MINIMUM COST COMPLIANCE STRATEGIES FOR COTTON GINS ACROSS THE U.S.

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Abstract

With increasing scrutiny from both SAPRAs and the public, the cotton ginning industry will be forced to invest in more stringent air pollution control equipment to reduce their Allowable Emission Rate (AER). This increased investment may put an undue financial burden on a cotton gin depending upon the air pollution abatement strategy selected. An airflow model was developed that lists the approximate volume rates of flow from each of ten process system exhausts of a "standard" gin. The 1996 AP-42 emission factors were modified to correspond to the "standard' gin with ten exhausts. The airflow model was used in conjunction with the modified 1996 AP-42 emission factors to approximate emission concentrations from each of the exhausts. It was a premise of this research that a cotton ginner could utilize abatement systems selectively to reduce their AER by identifying the exhausts with the highest emission concentrations.. After the identification of problematic exhausts, gins can approach the task of reducing their emissions with a minimum cost of compliance. In addition, states utilizing Process Weight Tables (PWT) can also utilize the airflow model to determine AERs and permitted emission factors. Source sampling data obtained from the California Air Resources Board (CARB) were used to demonstrate the utility of the procedures and to compare emission factors calculated using the air model. The procedures and models presented in this paper can assist cotton ginners across the cotton belt to comply with air pollution regulations at the minimum cost.

Introduction

Cotton gins across the cotton belt are faced with increased scrutiny from State Air Pollution Regulatory Agencies (SAPRAs). Some gins are having to become permitted for the first time. Other gins are being forced to reduce the Allowable Emission Rate (AER) as a consequence of a public complaint. Some are in the dilemma of choosing the appropriate air pollution abatement equipment that will allow them to comply. Each SAPRA is approaching the regulation of air pollution associated with cotton gins differently. The amount of money invested in air pollution control to achieve compliance with air pollution regulations reduces the profit margin of a ginning operation. The number of viable operating gins in the U.S. is steadily declining and the imposition of expensive controls to comply with SAPRA rules and regulations can continue or accelerate this trend. The goal of this research is to develop procedures that can be used by the ginning community across the cotton belt to comply with SAPRA rules and regulations while minimizing the reduction in the number of gins.

Why is there an increased scrutiny of cotton gins across the cotton belt? One factor is that the 1990 Federal Clean Air Act (FCAA) amendments dramatically increased the funding of SAPRAs. Prior to the passage of this law, most of the efforts by SAPRAs emphasized the control of emission from large emitters located near populated areas. SAPRAs did not have the resources to address the smaller polluters. With the increased resources, all polluters are subject to a similar level of scrutiny. Another factor that has influenced the increased scrutiny is the public attitude and concern. We are living in an environmentally sensitive society. People desire clean air and water and are mandating that SAPRAs and EPA do what ever it takes to ensure that their family members are not exposed to pollution. There was a time that the public was less sensitive to environmental issues and more concerned with the viability of small businesses . Times have changed. Do SAPRAs have the power to enforce new regulations affecting cotton gins? The answer is yes!

The Texas SAPRA, the Texas Natural Resources Conservation Commission (TNRCC) requires that all cotton gins install Best Available Control Technology (BACT) by rule. By definition, BACT must include consideration of "economic reasonableness and technical practicability". In air pollution regulation, there are three levels of controls:

- Reasonably Available Control Technology (RACT) - The FCAA mandated that all sources of NO_x install RACT in ozone non-attainment areas. This level of control is not as sophisticated as BACT and is less costly and must include consideration of economic reasonableness. It is accepted in Texas that a level of control that costs more than $2,000 per ton of reduced emissions would exceed the economic reasonableness associated with RACT.
- BACT - All permitted cotton gins must have BACT installed. BACT must include consideration for economic reasonableness, but the criteria for establishing whether an abatement strategy is economically unreasonable has not been established. It is likely that this criteria will be more than $2,000 per ton of reduced emissions. This is the subject of Ramaiyer's et al. (1997) paper at this conference.
- Maximum Achievable Control Technology (MACT) - This is level of controls is associated with the Lowest Achievable Emission Rate (LAER). This level of regulation is used for polluters in non-attainment areas of a regulated pollutant. There is no required consideration of economic reasonableness for MACT.

