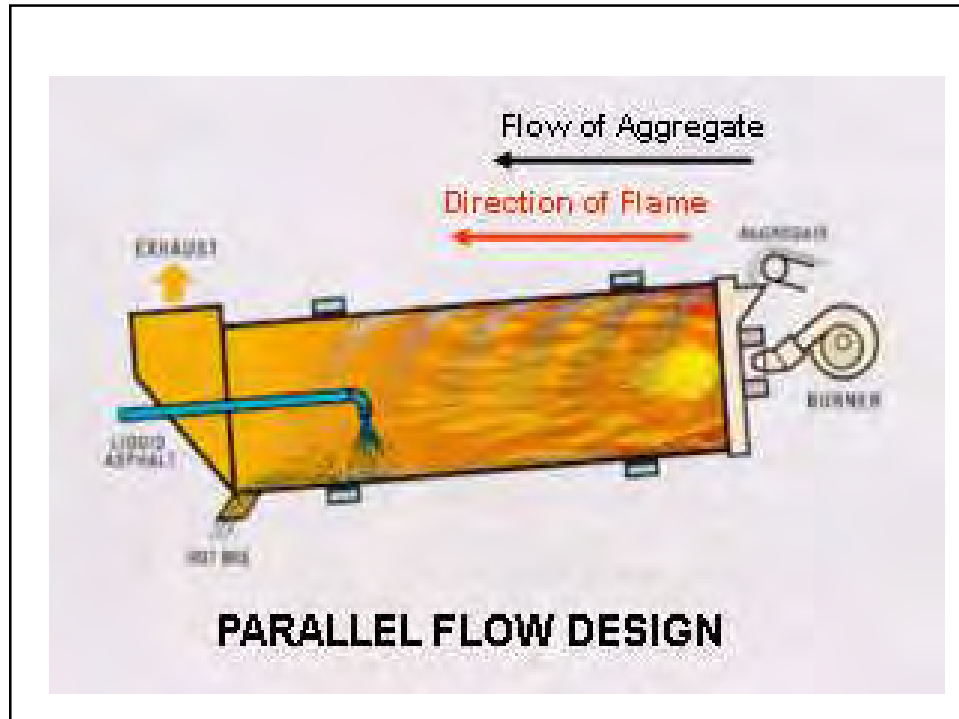
- ▶ 4 general designs
 - ✓ Counter Flow Dryer Coater
 - ✓ Parallel Flow Drum Mixer
 - ✓ Double Barrel Drum Mixer
 - ✓ Triple-Drum™ Mixer
- ▶ Drum mixers two zones:
 - ✓ primary for aggregate drying and heating
 - ✓ secondary for mixing heated aggregate with binder and filler

Counterflow Dryer and Coater



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**Inside View of Double Drum
Dryer Section**

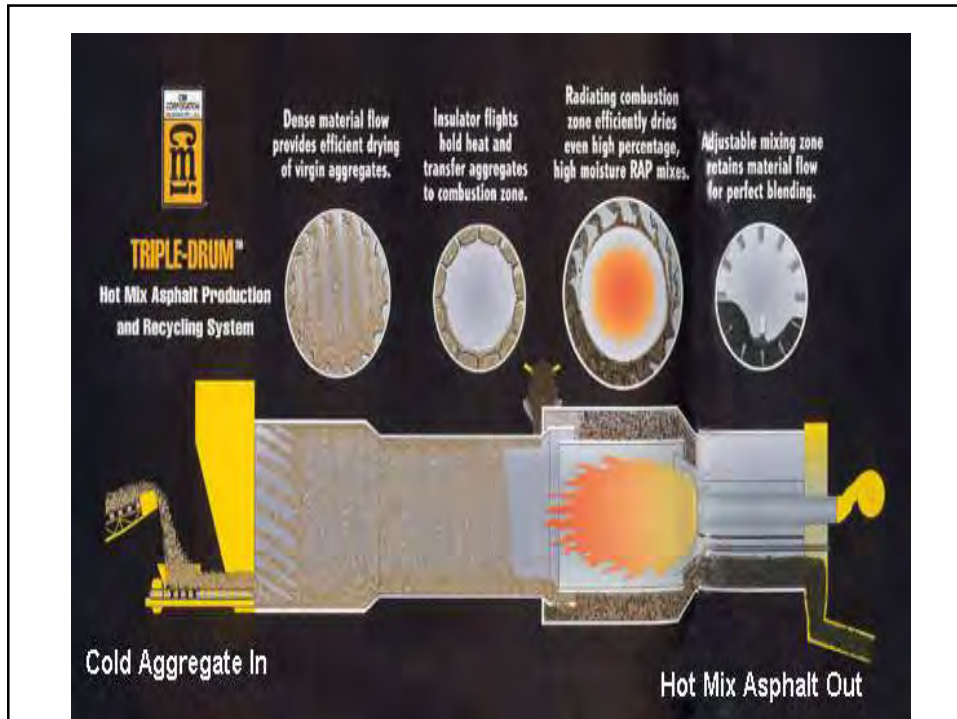


**Inside View of Double Drum
Mixer Section**



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Triple-Drum



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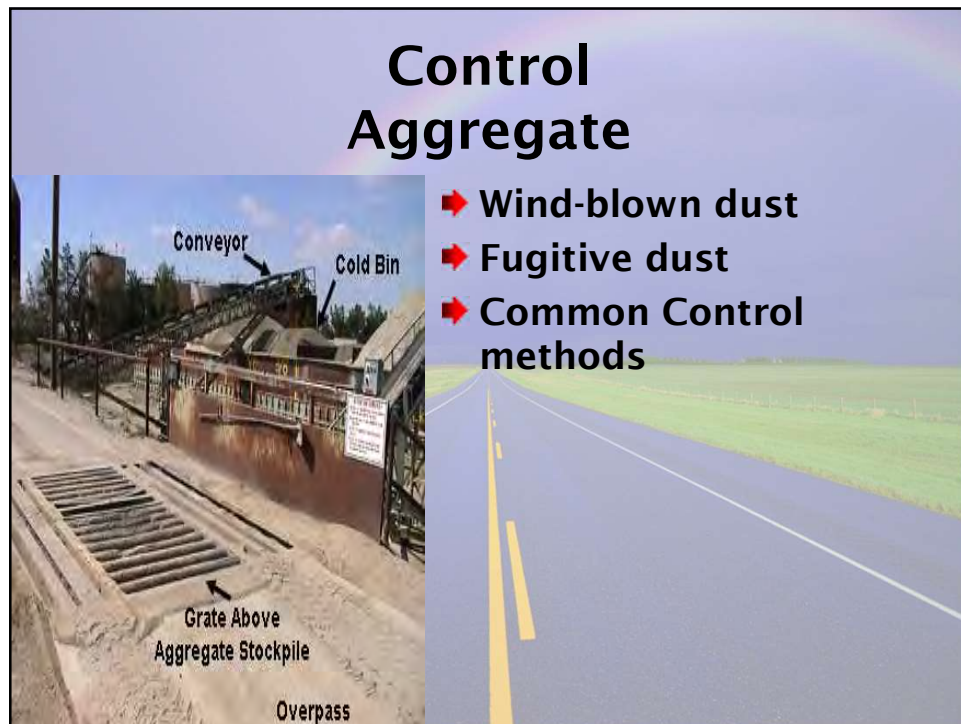


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Emission Controls





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Emission Control Hot Aggregate Handling

