

## ENGINEERING AND GINNING

### Mote Trash System PM<sub>10</sub> Emission Factors and Rates for Cotton Gins: Method 201A PM<sub>10</sub> Sizing Cyclones

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#### ABSTRACT

**This report is part of a project to characterize cotton gin emissions from the standpoint of stack sampling. The impetus behind this project was the urgent need to collect additional cotton gin emissions data to address current regulatory issues. A key component of this study was focused on EPA emission factors for particulate matter with a particle diameter nominally less than or equal to 10 µm (PM<sub>10</sub>). The 1996 EPA AP-42 emission factors were assigned quality ratings, from A (Excellent) to E (Poor), to assess the quality of the data being referenced. Emission factor quality ratings for cotton gins were extremely low. Cotton gin data received these low ratings because they were collected almost exclusively from a single geographical region. The objective of this study was to collect additional PM<sub>10</sub> emission factor data for mote trash systems at cotton gins located in regions across the cotton belt based on EPA-approved stack sampling methodology, Method 201A. The project plan included sampling seven cotton gins across the cotton belt. Key factors for selecting specific cotton gins included: 1) facility location, 2) production capacity, 3) processing systems, and 4) abatement technologies. Two of the seven gins had mote trash systems where the exhaust airstreams were not combined with other major systems. In terms of capacity, the two gins were typical of the industry, averaging 32.4 bales/h during testing. The mote trash system average emission factors for PM<sub>10</sub> and**

**total particulate were 0.011 kg/227-kg bale (0.025 lb/500-lb bale) and 0.021 kg/bale (0.046 lb/bale), respectively. The system average PM<sub>10</sub> emission factor was higher and the system average total particulate emission factor was lower than those currently published in EPA AP-42. Mote trash system PM<sub>10</sub> emission rate test averages ranged from 0.32 to 0.37 kg/h (0.72-0.81 lb/h). The ratio of mote trash system PM<sub>10</sub> to total particulate was 53.2%.**

U.S. Environmental Protection Agency (EPA) emission factors published in EPA's Compilation of Air Pollution Emission Factors, AP-42 (EPA, 1996b) were assigned a rating that is used to assess the quality of the data being referenced. Ratings can range from A (Excellent) to E (Poor). Current EPA emission factor quality ratings for particulate matter with a particle diameter less than or equal to a nominal 10-µm (PM<sub>10</sub>) aerodynamic equivalent diameter from cotton gins are extremely low. Cotton gin data received these low ratings because they were collected almost exclusively from a single geographical region (EPA, 1996a). Cotton ginners' associations across the cotton belt, including the National, Texas, Southern, Southeastern, and California associations, agreed that there was an urgent need to collect additional cotton gin emissions data to address current regulatory issues. Working with cotton ginning associations across the country, state and federal regulatory agencies, Oklahoma State University, and USDA-Agricultural Research Service (ARS) researchers developed a proposal and sampling plan that was initiated in 2008 to address this need for additional data. This report is part of a series that details cotton gin emissions measured by stack sampling. Each manuscript in the series addresses a specific cotton ginning system. The systems covered in the series include: unloading, 1<sup>st</sup> stage seed-cotton cleaning, 2<sup>nd</sup> stage seed-cotton cleaning, 3<sup>rd</sup> stage seed-cotton cleaning, overflow, 1<sup>st</sup> stage lint cleaning, 2<sup>nd</sup> stage lint cleaning, combined lint cleaning, cyclone robber, 1<sup>st</sup> stage mote, 2<sup>nd</sup> stage mote, combined mote, mote cyclone robber, mote

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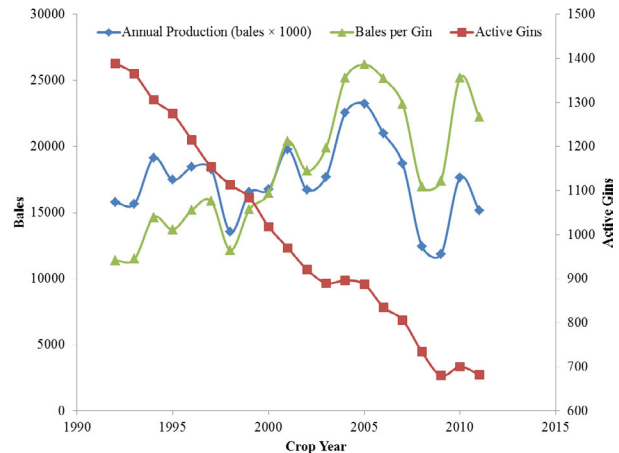
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cleaner, mote trash, battery condenser, and master trash. This report focuses on PM<sub>10</sub> emission from mote trash systems.