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It is the premise of this research that imposed controls that result in a gin going out of business are more stringent than BACT. Some could argue that it is the imposition of MACT. No cotton gin should be subject to MACT if it is located in an attainment area for PM10.

Cotton gins are for the most part regulated under the nuisance standard. " Air pollution is the presence in the outdoor atmosphere of any one or more substances or pollutants in quantities which are harmful or injurious to human health or welfare, animal or plant life or property… "- (health effects standard) "… or unreasonably interfere with the enjoyment of life or property, including outdoor recreation." -(nuisance standard). The regulation of air pollution under the nuisance standard does not require any potential or real impact of health on the public. Strong odors from a source can result in SAPRA enforcement as can lint fly on trees and bushes although neither of these conditions are related to public health. The one exception is the use of downwind concentrations when compared to the National Ambient Air Quality Standards (NAAQS). NAAQS are based upon health effects. In other words, a violation of the NAAQS could be interpreted as impacting public health downwind from the source. Air pollution is dependent upon pollutant concentration measurements off the property.

Cotton gins are required to obtain a permit from a SAPRA as a potential polluter. The permitting process includes a description of the abatement system design and an estimate of the emission factors associated with each exhaust. The EPA AP-42 emission factors were changed in 1996 from the 1988 AP-42 of 2.24 pounds per bale (lb/b) to 3.1 lb/b total suspended particulate (TSP). It was generally assumed that 50% of the TSP emitted by a gin was PM10 prior to the publication of the new AP-42. The new AP-42 lists TSP and PM10 emission factors with the PM10 fraction of TSP varying by process. The new AP-42 specifies an average of 39% of the TSP is PM10. Emission factors can be used to calculate the Allowable Emission Rate (AER) provided the volume rate of flows (Q) are known. Parnell et al. (1994) reported that picker and stripper gins utilize 7,000 and 8,000 cubic feet per minute (cfm) per bale per hour (bph) total volume rate of flow (Q) for materials handling for a gin processing picker and stripper cottons, respectively. For example, a 20 bale per hour (bph) cotton gin processing picked cotton may be permitted to emit 2 lb/b (TSP). Hence, this gin will have an allowable emission rate of 40 pounds of TSP per hour. If the SAPRA were to receive a complaint and the SAPRA enforcement personnel were to determine that the gin was guilty of violating the nuisance standard, the AER could be reduced to less than 2 lb/b. The AER of 2 lb/b corresponds to an average emission concentration (over all the exhausts) of 0.033 grains per cubic foot (gr/ft^3) or 76.3 milligrams per cubic meter (mg/m^3) assuming that this gin was utilizing 140,000 cfm.. It would be too costly for a ginner to pay for source sampling all of his exhausts to demonstrate that the average emission concentration of all of his exhausts was less than 76.3 mg/m^3. However, if one had an estimate of the volume rate of flow for each of the process exhausts listed in AP-42, the emission concentrations could be calculated for each process exhaust using the permitted emission factors and vice versa; if the emission concentrations for a process exhaust were known, the emission factor for that exhaust could be calculated.

How does the ginning management select an abatement strategy to comply with a reduction in AER? The logic of reducing emission factors to date has been to install rotary drum filters as secondary collectors on several exhausts, replace cyclones, replace axial-flow fans with centrifugal fans with an associated replacement of covered condenser drums with cyclones. These responses are expensive. It is the premise of this research that a less costly strategy would be to selectively reduce the emission concentrations of the exhausts with priority given to those associated with the highest emission concentrations.