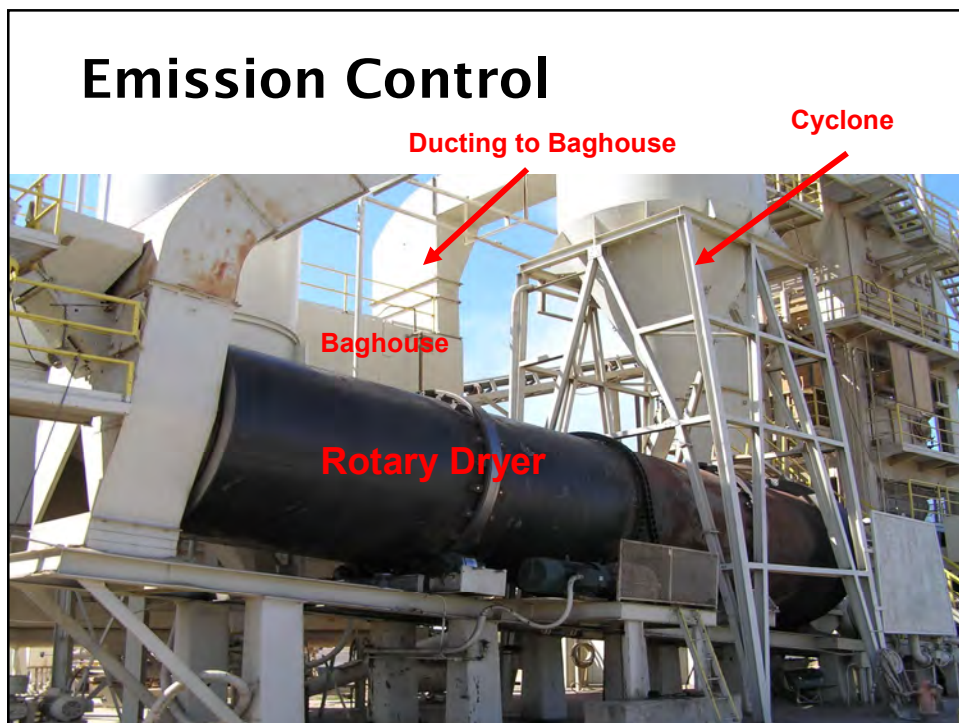
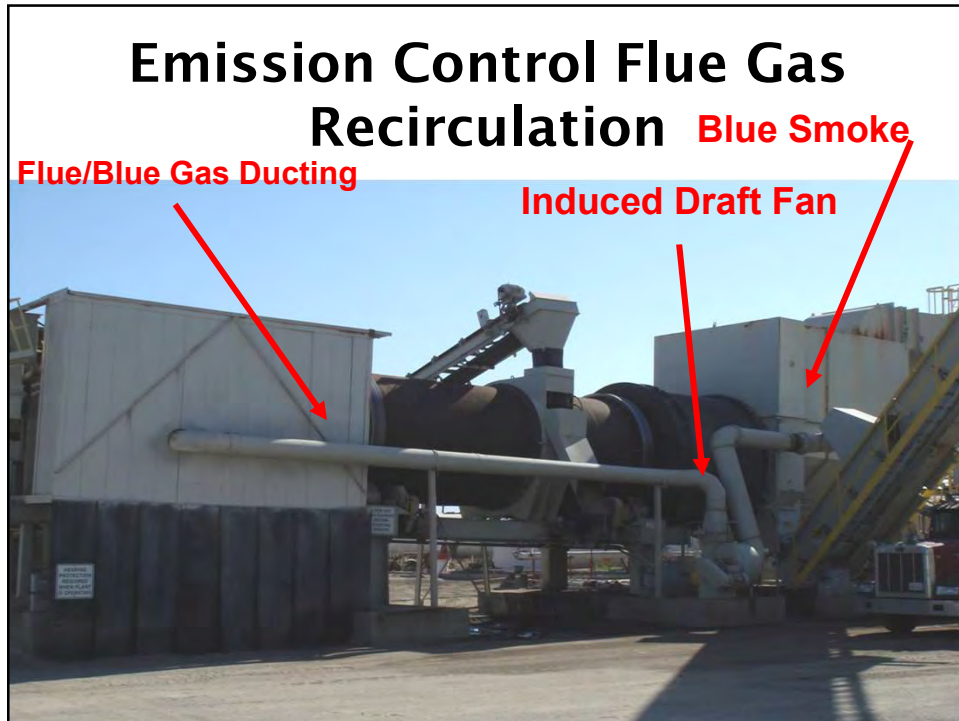


Emission Control Hot Aggregate Handling

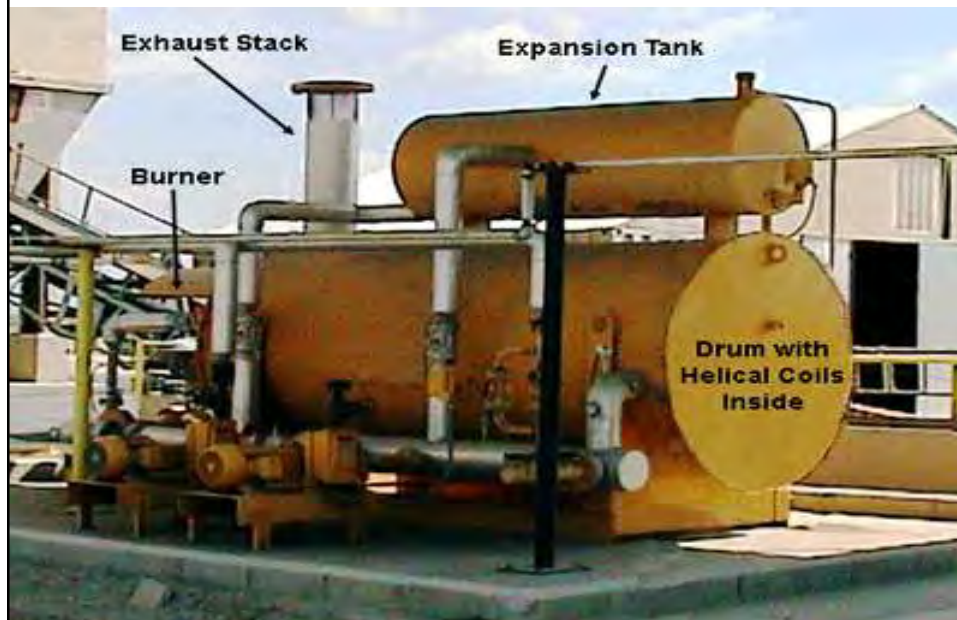


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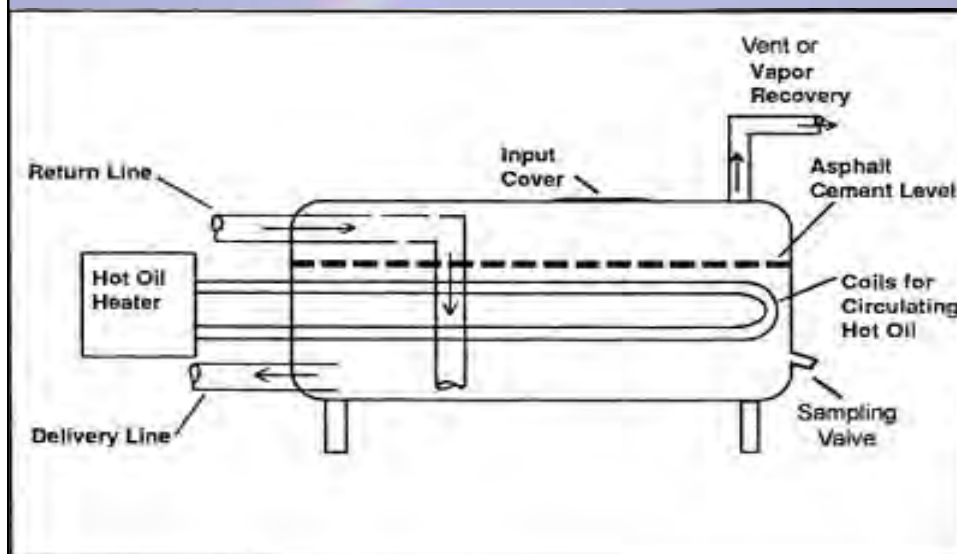
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Small Binder Storage Tank



Hot Oil Heater Coils



**Process
Underground Storage Tanks**



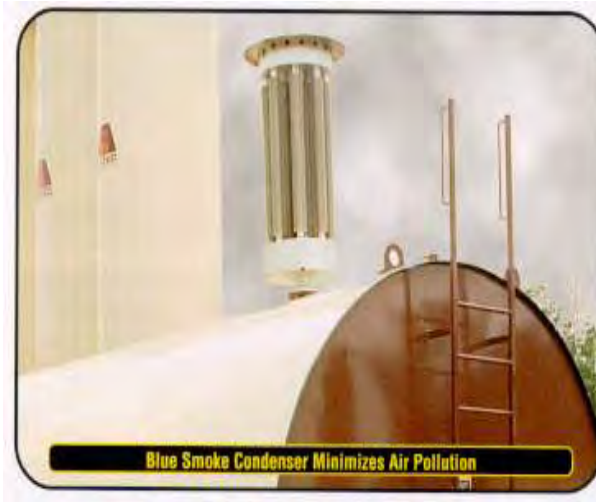
**Uncontrolled RAC
Binder Storage Tank**



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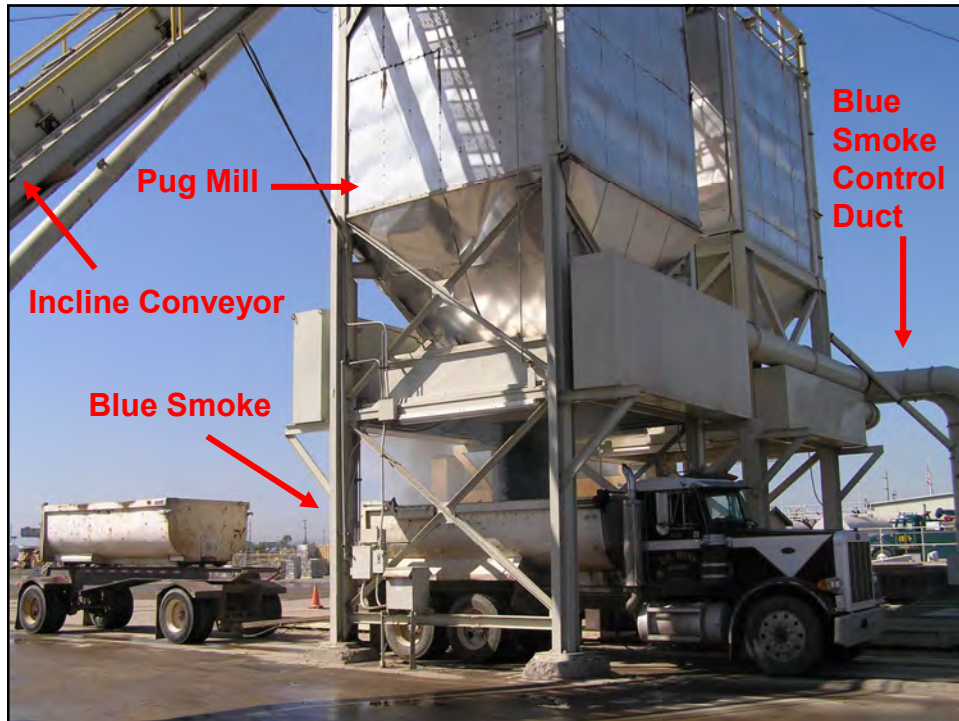
Controlled Binder Storage Tank Vent Condenser



