CHARACTERIZATION OF COTTON GIN PM_{10} EMISSIONS BASED ON EPA STACK SAMPLING METHODOLOGIES AND PARTICLE SIZE DISTRIBUTIONS

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Abstract

A project to characterize cotton gin emissions in terms of stack sampling was conducted during the 2008 through 2011 ginning seasons. The impetus behind the project was the urgent need to collect additional cotton gin emissions data to address current regulatory issues. EPA AP-42 emission factors are generally assigned a rating that is used to assess the quality of the data being referenced. The ratings can range from A (Excellent) to E (Poor). EPA current PM_{10} emission factor quality ratings for cotton gins are extremely low. Cotton gins received these low ratings because the data was collected almost exclusively from a single geographical region. The objective for this study was to collect additional PM_{10} emission factor data for cotton gin systems in regions across the cotton belt based on the EPA approved stack sampling methodologies: Other Test Method 27; Method 201A; and a method that uses Method 17 concentrations multiplied by the percent less than 10 microns determined by the particle size analysis of the Method 17 filter and wash retrieved from each run. Emission factors were developed for 17 different ginning systems including: unloading, 1st stage seed-cotton cleaning, 2nd stage seed-cotton cleaning, 3rd stage seed-cotton cleaning, overflow, 1st stage lint cleaning, 2nd stage lint cleaning, combined lint cleaning, cyclone robber, 1st stage mote, 2nd stage mote, combined mote, mote cyclone robber, mote cleaner, mote trash, battery condenser and master trash. Results showed discrepancies between the various methods (Figure 1). These discrepancies were attributed to the cotton fibers and large particles in the exhaust stream impacting the performance of the PM_{10} sizing cyclone. Figure 2 compares the average of the EPA stack sampling methodologies, Method 17 and particle size method, and AP-42 emission factor estimates. Combining the measured emission factors for systems that represent a typical gin in AP-42 (Table 1), the typical AP-42 gin PM_{10} emission factor based on EPA approved methodologies was 0.987 lb/bale; about 20% higher than the current AP-42 value of 0.817 lb/bale. If the test results were merged with AP-42, in most cases more than tripling the size of the dataset, the merged PM_{10} emission factor for the typical AP-42 gin would be 0.926 lb/bale; about 13% higher than the current AP-42 value. In Table 2 the PM_{10} emission factors based multiplying the Method 17 concentrations by the percent less than 10 microns obtained from the particle size analysis was compared to emission factors obtained from Method 201A and OTM27 and current AP-42 values for a typical gin. The Method 17 and particle size analysis PM10 emission factor for a typical gin was 0.66 lb/bale; about 33% less than the emission factor determined from Method 201A and OTM27 and about 20% lower than current AP-42 emission factor estimates. These substantial differences were attributed to the cotton fiber and larger particles impacting the PM_{10} sizing cyclone. Additional information can be found in technical reports at http://buser.bioen.okstate.edu/air-quality/national-cotton-gin-technical-reports.