Objectives

The overall goal of this research is the development of a process that would allow for the minimum cost of compliance with air pollution regulations for cotton ginners across the cotton belt. This goal will be met by accomplishing the following objectives:

- To establish contact with SAPRA representatives in every cotton belt state. These contacts will be used to assist and evaluate results from this research and the potential impact on cotton gins in the different states.
- To develop air pollution control strategies that will allow cotton gins in each state to comply with State Air Pollution Regulatory Agency's (SAPRA's) at a minimum cost to the gin. .
- To perform economic analysis of the developed strategies to indicate the reasonableness of the implementation for some gins. (Example. Small gins (<10 bale/hr) have less capitol to invest than a larger gin (>25 bale/hr))

Air Flow Model

To facilitate the formulation of strategies to comply with SAPRA rules and regulations, an air distribution model was developed for a "standard gin' with process exhausts corresponding to the ten exhausts in the 1988 AP-42. Table 1 illustrates the ten processing system exhausts for the "standard" gin with the
fractions of the total volume rate of flow listed. The assumptions and descriptive parameters associated with the development of this model were as follows:

- A bale of picker and stripper cotton delivered to the gin for processing (seed cotton) contains 1,500 and 2,200 pounds of lint, seed and trash, respectively.
- A bale of seed cotton contains 500 pounds of lint and 800 pounds of seed. Typical picked and stripped seed

cotton contains 200 and 900 pounds of gin trash, respectively.

- One half of the gin trash in the seed cotton minus the 50 pounds that passes through the gin stand to the lint cleaning system is removed by the first push/pull. The remaining gin trash removed by the seed cotton cleaning system is removed by the second push/pull. For example: A 20 bph gin processing stripped cotton will contain 900 pounds of gin trash. 50 pounds of the trash will remain with the lint following the lint-seed separation. Of the 850 pounds removed by the seed cotton cleaning system, 425 pounds are removed by the first push/pull system and 425 pounds are removed by the second push/pull.
- All but 50 lbs of trash are removed by the seed cotton cleaning system for both picked and stripped cotton. The remaining 50 pounds are removed by the lint cleaning systems.
- A minimum of 25 cubic feet of air per pound of material is needed to reliably convey materials. A minimum of 30 cubic feet of air is needed for the unloading system as a consequence of high moisture contents of some cotton entering the ginning process.
- The Q for an individual processing system is the total Q for that system. For example, a 20 bph picker gin will utilize 140,000 cfm (total) with 63,000 cfm (0.45*140,000) for the axial flow process. It is estimated that 30% of the total Q for axial-flow is utilized for the first stage lint cleaning system 18,900 cfm. This system may consist of three lint cleaners with one behind each of three gin stands. Each lint cleaner will have 6,300 cfm.
- Processing systems 1-7 are associated with centrifugal fan exhausts; 8-10 are associated with axial-flow fan exhausts.
- The fractions of Q for each processing system were determined using published data (Shaw et al., 1977).

This "standard" gin would require 7,000 cfm/bph if it were a picker gin and 8,000 cfm/bph if it were a gin processing stripper cotton. A distribution of the total air flow (Q_T) for each processing system was made for picker and stripper gins with 55%/45% and 60%/40% distribution of the Q_T for centrifugal/axial-flow air flows. Table 2 lists the percent of Q_C for each of the seven process exhausts associated with centrifugal fans. Table 3 lists the percent of Q_A for the four process exhausts associated with axial flow fans. Figure 1 shows the airflow through the "standard" gin. Each exhaust in figure 1 is represented as a percent of the total flow (Q_T).

Example 1 illustrates how the model can be used to estimate the individual flow rates from each of the ten process exhausts.

Example 1:

A 20 bph cotton gin processing picker cotton will have a total airflow of 140,000 cfm (Q_T), (20 bph * 7,000 cfm/bph). This cotton gin will have a Q_C of 77,000 cfm (140,000 cfm * 55%) and a Q_A of 63,000 cfm (140,000 cfm * 45%). The flowrate through the unloading system will be 18,200 cfm (140,000 cfm * 13%).