The 1996 EPA AP-42 average PM<sub>10</sub> emission factor for the mote trash fan was 0.0095 kg (0.021 lb) per 217-kg (480-lb) equivalent bale with a range of 0.0021 to 0.018 kg (0.0046-0.040 lb) per bale (EPA, 1996a, b). This average and range was based on three tests conducted in one geographical location and the EPA emission factor quality rating was D, which is the second lowest possible rating (EPA, 1996a). The AP-42 average total particulate emission factor for the mote trash fan was 0.035 kg (0.077 lb) per bale with a range of 0.025 to 0.051 kg (0.055-0.11 lb) per bale. This average and range was based on three tests conducted in one geographical location and the EPA emission factor quality rating was also D.

Seed cotton is a perishable commodity that has no real value until the fiber and seed are separated (Wakelyn et al., 2005). Cotton must be processed or ginned at the cotton gin to separate the fiber and seed, producing 227-kg (500-lb) bales of marketable cotton fiber. Cotton ginning is considered an agricultural process and an extension of the harvest by several federal and state agencies (Wakelyn et al., 2005). Although the main function of the cotton gin is to remove the lint fiber from the seed, many other processes also occur during ginning, such as cleaning, drying, and packaging the lint. Pneumatic conveying systems are the primary method of material handling in the cotton gin. As material reaches a processing point, the conveying air is separated and emitted outside the gin through a pollution control device. The amount of dust emitted by a system varies with the process and the condition of the material in the process.

Cotton ginning is a seasonal industry with the ginning season lasting from 75 to 120 days, depending on the size and condition of the crop. Although the trend for U.S. cotton production remained generally flat at about 17 million bales per year during the last 20 years, production from one year to the next often varied greatly for various reasons, including climate and market pressure (Fig. 1). The number of active gins in the U.S. has not remained constant, steadily declining to fewer than 700 in 2011. Consequently, the average volume of cotton handled by each gin has risen and gin capacity has increased to an average of approximately 25 bales per hour across the U.S. cotton belt (Valco et al., 2003, 2006, 2009, 2012).



**Figure 1.** Annual U.S. cotton production, active U.S. gins, and average ginning volume (bales per gin) (NASS, 1993-2012).

Typical cotton gin processing systems include: unloading system, dryers, seed-cotton cleaners, gin stands, overflow collector, lint cleaners, battery condenser, bale packaging system, and trash handling systems (Fig. 2); however, the number and type of machines and processes can vary. Each of these systems serves a unique function with the ultimate goal of ginning the cotton to produce a marketable product. Raw seed cotton harvested from the field is compacted into large units called “modules” for delivery to the gin. The unloading system removes seed cotton either mechanically or pneumatically from the module feed system and conveys the seed cotton to the seed-cotton cleaning systems. Seed-cotton cleaning systems assist with drying the seed cotton and remove foreign matter prior to ginning. Ginning systems also remove foreign matter and separate the cotton fiber from seed. Lint-cleaning systems further clean the cotton lint after ginning. The battery condenser and packaging systems combine lint from the lint-cleaning systems and compress the lint into dense bales for efficient transport. Cotton gin systems produce some type of by-products or trash, such as rocks, soil, sticks, hulls, leaf material, and short or tangled immature fiber (motes), as a result of processing the seed cotton or lint. These streams of by-products must be removed from the machinery and handled by trash collection systems. These trash systems typically further process the by-products (e.g., mote cleaners) and/or consolidate the trash from the gin systems into a hopper or pile for subsequent removal.

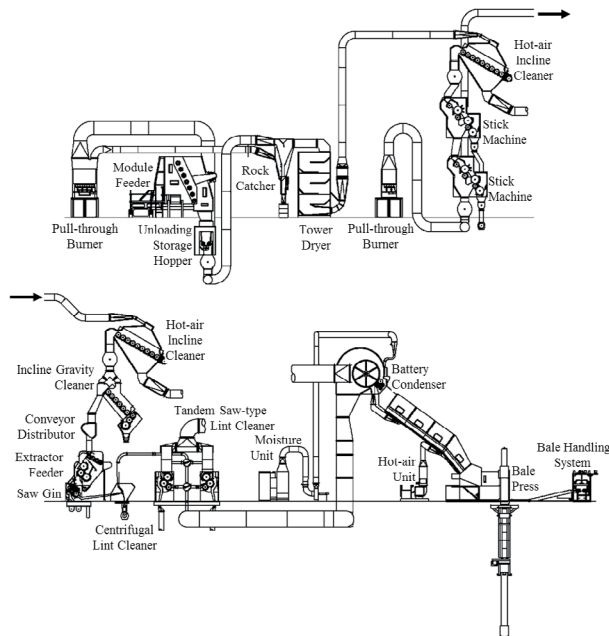


Figure 2. Typical modern cotton gin layout (Courtesy Lummus Corporation, Savannah, GA).

