Introduction

Industry Background
- Over 125 Hot Mix Asphalt (HMA) facilities in CA
  - 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

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, NOx, SOx, VOCs and other toxic substances.

NOx and VOCs are Ozone (O₃) precursors each reacts with sunlight to form O₃.
### Emissions/Effects

<table>
<thead>
<tr>
<th>Typical HMA Pollutants</th>
<th>Emissions (tons/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM (total for all size categories)</td>
<td>1500</td>
</tr>
<tr>
<td>PM10</td>
<td>700</td>
</tr>
<tr>
<td>PM2.5</td>
<td>400</td>
</tr>
<tr>
<td>CO</td>
<td>800</td>
</tr>
<tr>
<td>NOx</td>
<td>450</td>
</tr>
<tr>
<td>Total Organic Compounds</td>
<td>200</td>
</tr>
<tr>
<td>Reactive Organic Gas</td>
<td>200</td>
</tr>
<tr>
<td>SOx</td>
<td>100</td>
</tr>
<tr>
<td>VOCs</td>
<td>200</td>
</tr>
</tbody>
</table>

### Emissions/Effects

**AB 2588 Emission Inventory**
- Requires HMA facilities to submit an emission inventory
- HMA emit 78 of the 730 listed “Toxic Substances”

**Emission Estimates**
- US EPA, AP-42;
- District; or
- Source Test

### Emissions/Effects

**Criteria and Precursor Pollutants**
- Created during production, storage, and transport of HMA
- PM from aggregate
Emissions/Effects

Criteria and Precursor Pollutants (cont.)
- PM, CO, NOx, VOCs, and SOx from fuel combustion and storage of asphalt binder and HMA
- Blue Smoke (VOCs) from production and loading

Process/Control

Hot Mix Facilities are Regulated Under Subpart OOO
- How much aggregate is processed
- Moisture content of the processed material
- Control efficiency of the air pollution control equipment
- Opacity

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

Process Composition of HMA
- Binder
- Filler
- Aggregate

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)

Process Binder Composition

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Process

Asphalt Grading

- Two grading methods
  - Viscosity Grading of Binder
  - Superpave Performance Grade (PG)

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)

Viscosity Grading of Binder (cond.)

- 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

Process
Polymer Modified Binders
- Proprietary blends added to bitumen
- Formula varies depending on desired result of end product
Filler
- Dust added to asphalt binder and aggregate to improve adhesion

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

Recipe for Hot Mix Asphalt
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

Anit-stripping Agents

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

Process

Alternative Binders

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

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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)

Advantages of Crumb Rubber

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

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

Process

RECIPE FOR RECYCLED HOT MIX
Process
In the News

- Watch for 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

Process
HMA Facility Types

- Batch
- Continuous Mix

Process
Batch Mix

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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

Process
Cold Bins
Aggregate Stockpiles
Batch Process
(continued)

- Hot aggregate dropped from elevator to vibrating screens, sorted by size
- Weighed, and dropped into pugmill for mixing with
- Hot liquid asphalt binder and filler until coated
- Dropped into truck for delivery

Process

Batch Facility Flow Chart

Batch Process
Hot Aggregate Conveyor to Pugmill

Pugmill
Conveyor from Dryer

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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
Continuous Mix 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 versus vertical
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Aggregate, Concrete Batching, and Hot Mix Asphalt Operations

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
Control Aggregate

- Wind-blown dust
- Fugitive dust
- Common Control methods

Process

Cold Bin Dust Collection System

- Design and installation
- Maintenance and operation
- Compliance with regulations
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.

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.
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
Wet Scrubber?

Process/Control
Wet Scrubber

- Used to control stack emissions
  - Must meet the emission requirements specified in Subpart OOO
  - Continuous emissions pressure monitor
    - \(+ 250\) pascals \(+ 1\) inch water gauge pressure
  - Continuous measurement of scrubbing liquid flow rate to 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
Particulate 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

Wet Scrubber Operation

- Particles collected by impaction
- Gasses collected by diffusion & absorption

Scrubber Liquor
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
Measuring Pressure Drop

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
Secondary Control
PM Control Techniques – Fabric Filter

Factors affecting efficiency
- Filter media
  - Abrasion
  - High temperature
  - Chemical attack
- Gas flow
- Broken or worn bags

(continued)
- Cleaning system failure
- Leaks
- Re-entrainment
- Damper or discharge equipment malfunction
- Corrosion
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 (continued)

- 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 (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**

What's wrong with this picture?

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Baghouse Monitoring
Triboelectric Sensor

- TESs are a newer technology
  - Primary use cement, coal fired power plants, and food manufacturing
  - US EPA encouraging 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 as BACT or compliance measurement tool

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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.

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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
Monitoring Device
Triboelectric Sensor

- TES work 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

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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 loadout
- Challenge to capture and control
- Primary reason for complaints
- Perception !!
Controls
Innovations in HMA Production

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

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

Permit Conditions cont.

- 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.

- 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?

Process/Control
Wet Scrubber

- Used to control stack emissions
  - Must meet the emission requirements specified in Subpart OOO
  - Continuous emissions pressure monitor
    - + 250 pascals + 1 inch water gauge pressure
  - Continuous measurement of scrubbing liquid flow rate to scrubber

Permitting/Inspection
HMA Source Test
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Aggregate, Concrete Batching, and Hot Mix Asphalt Operations

Control Equipment
Emission Points from Batch Facilities
HMA Batch Mix Process
Emission Points

Emission Points from Continuous Feed HMA Continuous Mix Process
Emission Points

Permit/Inspection Objectives
Determine compliance with District, Federal regulations & permit conditions
- Fugitive emissions
- Stack emissions
- Visible emission tests
- Oxides of nitrogen (for fuel burning equipment)