Dust Silo



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**Control
Draft Air**



Control Draft Air

- **Draft air passes through ducting due to pressure differential**
- **Draft air affects**
 - 1. Combustion efficiency**
 - 2. How a system develops leaks**
 - 3. Control effectiveness**

Control Types of Draft Air

- **4 Type**
 - 1. Forced Draft Air**
 - ✓ **Air that is pushed resulting in positive pressure**
 - 2. Induced Draft**
 - ✓ **Air is pulled by a fan resulting in negative pressure**

Control Draft Air (cont'd)

3. Natural Draft Air

- ✓ Difference in temp between flue gases and the ambient air.

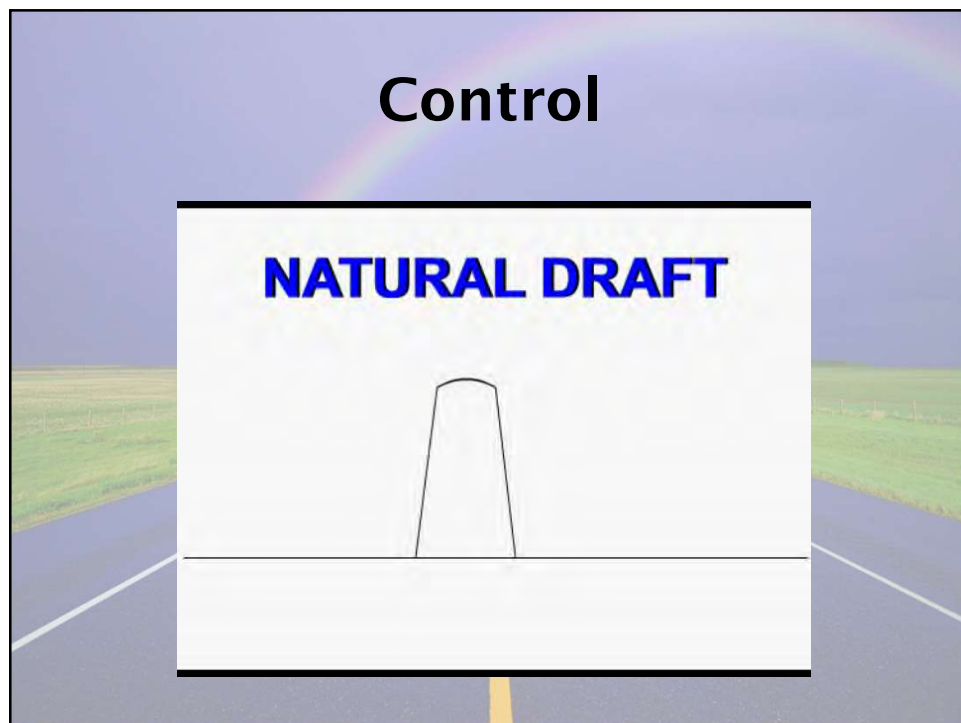
4. Balanced Draft

- ✓ Forced draft fan pushes combustion air into combustion chamber.

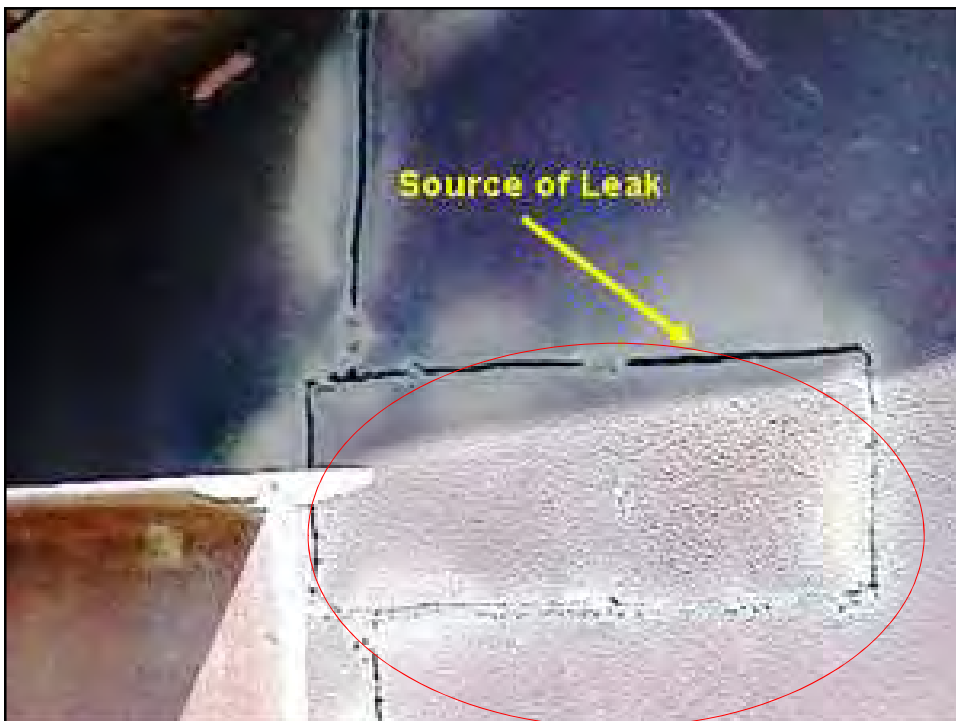
Control

FORCED DRAFT

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Leak in a Rotary Dryer



Control Drum/Dryer Emission

- ▶ **Drum/Dryer produce large amounts of PM**
- ▶ **Two control devices**
 - ✓ **Primary for large particles and**
 - ✓ **Secondary for small particles**
- ▶ **Combined efficiency is 99% or greater**
- ▶ **Ask for manufacturer or facility guarantee**