Material captured by cyclones that handle airstreams laden with greater amounts of lint (battery condenser, lint cleaning, and mote system cyclones), referred to as “motes”, have considerable value, especially when cleaned further in a device that removes much of the non-lint material. The cleaned motes typically drop directly into packaging machinery and the trash removed by the cleaner must be handled and conveyed by the mote trash system (Fig. 3). The mote trash is pulled by suction from the trash exit of the mote cleaner and pneumatically conveyed through a centrifugal fan to the mote trash cyclone. The material handled by the mote trash cyclone typically includes particulate, small leaf material, and lint fibers (Fig. 4).

Cyclones are the most common particulate matter abatement devices used at cotton gins. Standard cyclone designs used at cotton ginning facilities are the 2D2D and 1D3D (Whitelock et al., 2009). The first D in the designation indicates the length of the cyclone barrel relative to the cyclone barrel diameter and the second D indicates the length of the cyclone cone relative to the cyclone barrel diameter. A standard 2D2D cyclone (Fig. 5) has an inlet height of  $D/2$  and width of  $D/4$  and design inlet velocity of  $15.2 \pm 2$  m/s ( $3000 \pm 400$  fpm). The standard 1D3D cyclone (Fig. 5) has the same inlet dimensions as the 2D2D or might have the original 1D3D inlet with height of  $D$  and width  $D/8$ . Also, it has a design inlet velocity of  $16.3 \pm 2$  m/s ( $3200 \pm 400$  fpm).

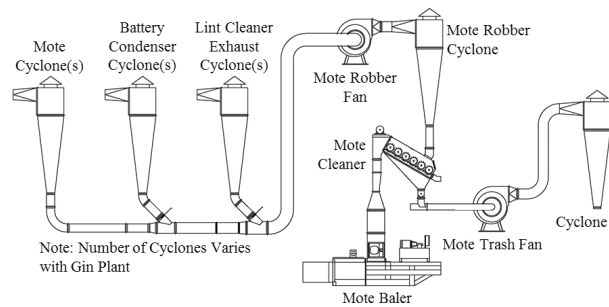


Figure 3. Typical cotton gin mote trash system layout (Courtesy Lummus Corporation, Savannah, GA).



Figure 4. Photograph of typical trash captured by the mote trash system cyclones.

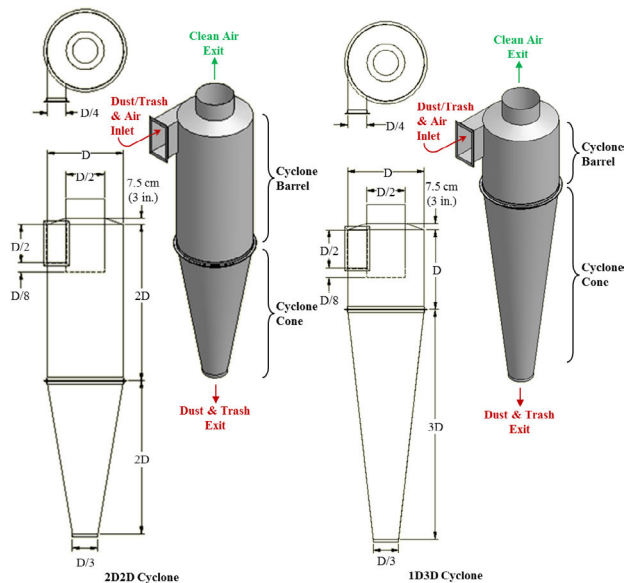


Figure 5. 2D2D and 1D3D cyclone schematics.

The objective of this study was to collect additional  $PM_{10}$  emission factor data for mote trash systems with cyclones for emissions control at cotton gins located in regions across the cotton belt based on EPA-approved stack sampling methodologies.

### METHODS

Two advisory groups were established for this project. The industry group consisted of cotton ginning industry leaders and university and government researchers. The air quality group included members from state and federal regulatory agencies and university and government researchers. These groups were formed to aid in project planning, gin selection, data analysis, and reporting. The project plan was described in detail by Buser et al. (2012).

Seven cotton gins were sampled across the cotton belt. Key factors for selecting specific cotton gins included: 1) facility location, 2) production capacity, 3) processing systems, and 4) abatement technologies. Operating permits, site plans, and aerial photographs were reviewed to evaluate potential sites. On-site visits were conducted on all candidate gins to evaluate the process systems and gather information including system condition, layout, capacities, and standard operation. Using this information, several gins from each selected geographical region were selected and prioritized based on industry advisory group discussions. Final gin selection from the prioritized list was influenced by crop limitations and adverse weather events in the region.