Emission Factor Model

The "standard" gin model defined in this paper includes a conveying system from the second stage seed cotton cleaning system to the auger distributer and separate exhausts for the first-stage and second-stage lint cleaning systems. This is similar to the system described in the 1988 AP-42. These individual exhaust points were not included in the 1996 AP-42 emission factors. The total 1996 AP-42 emission factor was 3.05 lbs/b (TSP) which is an increase from the 1988 AP-42 of 2.24 lbs/b (TSP). It was assumed that a typical gin would have an auger distributer separator exhaust and separate exhausts for each lint cleaning process. The 1996 AP-42 emission factors were modified to facilitate a auger distributer separator exhaust and a separate exhaust for the first and second stage lint cleaning systems while maintaining to total emission factor of 3.05 lbs/b. The following equation was used to modify the AP-42:

$$MEF = \left(\frac{1988\ PEF}{1988\ TEF_i} - \frac{1996\ PEF}{1996\ TEF_i} \right) \left(1988\ TEF_i - 1996\ TEF_i \right) + 1996\ PEF \qquad \text{(Eq. 1)}$$

where: MEF = modified 1996 AP-42 emission factor
PEF = process emission factor,
TEF_i = total emission factor, and
i = fan type (centrifugal or axial).

The following equation was used to distribute the 1996 AP-42 lint cleaning emission factor into two stages:

$$MEF = \left(\frac{1988\ SLCEF}{1988\ 1^{st}LCEF + 1988\ 2^{nd}LCEF} \right) (1996\ LCEF) \qquad \text{(Eq.2)}$$

where: MEF = modified 1996 AP-42 emission factor
SLCEF = stage of lint cleaning emission factor, and
LCEF = lint cleaning emission factor.

Table 4 lists the modified AP-42, the 1988 AP-42, and the 1996 AP-42 emission factors. The 1996 AP-42 and the modified AP-42 total emission factor (TEF) were maintained at 3.05 lb/b. In addition, it was important to have the emission factor distribution of the 1996 AP-42 and the modified AP-42 be comparable. For example, in both the 1996 and the modified AP-42's, the master trash fan had a higher emission factor than the unloading fan.

Emission Factors from Source Sampling Data

Source sampling data were acquired for several cotton gins in California (CARB, 1992). These data included emission concentrations, emission factors, and the type of abatement control equipment utilized for each exhaust sampled. (See Table 5.) However, no measured flow rates or gin sizes were provided. In addition, there was no explanation on how the reported emission factors were developed. The calculation of the emission factors from concentration measurements must incorporate a process flow rate. The flow rates from the air flow model were used with the measured emission concentrations to calculate emission factors for each of the process exhausts. These data are listed in Table 5 - Air Flow Emission Factor column. The CARB (1992) reported emission factors with their data. These are listed in Table 5 - Source sampling Emission Factors. Since the volume rate of flows were not listed, there is no way to determine whether the appropriate flow rates for each process system were used.

Examination of the individual results show that there is some variation between the air flow model emission factors and the source sampling emission factors. The variations can be attributed to the underlying assumptions of the air flow model. The air flow model has an incorporated assumption of a constant flow rate depending upon whether the gin is processing stripped or picked cotton. The actual flow rate for individual processes may vary between gins. Another possibility is that the process flow rate may be divided into several exhausts. For example, three first stage lint cleaners, one behind each of three gin stands, may exist at the gin sampled. If the consultant was not aware that he was to calculate the process emission factor and used the volume rate of flow from one of the lint cleaners instead of all three, an error could have been made and reported. The flow rate is a crucial factor in the determination of the emission factor.

Figures 2 and 3 show the comparison of the two emission factors for individual processes for both centrifugal and axial fan processes, respectively. Examination of the figures indicates that the air flow model emission factors tend to exceed the reported source sampling emission factors. These can be considered to be a conservative estimates. However, for processes 5, 7, 8A, 8B, and 10 the air flow model emission factors are lower than the reported sources sampling emission factors. The only explanation as to why the two emission factors differ for each process is that the source sampling emission factors used a much different flow rate for these exhausts. It would appear that the different flow rates for some of the exhausts are considerably less than the one utilized by the air flow model.

Discussion

Having a procedure such as the one described in this paper can impact both SAPRA regulations and the cotton ginning industry. The model is simple and follows common sense reasoning. The use of the air distribution model by both ginners and regulators will simplify the calculations of emission factors from source sampling data.. Some benefits of air model can be illustrated with the following examples:

Example 2:

> A 20 bph gin is assumed to have an emission factor of 0.81 lb/b (AP-42, 1988) for the first stage lint cleaning system. The average concentration leaving any one of the three lint cleaners is 229 mg/m^3. Parnell (1990) has indicated that properly designed and operated cyclones should be able to achieve 0.03 gr/ft^3 (69 mg/m^3). If a cyclone can lower the emission concentration to 69 mg/m^3, the emission concentration can be reduced to 0.24 lb/b by using cyclones in the place of covered condenser drums. This calculation is dependent upon the use of the air flow model.