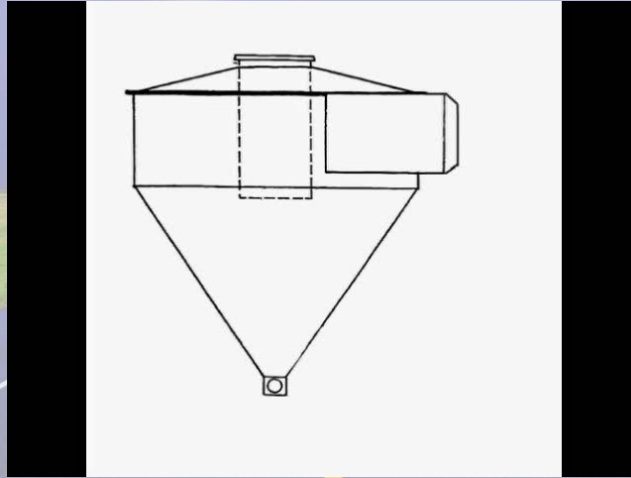
Primary Controls Cyclone



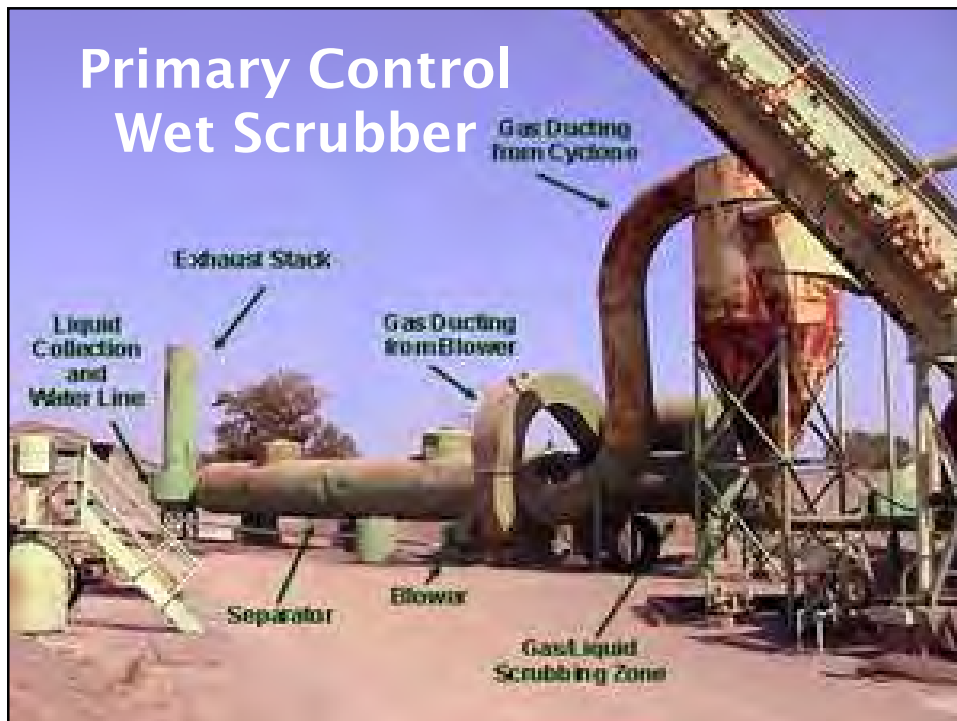
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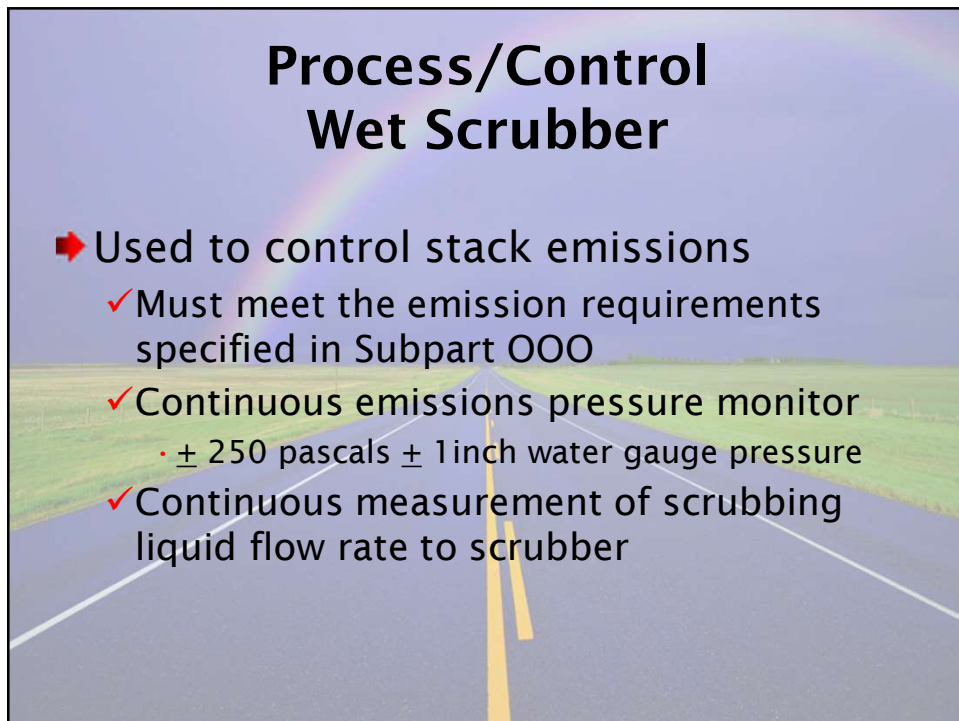
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Primary Control Cyclone



Primary Control Wet Scrubber





Control Techniques Wet Scrubber

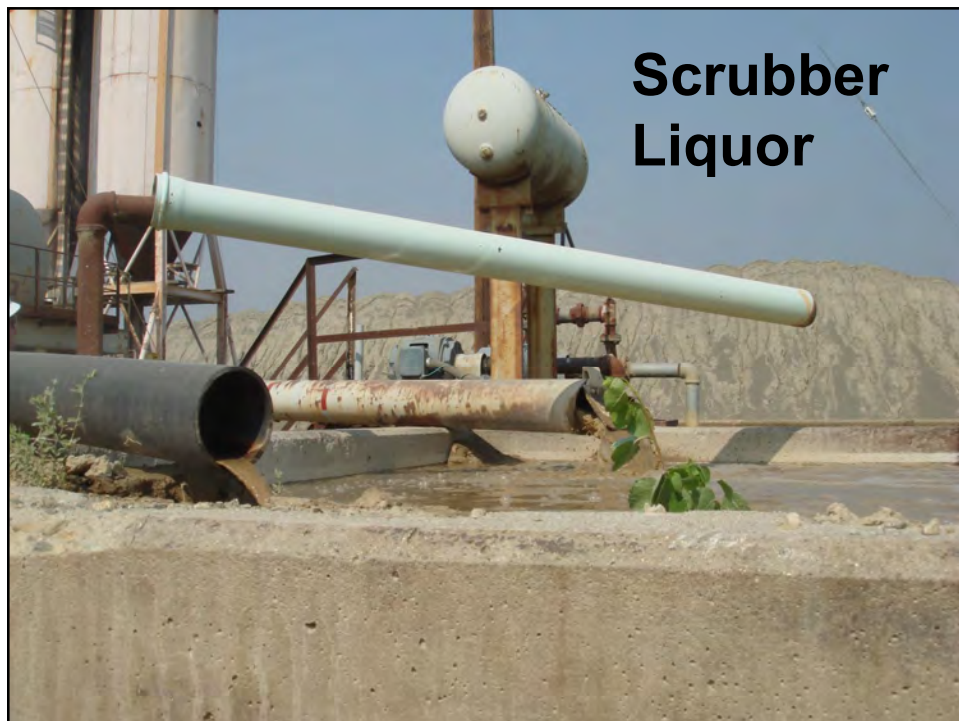
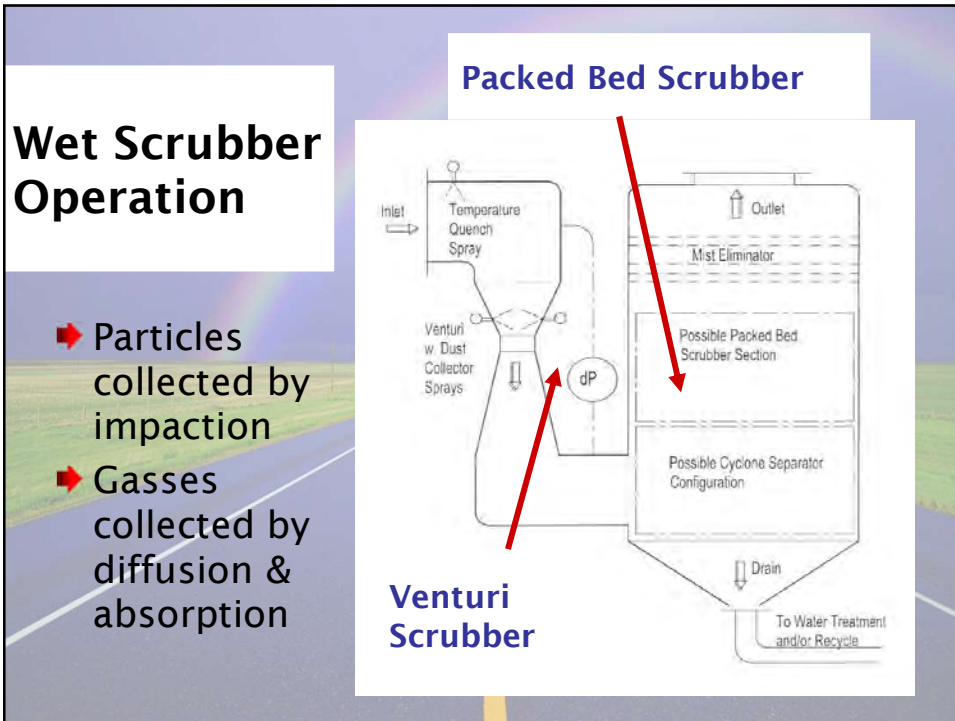
- General description
 - ✓ Particles get trapped in liquids
 - Inertial impaction and diffusion
 - ✓ Liquids must contact particles and dirty liquids must be removed from exhaust gas

Particle Scrubbers

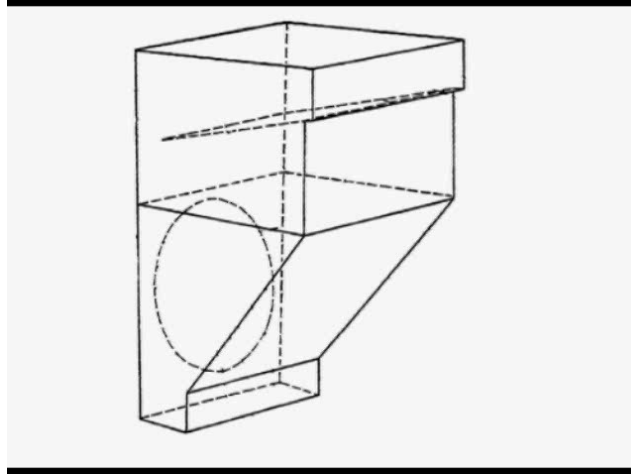
- Initial quench – use clean water
- Water drops and particles must contact (impact)
 - ✓ Requires water flow and mixing energy
- Dirty water collection
- Water treatment & recirculation