Based on air quality advisory group consensus, EPA Method 201A was used to sample the mote trash system at each gin. Method 201A was revised in 2010 to incorporate options for PM<sub>2.5</sub> (particulate matter with particle diameter less than or equal to a nominal 2.5- $\mu\text{m}$  aerodynamic equivalent diameter) sampling (CFR, 2010); these revisions did not affect the PM<sub>10</sub> stack sampling methodology used in this project. Method 201A is a constant sampling-rate procedure. For the PM<sub>10</sub> sampling methodology, the particulate-laden stack gas was withdrawn isokinetically (the velocity of the gas entering the sampler was equal to the velocity of the gas in the stack) through a PM<sub>10</sub> sizing cyclone and then collected on an in-stack filter (Fig. 6). The methods for retrieving the filter and conducting acetone washes of the sizing cyclone are described in detail in Method 201A (CFR, 2010). The mass of each size fraction was determined by gravimetric analysis and included: > 10  $\mu\text{m}$  (PM<sub>10</sub> sizing cyclone catch acetone wash) and  $\leq 10 \mu\text{m}$  (PM<sub>10</sub> sizing cyclone exit acetone wash and filter). The PM<sub>10</sub> mass was determined by adding the mass of particulates captured on the filter and the  $\leq 10 \mu\text{m}$  wash. Total particulate was determined by adding the PM<sub>10</sub> mass and the mass of the > 10  $\mu\text{m}$  wash.

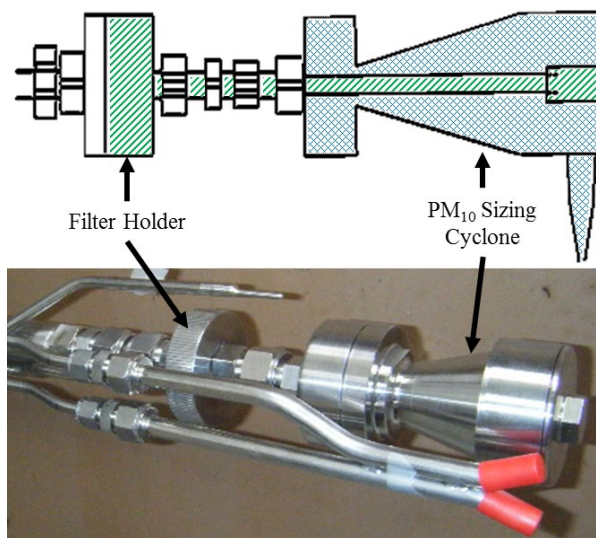


Figure 6. EPA Method 201A PM<sub>10</sub> sizing cyclone and in-stack filter holder schematic (CFR, 2010) and photograph ( $\leq 10 \mu\text{m}$ ,  $> 10 \mu\text{m}$ ).

Figure 7 shows the performance curves for the Method 201A sizing cyclones. To measure PM<sub>10</sub>, the method requires selecting a gas sampling nozzle to achieve a sampling rate that produces a cut size between 9.0 and 11.0  $\mu\text{m}$  at the stack gas temperature. For this study, Method 201A was specifically used to collect filterable PM<sub>10</sub> emissions (solid particles emitted by a source at the stack and captured in the  $\leq 10 \mu\text{m}$  wash and on the filter [CFR, 2010]).

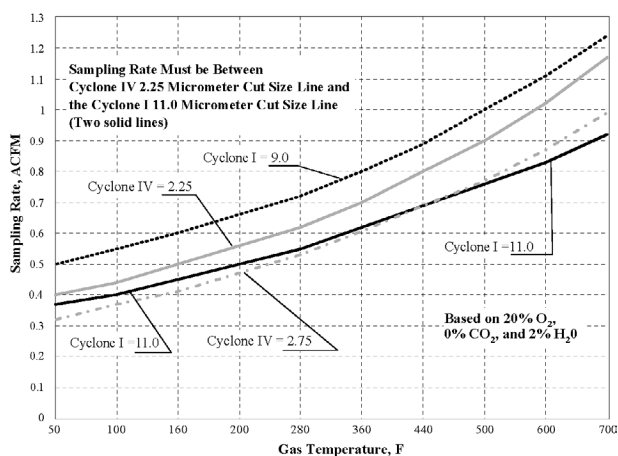


Figure 7. Acceptable sampling rate for sizing cyclones (CFR, 2010) Cyclone I = PM<sub>10</sub> sizing cyclone (gas temperatures for the mote trash systems tested ranged from 31 to 41°C (88-106°F)).