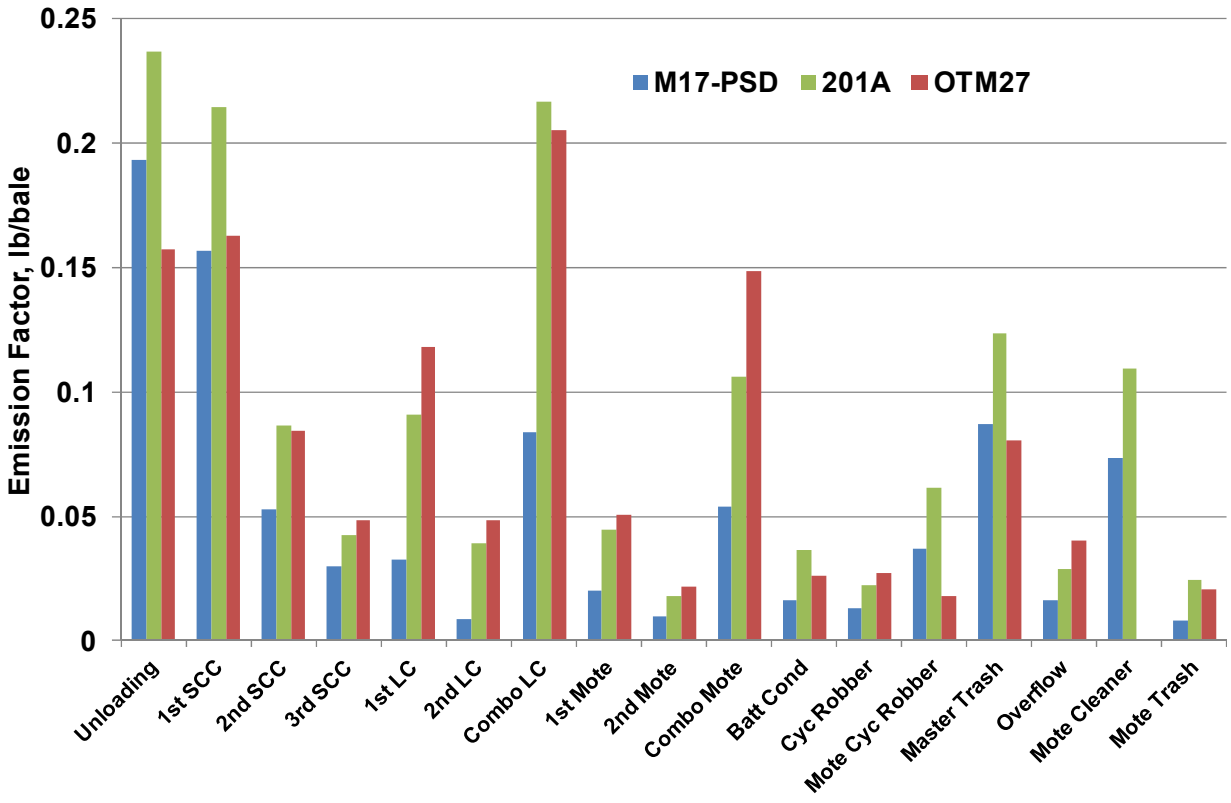

Figure 1. Average measured PM_{10} emission factors from EPA Method 17 multiplied by the percent less than 10 microns from the particle size analysis, Method 201A with only the PM10 sizing cyclone, and Method 201A with both the PM_{10} and $PM_{2.5}$ sizing cyclones.