In addition, the model can be utilized to determine the emission concentration for each individual exhaust point. Knowing the emission concentrations of individual exhausts allows the ginner to identify particular exhausts emitting high particulate concentrations and to selectively augment the air pollution abatement system associated with these particular exhausts.

Tables 6 and 7 list the flow rates and expected emission concentrations associated with the modified AP-42 emission factors for the purpose of identifying problem exhausts for a 20 bph picker and 20 bph stripper gin, respectively. (Note that in both table 6 and 7, the Q_A for axial-flow fans is approximately the same for stripper and picker gins (63,000 cfm versus 64,000 cfm). It was an assumed that the mass of lint and trash leaving the gin stand and entering the first stage lint cleaning process would be the same whether the gin was processing picked or stripped cotton.) A comparison of the resulting emission concentrations from both tables 6 and 7, can be compared to the source sampling data that was acquired for cotton gins in California. Table 8 shows the emission concentrations for both picker gin and stripper gins and the average emission concentrations from source sampling data (CARB,1992). Analysis of the table indicates that the modified AP-42 emission factors used with the developed air flow model can predict emission concentration fairly accurately.

A comparison of the emission concentrations results listed in tables 6 and 7 for each of the process exhausts illustrates the proposed strategy that should be used to minimize the cost of complying with air pollution regulations. The last column of each table is labeled strategy priority. This column offers a representation of the order in which the exhaust emissions should be reduced. The degree of reduction required dictates the depth into the rank that is needed. The master trash fan has the highest emission concentration. Having identified the high concentration exhaust, the AER of the gin can be reduced by simply adding additional air pollution control to the master trash exhaust. However, if this is not a sufficient, the next step would be to add controls to the first stage lint cleaning process. The next exhaust would then be the mote system. If further reduction is necessary then the priority ranking suggests that the abatement systems associated with the unloading, first and second stages of seed cotton cleaning systems should be augmented. Some of the exhausts in the examples are not ranked in the priority column strategy. The reason they are not ranked is that their emission concentration is very low, and that additional controls on these exhausts would not greatly effect the total AER of the gin. Hence additional controls on these exhaust would be an unwise use of gin resources. This method is simple and easy to follow. It also allows the gin to comply with regulations while minimizing the cost of compliance.

Ramaiyer et al., (1996), developed several air pollution abatement strategies for cotton gins in Texas. The approach to the strategy development was similar to the method outlined above. Four strategies were developed, each strategy differs in the degree of AER reduction achieved. Each strategy reduced a gin's AER by adding additional abatement devices to high concentration exhausts. The first abatement strategy (ACT 1) replaced the abatement device on the first lint cleaning exhaust with a more efficient and effective abatement device. As the strategies further reduce emissions, the degree of control increases. This increase is similar to the process of systematically reducing individual exhausts to achieve a lower AER identified above. Ramaiyer's priorities were not the same as those presented in this paper, but the approach to the development of the strategies was the same. This method of developing air pollution control strategies is simple and effective. By reducing individual emission concentrations systematically, the gin can better utilize resources to comply with regulations.

Note that table 9 allows for comparison of the source sampling emission factors, air flow model emission factors calculated from source sampling emission concentrations, 1988 AP-42 emission factors, and modified AP-42 emission factors. Analysis of the table results in several conclusions. First, the process emission factors vary between the source sampling and air flow model emission factors, but the total emission factor is the same. Both the source sampling and the air flow model total emission factors exceed the 1988 AP-42 emission factor by 25%. In addition, both total emission factors are less than the modified AP-42 total emission factor and hence are less than the 1996 AP-42 total emission factor.

