Characterization of Cotton Gin Particulate Matter Emissions

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Background

- 2006 – EPA implemented more stringent rules for PM$_{2.5}$
- State Implementation Plans may assume that PM$_{2.5}$ emissions from cotton gins warrant further study and additional control measures
- Primary issues surrounding particulate matter regulations for cotton gins
  - 1) limited or lack of PM$_{2.5}$ data
  - 2) over-prediction of current dispersion models
  - 3) effects of sampler errors
Background

- All cotton gins across the cotton belt will eventually be impacted by this standard.

- The cotton ginners’ associations across the cotton belt,
  - National, California, Texas, Southern, and Southeastern associations
  agreed that there is an urgent need to collect gin emission data to address these issues.
Study Objectives

- Develop PM$_{2.5}$ gin emission factors and verify current PM$_{10}$ & TSP emission factors
- Develop robust particulate matter emissions data sets for design, development, and evaluation of current and future air quality dispersion models.
- Characterize the particulate matter emitted from cotton gins across the cotton belt in terms of particle size distribution, particle density, and particle shape.
- Collect field data to further quantify PM$_{10}$ and PM$_{2.5}$ EPA federal reference method stack and ambient sampler errors.
Emission Factors – Stack Sampling

Current Regulatory PM$_{2.5}$ Estimates $\sim 36\%$ of TSP

Current USDA-ARS PM$_{2.5}$ Estimates $\sim < 5\%$ of TSP
Dispersion Modeling

Current models are estimated to over-predict by a factor of 10.
PM Characteristics

#1 A & B Stick Machine
{Based on Method 5 filter PSD}
MMD = 6.4 µm
GSD = 1.8
PM$_{10}$ = 78.3%
PM$_{2.5}$ = 4.89%

Feeder Dust
{Based on Method 5 filter PSD}
MMD = 6.0 µm
GSD = 1.6
PM$_{10}$ = 86.3%
PM$_{2.5}$ = 3.29%
Errors Associated with PM Stack & Ambient Samplers

<table>
<thead>
<tr>
<th>Source</th>
<th>PM$_{10}$ Over-Sampling Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton Gin</td>
<td>181 %</td>
</tr>
<tr>
<td>Cattle Feed Yard</td>
<td>185 %</td>
</tr>
<tr>
<td>Almond Harvesting</td>
<td>139 %</td>
</tr>
</tbody>
</table>

**Study Results**

<table>
<thead>
<tr>
<th></th>
<th>PM$_{10}$ Over-Sampling</th>
<th>PM$_{2.5}$ Over-Sampling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limestone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rate = 32 g/m$^3$</td>
<td>123%</td>
<td>700%</td>
</tr>
<tr>
<td>Rate = 148 g/m$^3$</td>
<td>133%</td>
<td>608%</td>
</tr>
<tr>
<td>Starch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rate = 32 g/m$^3$</td>
<td>477%</td>
<td>30000%</td>
</tr>
<tr>
<td>Rate = 148 g/m$^3$</td>
<td>444%</td>
<td>25316%</td>
</tr>
</tbody>
</table>

*Limestone - MMD = 7.3 μm ESD; GSD = 1.71; ρ = 2.52 g/cm$^3$  
*Starch - MMD = 15.1 μm ESD; GSD = 1.33; ρ = 1.26 g/cm$^3$
Stack Sampling
Stack Sampling

PM2.5
PM10
TSP
Ambient Sampling

- Tower Samplers
- Stand – Alone Samplers

~200 feet
~200 feet
~200 feet
~250 feet
~250 feet
~250 feet
30°
Ambient Setup
2 Tower Sites:
1 – TEOM
2 – PM10 Samplers
2 – PM2.5 Samplers
1 - Tower

2 Tower Sites:
1 – TEOM
1 – PM10 Sampler
1 – PM2.5 Sampler
1 - Tower

8 Tower Sites:
1 – PM10 Sampler
1 – PM2.5 Sampler
1 - Tower
Ambient Sampling

22 Stand Alone Sites: (Target)
1 – TSP Sampler
Progress

- Planning & Preparation
- Sampling
  - New Mexico Gin
  - “South” Texas Gin
  - California Saw Gin
  - California Roller Gin
- Sample Analysis – NM, TX, & CA
  - Filters
  - Washes
Murphy’s Law
Murphy’s Law
Murphy’s Law
Murphy’s Law
Murphy’s Law
Murphy’s Law
Future Work

- West Texas Gin - 2010
- Missouri Gin - 2010
- North Carolina Gin - 2011