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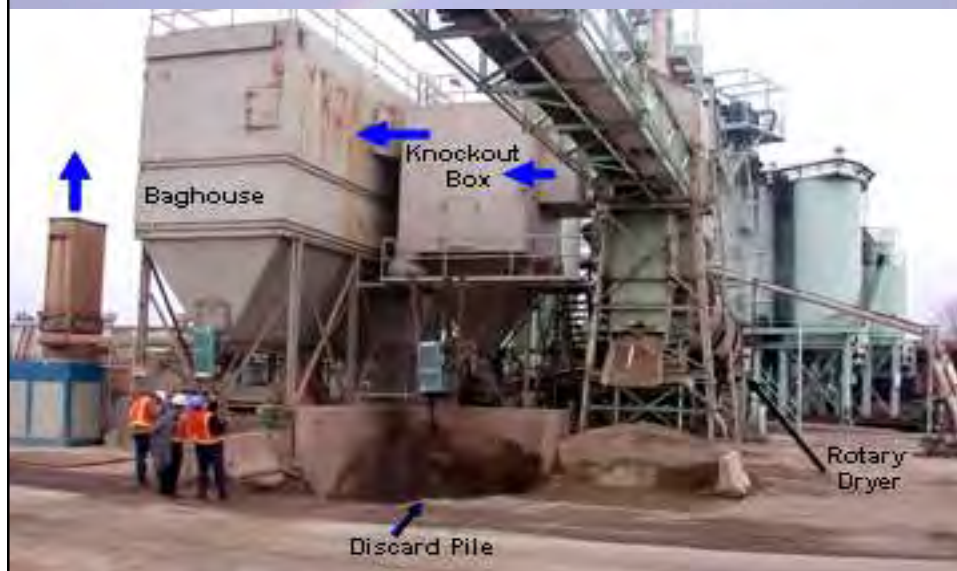
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Primary Control Knock Out Box



Primary Controls Knock-out Box

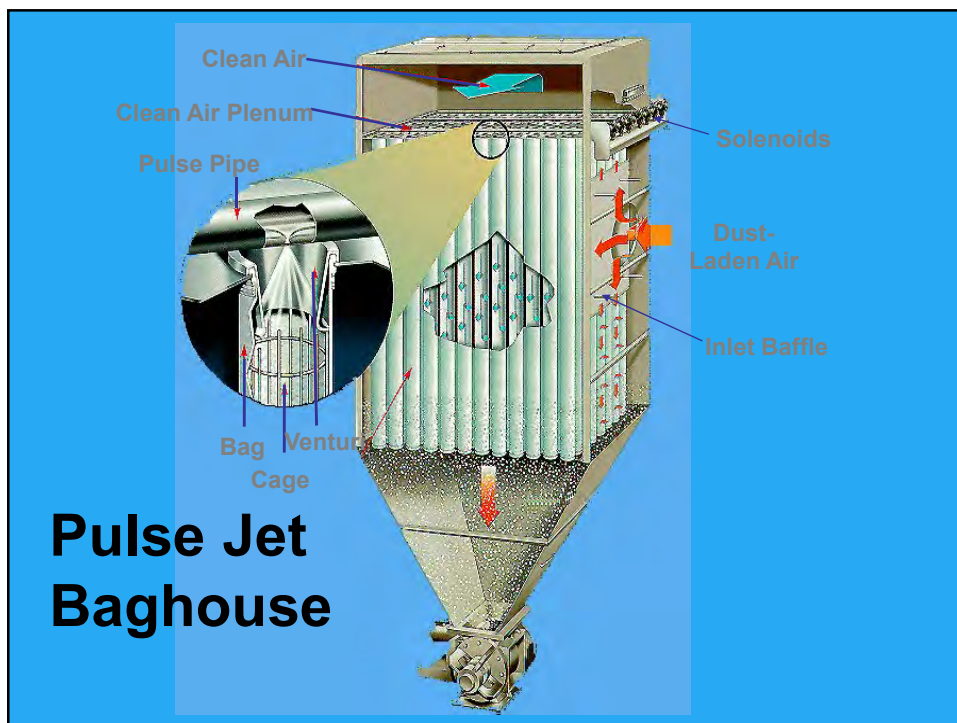
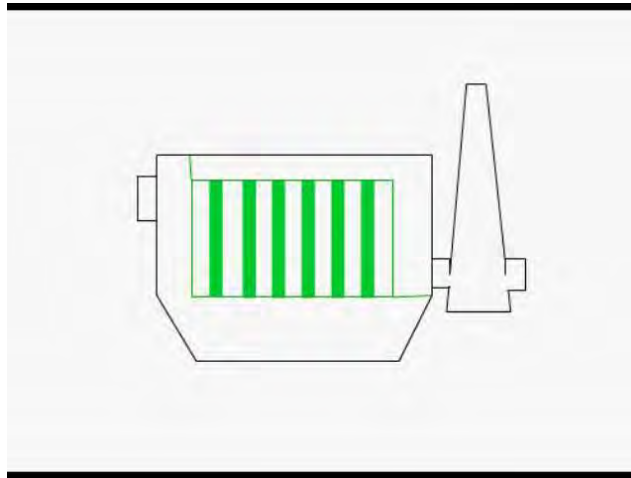




Secondary Control Baghouses

- ➡ **General description**
 - ✓ Particles trapped on filter media, then removed
 - ✓ Either interior or exterior filtration systems
 - ✓ Up to 99.9% efficiency
 - ✓ Fabric filters are big vacuum cleaners with a cleaning mechanism

Secondary Control Baghouse



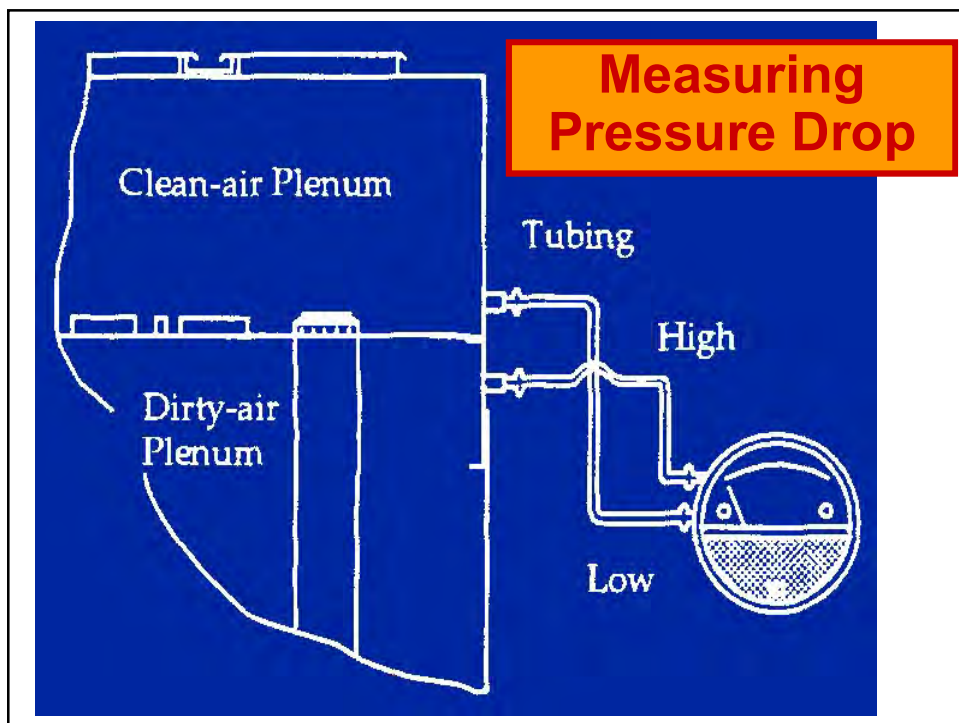
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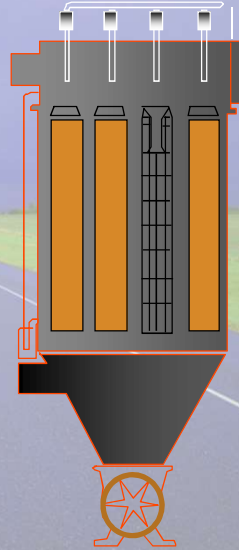
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Baghouse Design Considerations

