Warm Mix Asphalt: the green pavement
Plant AND field (application) emissions

Plant emissions are mainly combustion-related AND sometimes odors

Field emissions are from hot asphalt “fume” AND diesel exhaust (equipment and traffic)
what are plant emissions?
Plant emissions are mainly combustion-related
- Based on production rate / fuel consumption
- Used in setting permissible limits under CAA
  - SOx = acid rain
  - NOx = ozone precursor
  - VOCs = ozone precursor + HAP + perception
  - CO – indication of burner efficiency
  - Particulates (dust)
  - CO2 = greenhouse gases
- Measured by “stack test”
- Detailed procedures at warmmixasphalt.com
Stack testing plant emissions
Stack testing plant emissions
Hot mix emissions values well-established AND controlled

- CO2, NOx, SOx, VOCs, CO, particulates

Various control systems (baghouse, LNBs)

HMA plants NOT considered as “Major Sources” of Criteria Pollutants under CAA

Still, total amount of annual emissions . . .

- CO2 emissions @ 2,500 tons per year

- Others MUCH less, but still @ tons

what are plant emissions?
what are field emissions?
Field emissions are from hot asphalt “fume” AND diesel exhaust (equipment and traffic)

Based on mix (binder) temperature **, binder type, weather (temp, humidity etc)

Measured by industrial hygiene (IH) monitoring

Detailed procedures at warmmixasphalt.com
sampling field emissions
what are field emissions?

- Used in ensuring safe worker environments
- “Regulatory” levels well-established
  - TLV measured as “asphalt fume BSM” – solvent extracted organic particulate
  - TLV @ 0.5 mg/m³ → equivalent to ~ 2 mg total inhaled for the work-day
- Compared to stack emissions . . .
- !! Exposure significant lower w/ paver controls !!
Reducing fuel consumption is win-win – saves $$$

Reducing field emissions improves the workplace and public’s perception of asphalt paving.

Reducing plant odor improves community relations.

Reducing plant emissions is also worth $$$

- May encourage higher production rates – how?
- Might be traded (e.g., NOx, CO2)
- Will be attractive to a State’s Implementation Plan (SIP)
  - allows state to meet Fed obligations easier
  - helps in non-attainment areas
  - e.g., NJ requiring LNBs @ $150K + op costs

Reducing emissions

*reducing emissions*
- R&D projects (pre ~ 2005)
  - Limited data, uncertain quality
- FHWA / TWG demo projects (~ 2006 and beyond)
  - Consistent emissions protocols developed
  - Assessments when project $$ available
    - ~ $3K – $5K for stack testing;
    - ~ $5K - $7K for IH sampling
- Vendor provided
  - Not necessarily consistent w/ TWG protocol
- European Scan Tour (2007)
  - Sparse data
- NCHRP 9-47
  - Lack of emissions data noted
Warm-Mix Asphalt: European Practice

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European Scan Tour (2008)
Difficult for direct comparisons

Different countries have different measurements

“significant reductions compared to HMA”

“appear to result in a 30 to 50 percent reduction”

“... indicate even larger reduction”

“lower mix temperatures also provide a more comfortable working environment”
Table 4. Reported reductions in plant emissions (percent) with WMA.\(^{10, 11, 12}\)

<table>
<thead>
<tr>
<th>Emission</th>
<th>Norway</th>
<th>Italy</th>
<th>Netherlands</th>
<th>France</th>
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<td>30–40</td>
<td>15–30</td>
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<td>NO(_x)</td>
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<td>18*</td>
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<tr>
<td>Dust</td>
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<td>NA</td>
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*Reported as NO\(_2\)*  
NA—not available

Reported fuel reduction @ 20 – 35%
Scan Tour: graphical stack results
Table 4. Reported reductions in plant emissions (percent) with WMA.\textsuperscript{(10, 11, 12)}

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Reported fuel reduction @ 20 – 35%
Limited Data to Date

Fuel consumption: ~ 10 – 25% reduction

Possibly burner tuning issues

SO2 : up to 70% reduction; some increases

NOx : up to 30% reduction

CO2 : up to 40% reduction; some increases

VOCs : up to 60% reduction; some increases

CO : up to 60% reduction

Bottom line: substantial reductions in all emission including CO2; but variable; need data

FHWA demos: stack results
Consistently > 50% reduction in fume emissions
When measured close to the source
Majority of “non-detect” for personal samplers
Indicates that lowering the mix temperature, substantially reduces occupational emissions
loadout emissions
More data; reduces variability

- May be significant effort to obtain data $$

Consistent protocols and measured parameters

- Different analysis methods produce different results (magnitude & reduction)
  - e.g., Method 25, vs 25A, vs 25Aap

- Tuning burners to operate at lower temps
- Reduces occupational exposure
- Saves $$ by reducing fuel consumption
- Improves the workplace and public’s perception of asphalt paving
- Improves community relations (odor)
- Easier to meet permitted levels of emissions (plant and paving)
- Offsets might be directly traded $$$
- More favorable operating conditions
  - Higher production rates; less LNB controls
- Attractive to states for SIPs, non-attainment
- Reduces GHG emissions
urban development – driving green
auto exhaust – driving green
Intergovernmental Panel on Climate Change (IPCC) assesses that global surface air temperature could increase by 2.5 to 10 degrees Celsius by the year 2100. The magnitude of projected climate change will depend on both natural climate variability and the response of the climate system to human choices about emissions.

Future climate depends on natural changes and human activities.
climate change – driving green
climate change – driving green
climate change – driving green
Massive regulatory’ (EPA), legislative (Congress), and public effort

- Costs of fuel will increase

Cap-and-trade **could** help HMA plants

- Trading carbon credits across HMA plants
- But unlikely that plants can participate (25K)

Still – states will look for aggregated reductions

- Solely based on fuel consumption / reduction

Bob Frank’s visual effort

World Bank’s UN-sanctioned effort
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http://www.pahotmix.org/images/bobfrank.swf

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Bottom line: methodology shows 10 – 15% fuel reduction (lower reduction at higher moisture)

Can we “document” greater reductions ??
- CO2 emissions data: fuel reduction / theoretical C
  - Done deal, but actual values are helpful
- NOx will be a big driver . . . Non-attainment
- Formaldehyde also of interest to states

- Large trials ??? – we need you assistance
  - Let us know; let NCAT know; let someone know
  - Liquid fuel gauges are available
  - Natural gas is easiest
questions ?