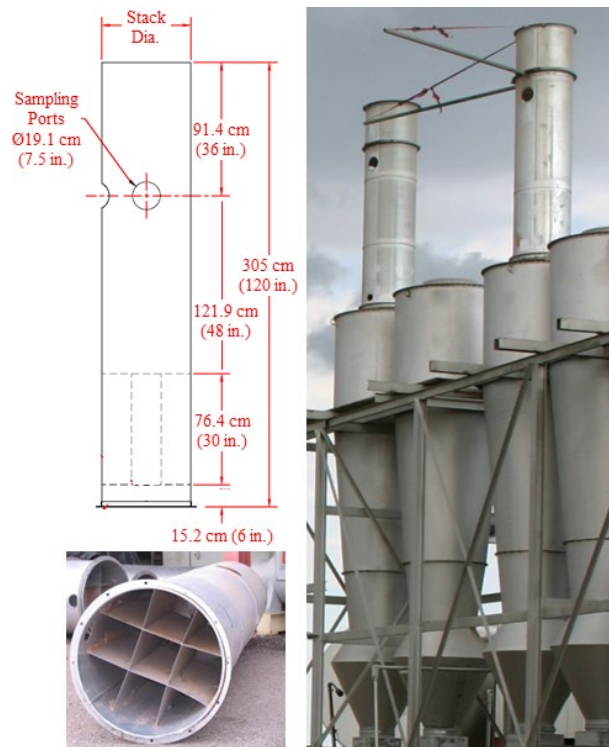
Only one stack from each mote trash system was tested. For systems with multiple stacks, it was assumed that emissions from each stack of the system were equivalent and the total emissions were calculated by multiplying the measured emission

rates by the total number of cyclones used to control the process tested (EPA, 1996a). To obtain reliable results, the same technician from the same certified stack sampling company (Reliable Emissions Measurements, Auberry, CA), trained and experienced in stack sampling cotton gins, conducted the tests at all seven cotton gins.

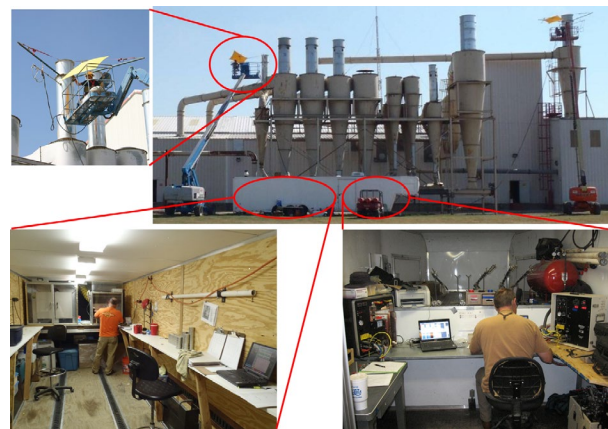
All stack sampling equipment, including the sizing cyclone, was purchased from Apex Instruments (Fuquay-Varina, NC) and met specifications of Method 201A. The sampling media were 47- $\mu$ m Zefluor filters (Pall Corporation, Port Washington, NY) and the sample recovery and analytical reagent was American Chemical Society certified acetone (A18-4, Fisher Chemical, Pittsburgh, PA; assay  $\geq$  99.5%). Filters and wash tubs with lids were pre-labeled, preweighed, and stored in sealed containers at the USDA-ARS Air Quality Lab (AQL) in Lubbock, TX, and then transported to each test site. Prior to testing, the certified stack testing technician calibrated and checked all sampling equipment according to EPA Method 201A.

Each cyclone selected for testing was fitted with a cyclone stack extension that incorporated two sampling ports (90° apart) and airflow straightening vanes to eliminate the cyclonic flow of the air exiting the cyclone (Fig. 8). The extensions were designed to meet EPA criteria (EPA, 1989) with an overall length of 3 m (10 ft) and sampling ports 1.2-m (48-in) downstream from the straightening vanes and 0.9-m (36-in) upstream from the extension exit.

The tests were conducted by the certified stack sampling technician in an enclosed sampling trailer at the base of the cyclone bank (Fig. 9). Sample retrieval, including filters and sampler head acetone washes, was conducted according to Method 201A. After retrieval, filters were sealed in individual Petri dishes and acetone washes were dried on-site in a conduction oven at 49°C (120°F) and then sealed with preweighed lids and placed in individual plastic bags for transport to the AQL in Lubbock, TX for gravimetric analyses. During testing, bale data (ID number, weight, and date/time of bale pressing) were either manually recorded by the bale press operator or captured electronically by the gin's computer system for use in calculating emission factors in terms of kg/227-kg bale (lb/500-lb bale). Emission factors and rates were calculated in accordance with Method 201A and ASAE Standard S582 (ASABE, 2005).