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

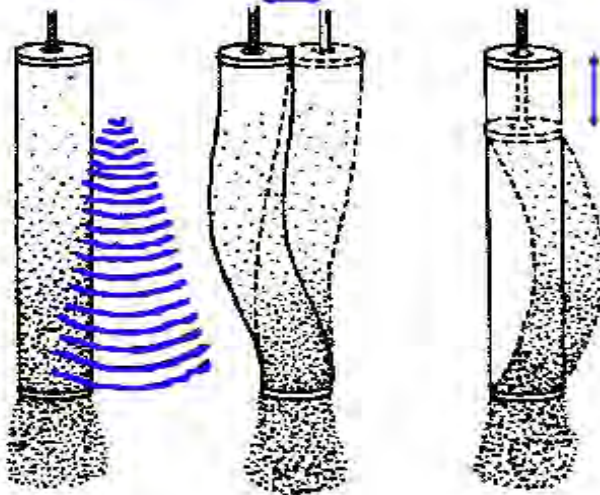


Secondary Control Shaker Method

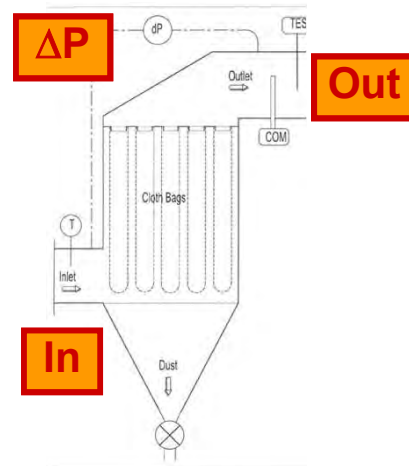
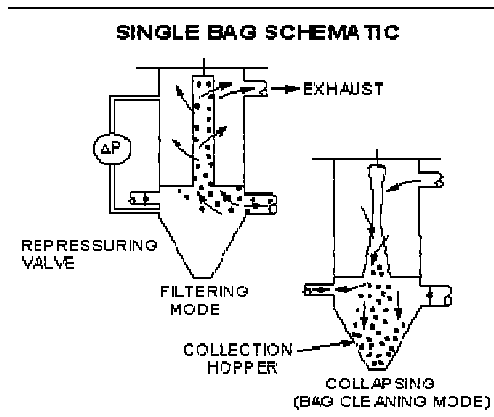
Sonic Vibration

Horizontal

Vertical



Secondary Control PM Control Techniques – Fabric Filter



Secondary Control PM Control Techniques – Fabric Filter

► Factors affecting efficiency

✓ Filter media

- Abrasion
- High temperature
- Chemical attack

✓ Gas flow

✓ Broken or worn-out bags



Secondary Control PM Control Techniques – Fabric Filter

- **Factors affecting efficiency
(continued)**
 - ✓ **Cleaning system failure**
 - ✓ **Leaks**
 - ✓ **Re-entrainment**
 - ✓ **Damper or discharge equipment
malfunction**
 - ✓ **Corrosion**



Secondary Control PM Control Techniques – Fabric Filter

- **Performance indicators**
 - ✓ **Outlet PM concentration**
 - ✓ **Bag leak detectors**
 - ✓ **Outlet opacity**
 - ✓ **Pressure differential**
 - ✓ **Inlet temperature**
 - ✓ **Temperature differential**

Secondary Control PM Control Techniques – Fabric Filter

► Performance indicators (cont'd)

- ✓ Exhaust gas flow rate**
- ✓ Cleaning mechanism operation**
- ✓ Fan current**
- ✓ Inspections and maintenance**

Secondary Control Bag House Monitoring

► Normal bag house emissions are very low.

- ✓ Opacity sensors Continuous Opacity Monitor (COM) aren't very good below 1-2%, so they don't detect initial problems.**
- ✓ Opacity will show a major particulate emissions increase.**
- ✓ COM or Method 9 may be OK for loose emission limits.**

Inspection Procedures Instrumentation

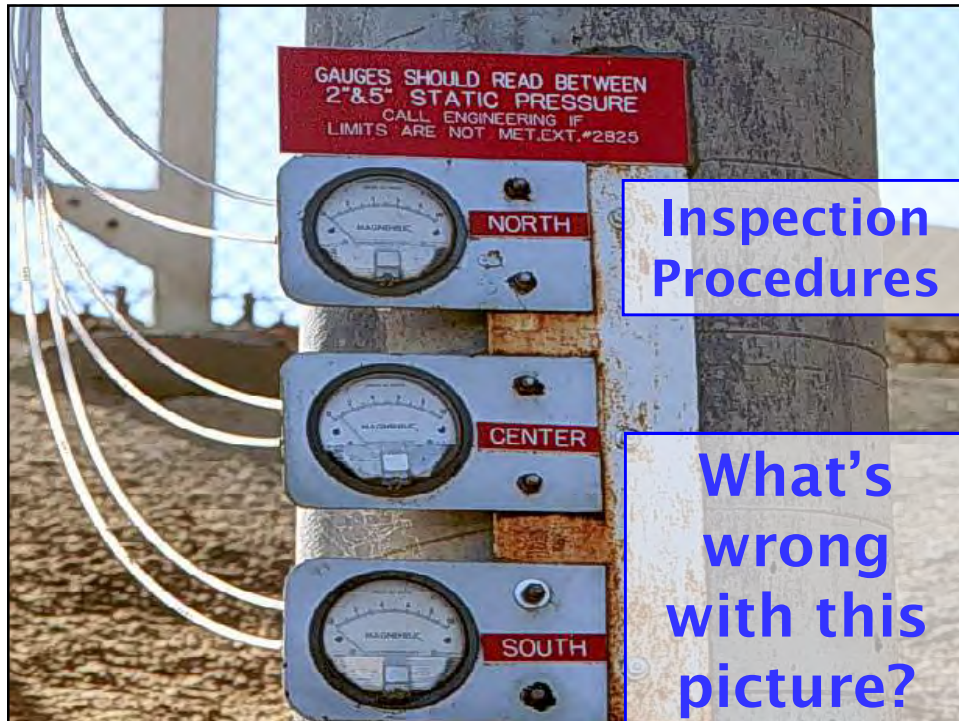
- ➡ **What types of instruments are being used to monitor for permit conditions?**
 - ✓ **Magnehelic Gauge**
 - ✓ **Triboelectric Monitor**

Inspection Procedures Magnehelic Gauge



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Baghouse Monitoring Triboelectric Sensor (TES)

- ➡ TESs are a newer technology
 - ✓ Primary use in cement, coal fired power plants, and food manufacturing
 - ✓ US EPA encourages use of TESs as CAM (compliance assistance monitoring, 40 CFR 64) or
 - ✓ As a performance indicator in lieu of a source test
- ➡ Districts are adopting TES as BACT or compliance measurement tool

Baghouse Monitoring Triboelectric Sensor

- ▶ Triboelectric sensors (TES) work well at very low particle concentrations (very sensitive).
- ▶ TES detects micro amp current from particles hitting a metal probe.
- ▶ TES is simple and inexpensive.
- ▶ TES is an effective monitor when a small to moderate increase in emissions is of concern.

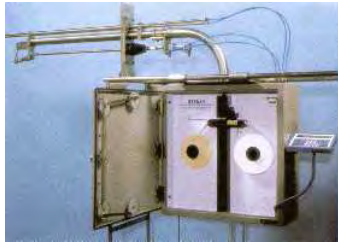
Baghouse Monitoring Triboelectric Sensor

- ▶ Operates on the principle of electric conductivity
 - ✓ Triboelectric Principle: When 2 solids contact an electrical charge is transferred between the 2
 - ✓ Current generated is proportional to the particulate mass flow rate
 - ✓ Instrument tuned to produce continuous analog output and/or an alarm at a specific signal level

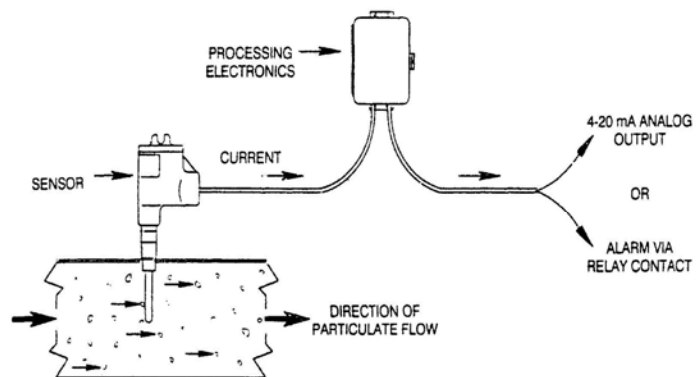
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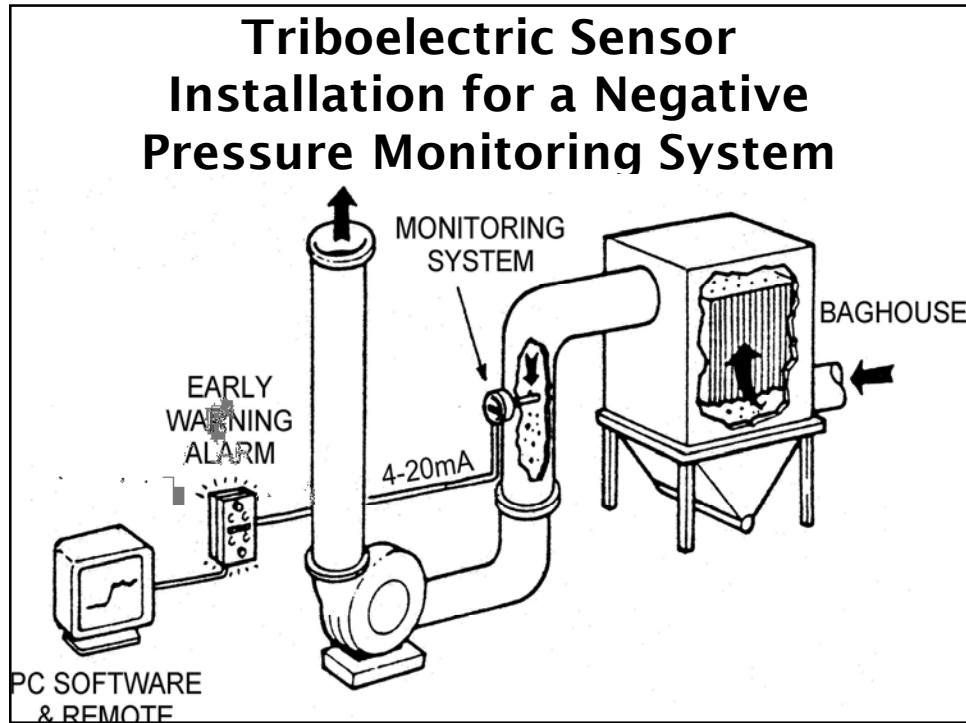
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Control Devices PM CEMS/TES Devices