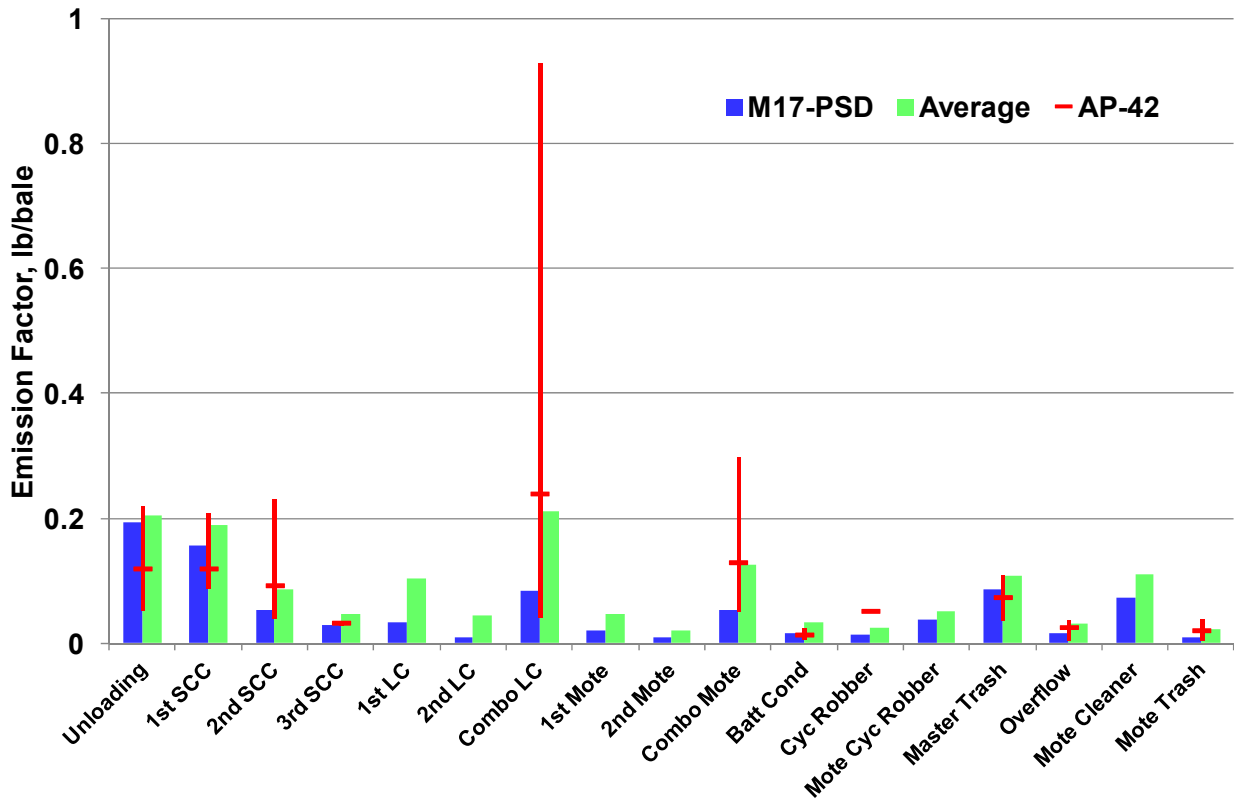

Figure 2. Average measured PM_{10} emission factors compared to EPA AP-42 emission factor averages (horizontal, red bars) and ranges (vertical, red error bars).

Table 1. Average measured PM_{10} emission factors from EPA approved stack sampling methodologies compared and merged with EPA AP-42 emission factors.

	Unloading	1st SCC	2nd SCC	Combo LC	Combo Mote	Batt Cond	Master Trash	Overflow	AP-42 Typical Gin
Test	0.205	0.188	0.086	0.211	0.126	0.032	0.107	0.032	0.987
No. of Tests	5	14	9	13	13	10	8	4	
AP-42	0.124	0.121	0.093	0.238	0.130	0.014	0.074	0.026	0.817
No. of Tests	5	5	5	6	6	5	2	4	
Difference									
Test-AP-42	65%	55%	-8%	-11%	-3%	127%	45%	21%	20%
Test Data Merged with AP-42 Data									
EF (lb/bale)	0.165	0.171	0.088	0.219	0.127	0.026	0.101	0.029	0.926
Change	32%	41%	-5%	-8%	-2%	84%	36%	10%	13%
No. of Tests	10	19	14	19	19	15	10	8	

Table 2. Average and comparison of PM_{10} emission factors from EPA approved stack sampling methodologies, Method 17 concentrations multiplied by the percent less than 10 microns from the particle size analysis, and EPA AP-42 emission factors.

	Unloading	1st SCC	2nd SCC	Combo LC	Combo Mote	Batt Cond	Master Trash	Overflow	AP-42 Typical Gin
PM_{10} Estimates									
PSD	0.193	0.156	0.053	0.084	0.054	0.016	0.087	0.016	0.660
Test	0.205	0.188	0.086	0.211	0.126	0.032	0.107	0.032	0.987
AP-42	0.124	0.121	0.093	0.238	0.130	0.014	0.074	0.026	0.820
Difference									
PSD - EPA	-6%	-17%	-38%	-60%	-57%	-49%	-19%	-50%	-33%
PSD-AP42	55%	29%	-43%	-65%	-59%	15%	18%	-39%	-20%