**Figure 8.** Schematic and photographs of stack extensions with sampling ports and straightening vanes (rail attached to extension above sampling port; at right, supports sampling probe during testing traverse).



**Figure 9.** Clockwise from top right: cotton gin stack sampling with air quality lab trailer and technicians on lifts; certified stack sampling technician in the trailer control room conducting tests; sample recovery in trailer clean room; technician operating the probe at stack level.

All laboratory analyses were conducted at the AQL. All filters were conditioned in an environmental chamber ( $21 \pm 2^\circ\text{C}$  [ $70 \pm 3.6^\circ\text{F}$ ];  $35 \pm 5\%$  RH) for 48 h prior to gravimetric analyses. Filters were weighed in the environmental chamber on a Mettler MX-5 microbalance (Mettler-Toledo Inc., Columbus, OH; 1  $\mu$ g readability and 0.9  $\mu$ g repeat-

ability) after being passed through an antistatic device. The MX-5 microbalance was leveled on a marble table and housed inside an acrylic box to minimize the effects of air currents and vibrations. To reduce recording errors, weights were electronically transferred from the microbalance directly to a spreadsheet. Technicians wore latex gloves and a particulate respirator mask to avoid contamination. AQL procedures required that each sample be weighed three times. If the standard deviation of the weights for a given sample exceeded 10 µg, the sample was reweighed. Gravimetric procedures for the acetone wash tubs were the same as those used for filters.

In addition to gravimetric analyses, each sample was visually inspected for unusual characteristics, such as cotton lint content or extraneous material. Digital pictures were taken of all filters and washes for documentation purposes prior to further analyses. After the laboratory analyses were completed, all stack sampling, cotton gin production, and laboratory data were merged.

Two of the seven gins had mote trash systems where the exhaust airstreams were not combined with other major systems. The mote trash systems sampled were typical for the industry. At gin E (Fig. 10), motes from the combined mote system were dropped directly into the mote cleaner. The cleaned motes then dropped into the mote press for packaging. The trash removed from the motes by the cleaner were picked up in the mote trash system and pneumatically conveyed through a fan and to the mote trash system cyclone where the trash was then combined into the master trash system. Trash from the mote cleaner was also picked up by the mote trash system at gin B (Fig. 11) but, before the fan, the mote trash airstream was combined with a conveying airstream containing trash from the cyclones for three 1<sup>st</sup> stage lint-cleaning systems. The combined airstreams then passed through a fan and were exhausted through the mote trash system cyclone.

Both mote trash systems sampled utilized 1D3D cyclones to control emissions (Fig. 5), but there were some cyclone design variations between the gins (Table 1 and Fig. 12). The mote trash systems at both gins B and E exhausted through a single cyclone. The cyclone inlet on the mote trash cyclone at gin B was a 2D2D type and

the gin E mote trash cyclone had inverted 1D3D type inlet. An expansion chamber was present on mote trash cyclone at gin B and the gin E cyclone had a standard cone. All of the cyclone configurations outlined above, if properly designed and maintained, are recommended for controlling cotton gin emissions (Whitelock et al., 2009).

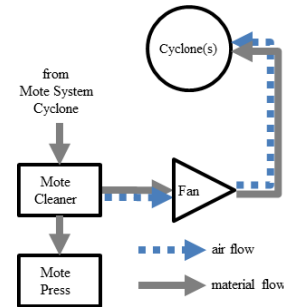


Figure 10. Schematic of mote trash system (gin E).

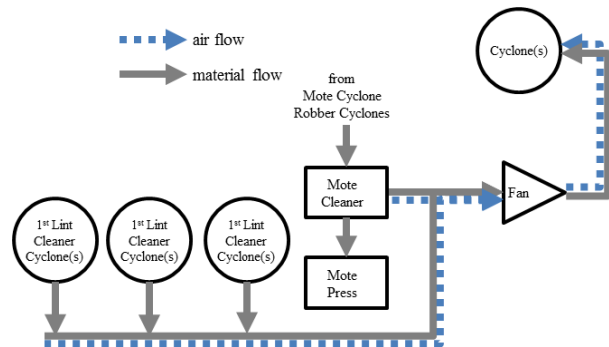


Figure 11. Schematic of mote trash system combined with airstream containing trash from 1<sup>st</sup> stage lint cleaning cyclones (gin B).



Figure 12. Cyclone design variations for the tested systems (left to right): 1D3D cyclone with an inverted 1D3D inlet; 1D3D cyclone with 2D2D inlet and expansion chamber on the cone; 1D3D cyclone with 2D2D inlet and standard cone.