Control Device Triboelectric Sensor Schematic





Monitoring Device Triboelectric Sensor

- ▶ **TES works well at low particulate concentrations**
- ▶ **Detects micro amp current from particles hitting a metal probe**
- ▶ **Simple and inexpensive**
- ▶ **Effective monitor when a small to moderate increase in emissions is of concern**

Baghouse Monitoring Device Triboelectric Sensor

- **Establish baseline**
- **Monitor detects gradual or instantaneous increases in the signal from baseline**
- **Baseline emissions can be as low as 0.1 mg/dscm (0.00005 gr/dscf)**

Inspection Procedures Fans/Blowers

- **Horsepower**
- **Number of Engines**

Control Scavenger System

- ▶ Collects fugitive emissions from:
 - ✓ Hot aggregate elevator
 - ✓ Vibrating screens
 - ✓ Hot bins



Control Asphalt Binder Storage

- ▶ May or may not be controlled
- ▶ Controls include
 - ✓ Condensers,
 - ✓ Vapor recovery system (similar to gas station)
 - Vapors returned to refinery for incineration
- ▶ Delivery truck lines are flushed with non-hazardous cleaners

CARB 246
Aggregate, Concrete Batching, and Hot Mix Asphalt Operations



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**Control
Blue Smoke**



**Control
Blue Smoke**



➡ **An aerosol
of
condensed
organic
particles
adsorbed
to dust or
water
particles**

Control Blue Smoke

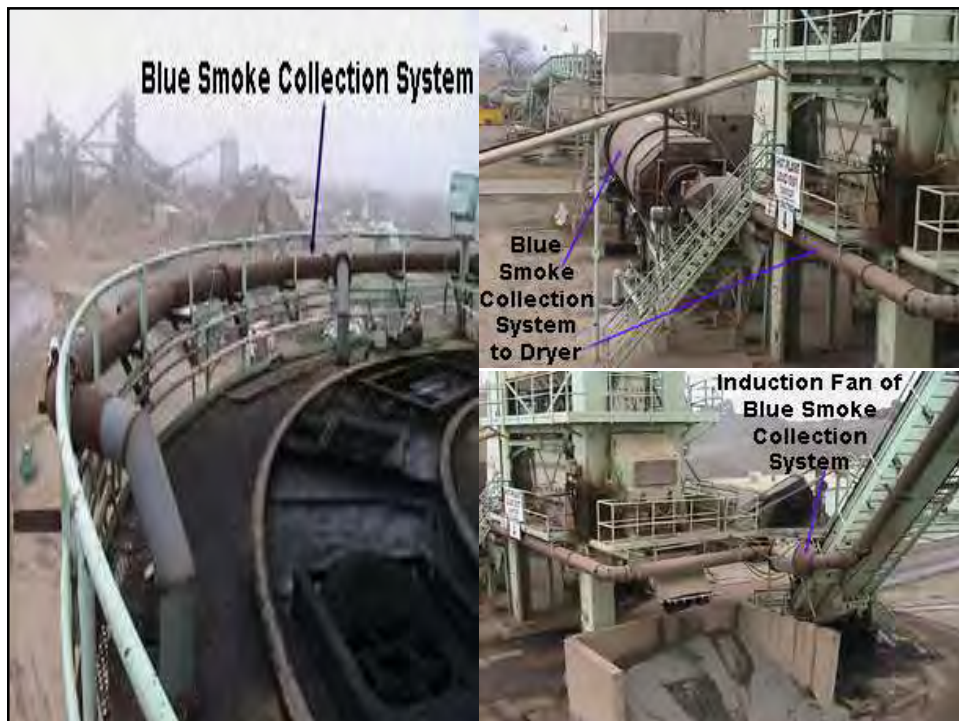
- Some organic compounds begin to
 1. vaporize at 300 F
 2. Condense in ambient air
 3. Adsorb to dust and water particles
- To form visible emissions
- Visible emissions are formed until the air becomes saturated



Control Blue Smoke Emissions Points

- Drop points of HMA from pugmill
- On top of surge bins/silos
- At the base of surge bins/silos
- Drag slat conveyors
- Truck load out

- Challenge to capture and control
- Primary reason for complaints
- Perception !!



CARB 246 Aggregate, Concrete Batching, and Hot Mix Asphalt Operations



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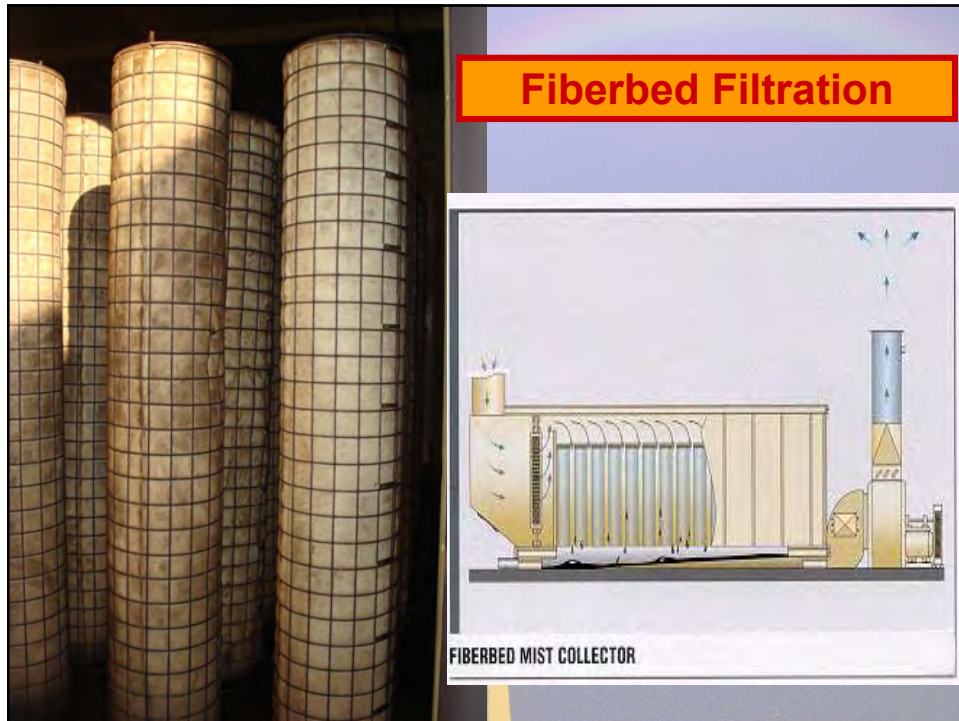
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Control of Blue Smoke Truck Entrance



Control Blue Smoke Enclosed Load Out



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Control Side View of HMA Drop with ESP/Smog Hog for Blue Smoke

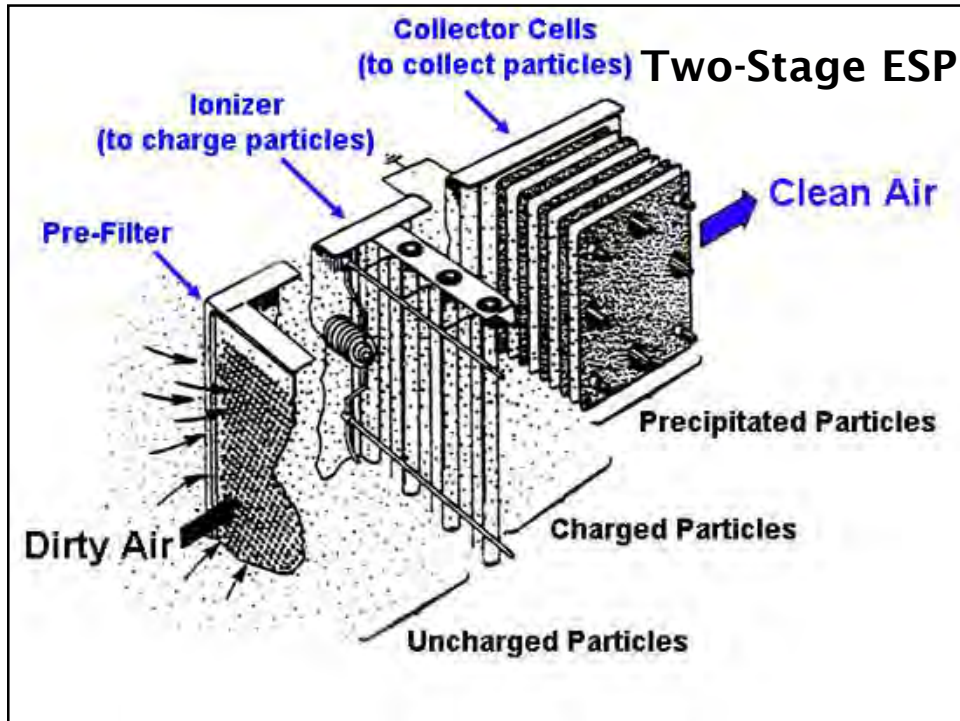


Control Ducting to ESP/Smog Hog



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Controls Innovations in HMA Production

- ➡ Four areas where the technology has improved
 - ✓ burner design,
 - ✓ fuels,
 - ✓ dryer/drum design, and
 - ✓ blue smoke controls

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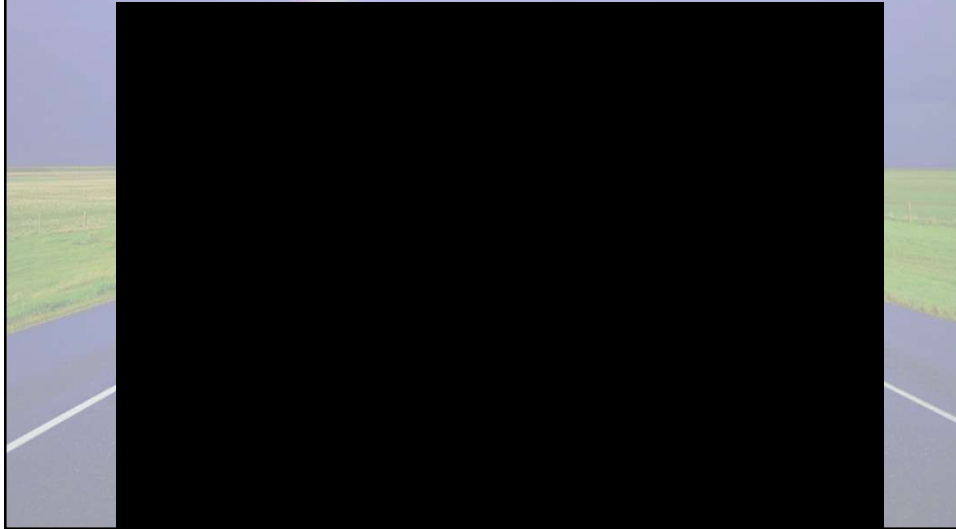
Controls
Triple-Drum Mixer



ASPHALT SEAL COAT AND PAVING
Reading a Moving Plume



Moving Source



Permit Conditions



- ➡ **Emission Controls**
 - ✓ **Emission Limits**
 - ✓ **Process Limits**
 - ✓ **Emission Rate Limits**
 - ✓ **Requirements to Minimize Emissions**
 - ✓ **Source Test**
 - ✓ **CAM (gauges on baghouse)**

Permit Conditions (cont'd)



➡ Fuel Requirements

- ✓ Type
- ✓ Nitrogen or Sulfur content
- ✓ Amount of fuel
- ✓ Type of backup fuel
- ✓ Method of measurement
- ✓ Recordkeeping of fuels purchased and used

Permit Conditions (cont'd)



➡ Visible Emissions Limits

- ✓ NSR lists are 20% or No. 1 on Ringleman
- ✓ Sources permitted before NSR maybe 40% or No. 2 on Ringleman

Process/Control Dry Collection Systems



➡ Baghouses are regulated in terms of

✓ Source Test Requirements and Methods

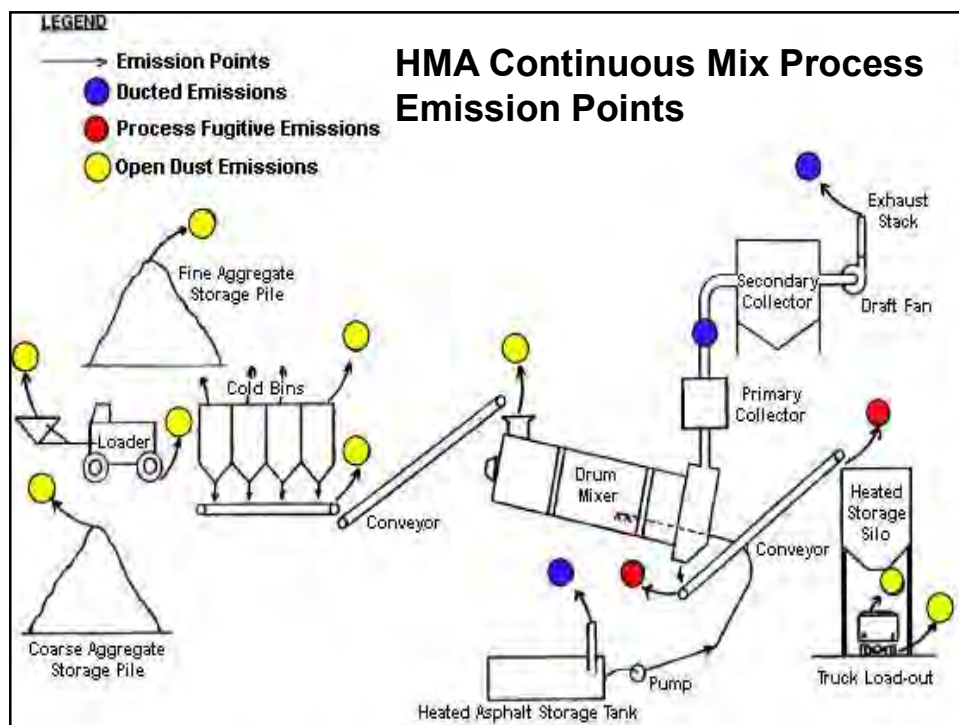
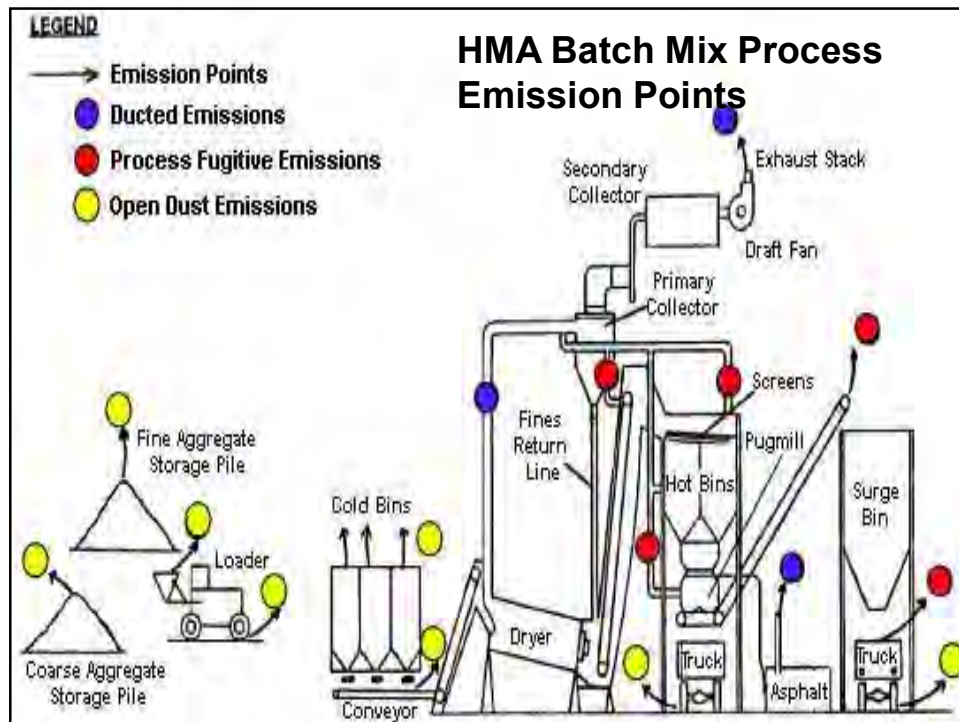
✓ Visual Test Method?

Permitting/Inspection HMA Source Test



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Aggregate, Concrete Batching, and Hot Mix Asphalt Operations



Permit/Inspection Objectives



**Determine compliance with
Local rules, State laws,
Federal regulations
& permit conditions**

- **Fugitive emissions**
- **Stack emissions**
- **Visible emission tests**
- **Oxides of nitrogen (for
fuel burning equipment)**