**Table 1. Abatement device configuration<sup>z</sup> for mote trash systems tested.**

Gin	Cyclone Type	Inlet Design <sup>y</sup>	Systems per Gin	Cyclones per Gin	Configuration	Cone Design	Trash Exits to <sup>x</sup>
B	1D3D	2D2D	1	1	Single	expansion chamber	auger
E	1D3D	inverted 1D3D	1	1	Single	Standard	auger

<sup>z</sup> Figures 5 and 12

<sup>y</sup> Inverted 1D3D inlet has duct in line with the bottom of the inlet

<sup>x</sup> Systems to remove material from cyclone trash exits: auger = enclosed, screw-type conveyor

## RESULTS

Table 2 shows the test parameters for each Method 201A test run for the mote trash systems sampled at the two gins. The system average ginning rate was 32.4 bales/h and the test average ginning rates at each gin ranged from 27.2 to 37.6 bales/h (based on 227-kg [500-lb] equivalent bales). The 1D3D cyclone sampled at gin E was operated with inlet velocity within design criteria,  $16.3 \pm 2$  m/s ( $3200 \pm 400$  fpm), whereas the cyclone sampled at gin B was operated outside the design criteria due to limitations in available system adjustments.

There are criteria specified in EPA Method 201A for test runs to be valid for PM<sub>10</sub> or total particulate measurements (CFR, 2010). Isokinetic sampling and PM<sub>10</sub> aerodynamic cut size must fall within EPA defined ranges ( $100 \pm 20\%$  and  $10.0 \pm 1.0$  μm, respectively) for valid PM<sub>10</sub> tests. All tests met both criteria (Table 2). To use the method to obtain total filterable particulate also, sampling must be within 90 to 110% of isokinetic flow. This criterion was not met in the first and third test runs for gin E; thus the

data associated with these runs were omitted from the total particulate test averages. Sampling rates ranged from 11.9 to 13.8 standard l/min (0.420-0.487 standard ft<sup>3</sup>/min). The stack gas temperatures ranged from 31 to 41°C (88-106°F).

PM<sub>10</sub> emissions data (ginning and emission rates and corresponding emission factors) for the mote trash systems are shown in Table 3. The system average PM<sub>10</sub> emission factor was 0.011 kg/bale (0.025 lb/bale). The test average emission factors ranged from 0.0086 to 0.014 kg (0.019-0.030 lb) per bale and emission rates ranged from 0.32 to 0.37 kg/h (0.72-0.81 lb/h). Total particulate emissions data (ginning and emission rates and corresponding emission factors) for the mote trash systems are shown in Table 4. The system average total particulate emission factor was 0.021 kg/bale (0.046 lb/bale). The test average emission factors ranged from 0.013 to 0.029 kg (0.028-0.064 lb) per bale. The test average total particulate emission rates ranged from 0.50 to 0.79 kg/h (1.11 to 1.74 lb/h). The ratio of PM<sub>10</sub> to total particulate was 53.2% (the ratio calculated using Tables 3 and 4 might vary slightly from that listed due to rounding).

**Table 2. Cotton gin production data and stack sampling performance metrics for the mote trash systems.**

Gin	Test Run	Ginning Rate bales/h <sup>z</sup>	Cyclone Inlet Velocity		Isokinetic Sampling %	Aerodynamic Cut Size D <sub>50</sub> PM <sub>10</sub> μm	Sampling Rate <sup>y</sup>		Stack Temperature	
			m/s	fpm			slpm	scfm	°C	°F
B	1	26.4	21.7	4270	97	10.0	13.2	0.468	41	105
	2	26.6	21.6	4258	102	9.7	13.8	0.487	41	106
	3	28.7	20.9	4107	104	9.8	13.6	0.479	41	105
	Test Average	27.2	21.4	4212						
E	1	34.1	16.0	3145	83 <sup>x</sup>	10.6	11.9	0.420	31	88
	2	39.0	15.8	3112	106	10.4	12.4	0.437	33	91
	3	39.6	15.6	3072	88 <sup>x</sup>	10.4	12.3	0.436	35	95
	Test Average	37.6	15.8	3110						
System Average		32.4	18.6	3661						

<sup>z</sup> 227 kg (500 lb) equivalent bales

<sup>y</sup> slpm = standard l/min, scfm = standard ft<sup>3</sup>/min

<sup>x</sup> Did not meet total particulate isokinetic sampling rate criteria ( $100 \pm 10\%$ )

**Table 3. PM<sub>10</sub> emissions data for the mote trash systems.**

Gin	Test Run	Emission Rate		Emission Factor	
		kg/h	lb/h	kg/bale <sup>z</sup>	lb/bale <sup>z</sup>
B	1	0.38	0.83	0.014	0.031
	2	0.43	0.95	0.016	0.036
	3	0.30	0.67	0.011	0.023
Test Average (n=3)		0.37	0.81	0.014	0.030
E	1	0.30	0.66	0.0088	0.019
	2	0.33	0.72	0.0084	0.019
	3	0.35	0.77	0.0088	0.019
Test Average (n=3)		0.32	0.72	0.0086	0.019
System Average (n=2)				0.011	0.025

<sup>z</sup> 227 kg (500 lb) equivalent bales

**Table 4. Total particulate emissions data for the mote trash systems.**

Gin	Test Run	Emission Rate		Emission Factor	
		kg/h	lb/h	kg/bale <sup>z</sup>	lb/bale <sup>z</sup>
B	1	0.82	1.82	0.031	0.069
	2	0.85	1.88	0.032	0.071
	3	0.68	1.51	0.024	0.053
Test Average (n=3)		0.79	1.74	0.029	0.064
E	1 <sup>y</sup>	0.45	0.99	0.013	0.029
	2	0.50	1.11	0.013	0.028
	3 <sup>y</sup>	0.52	1.15	0.013	0.029
Test Average (n=1)		0.50	1.11	0.013	0.028
System Average (n=2)				0.021	0.046

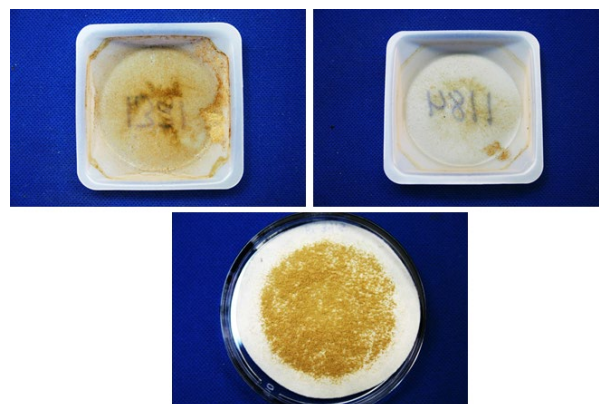
<sup>z</sup> 227 kg (500 lb) equivalent bales

<sup>y</sup> Test run omitted from test averages because isokinetic sampling rate (100 ± 10%) was not met

The average mote trash system total particulate emission factor for this project was about 60% of the EPA AP-42 published value for the mote trash fan (EPA, 1996a, b), which is an equivalent system to the mote trash system. The range of test average total particulate emission factors determined for this project and the range of AP-42 emission factor data overlapped. The average mote trash system PM<sub>10</sub> emission factor for this project was 1.17 times the EPA AP-42 published value for the mote trash fan. The test average PM<sub>10</sub> emission factor range fell within the AP-42 emission factor data range.

Figure 13 shows an example of samples recovered from a typical mote trash system test run. Often, there were cotton lint fibers, which have cross-sectional diameters much greater than 10 μm, in the cotton gin cyclone exhausts. Therefore, it was not unusual

to find lint fiber in the > 10 μm wash from Method 201A. However, lint fibers could also pass through the PM<sub>10</sub> cyclone and collected in the ≤ 10 μm wash or on the filter. This type of material carryover can bias the gravimetric measurements and affect reported PM<sub>10</sub> emission data. EPA Method 201A does not suggest methods to account for these anomalies. Thus, no effort was made to adjust the data reported in this manuscript to account for these issues.



**Figure 13. Typical EPA Method 201A filter and sampler head acetone washes from the mote trash system. Clockwise from top left: > 10 μm wash, ≤ 10 μm wash, and filter.**

## SUMMARY

Seven cotton gins across the U.S. cotton belt were sampled using EPA Method 201A to collect additional data to improve the EPA AP-42 PM<sub>10</sub> emission factor quality ratings for cotton gins. Two of the seven gins were equipped with mote trash systems where the exhaust airstreams were not combined with other major systems. The tested systems were similar in design and typical of the ginning industry. Both systems were equipped with 1D3D cyclones for emissions control with some slight variations in inlet and cone design. In terms of capacity, the two gins were typical of the industry, averaging 32.4 bales/h during testing. The mote trash system average emission factors for PM<sub>10</sub> and total particulate were 0.011 kg/227-kg bale (0.025 lb/500-lb bale) and 0.021 kg/bale (0.046 lb/bale), respectively. The system average PM<sub>10</sub> emission factor was higher and the system average total particulate emission factor was lower than those currently published in EPA AP-42. Gin test average PM<sub>10</sub> and total particulate emission rates ranged from 0.32 to 0.37 kg/h (0.72-0.81 lb/h) and 0.50 to 0.79 kg/h (1.11-1.74 lb/h), respectively. Based on the mote trash system average emission factors, the ratio of PM<sub>10</sub> to total particulate was 53.2%.



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