This model has the added benefit of potentially being used in California where the California Air Resources Board (CARB) utilizes a unique process weight table to determine whether or not the various processing systems comply with process weight table limits. The two equations that describe the process weight limits for California are as follows:

$$AER = 3.59\, P^{0.62} \quad \text{for } P < 30 \text{ tons per hour} \qquad \text{(Eq. 3)}$$

$$AER = 17.31\, P^{0.16} \quad \text{for } P > 30 \text{ tons per hour} \qquad \text{(Eq. 4)}$$

To illustrate the procedure that the CARB would use, the 20 bph hour gin would have a processing rate of 5.5 tons per hour through the first stage lint cleaning system (550 lb/b*20 b/h/2000 lb/ton). The AER calculated using Eq. 3 would be 10.3 lbs/h which is equivalent to 0.52 lbs/b. The allowable emission concentration is 146 mg/m^3. To demonstrate that the first stage lint cleaning exhaust is in compliance with the process weight limits , all that is required is source sampling of one of the lint cleaners demonstrating that the emission concentration is less than 146 mg/m^3.

Another potential benefit of the air model is settlement of disagreements with SAPRA permit engineers. For example, suppose that a cotton ginner were to propose that the installation of cyclones on his first stage lint cleaner exhaust would reduce the emission factor from 0.81 lb/b to 0.24 lb/b. Using the air model, it can be demonstrated that the emission concentration should be 0.03 gr/ft^3 (69 mg/m^3). Source sampling of one lint cleaner exhaust can be used to demonstrate this reduction.

Summary

In summary, with increasing scrutiny from both SAPRAs and the public, the cotton ginning industry will be forced to invest in more stringent air pollution control equipment to reduce their AER. The use of the airflow "standard" gin model in conjunction with the modified AP-42 model will identify high emission exhausts. After the identification of problematic exhausts, gins can approach the task of reducing their emissions with consideration to cost. In addition, states utilizing other emission factor criteria can also use the airflow model to determine emission concentrations from cotton gins. In conclusion, the models described in this paper can help the cotton ginning industry cope with increased scrutiny from the public and SAPRAs.

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Table 1. "Standard" Gin Process Exhausts.

Exhaust #	Process	Fan Type
1	Unloading system	CF
2	1st Push/Pull	CF
3	2nd Push/Pull	CF
4	Auger Distributor Separator	CF
5	Master Trash	CF
6	Overflow	CF
7	Mote system	CF
8	1st Stage Lint Cleaning	AF
9	2nd Stage Lint Cleaning	AF
10	Battery Condenser	AF

*CF- Centrifugal Fan
AF- Axial Fan

Table 2. Distribution of the Volume Rate of Flow Associated with Centrifugal Fans (Q_C) in the "Standard" Gin.

Process	Total Flow
1	23%
2	19%
3	15%
4	12%
5	8%
6	12%
7	11%
Total	100%

Table 3. Distribution of the Volume Rate of Flow Associated with Axial Fans (Q_A) in the "Standard" Gin.

Process	Total Flow
8	30%
9	30%
10	40%
Total	100%

Table 4. Comparison of AP-42's Emission Factors (lb/bale).

Process	'88 AP-42	'96 AP-42 Original	'96 AP-42 Modified
1	0.32	0.29	0.38
2	0.18	0.36	0.33
3	0.10	0.24	0.21
4	0.04	---	0.03
5	0.17	0.54	0.44
6	0.08	0.07	0.09
7	0.20	0.28	0.30
CF Total	**1.09**	**1.78**	**1.78**
8	0.81	1.10	0.93
9	0.15		0.17
10	0.19	0.17	0.17
AF Total	**1.15**	**1.27**	**1.27**
Total	**2.24**	**3.05**	**3.05**

Table 5. Comparison of Air Flow Model and Source Sampling Data.

Picker
Gin Size 20 bph
Flowrate 7000 cfm/bale/hr
Total 140000 cfm

Process	**Emission Conc. (gr/dscf)**	**Process Flowrate (cfm)**	**Air Flow Model Emission Factor (lb/bale)**	**Source Sampling Emission Factor (lb/bale)**	**Abatement Device**
1	0.066	18200	0.515	0.340	cyc
	0.048	18200	0.374	0.249	cyc
	0.062	18200	0.484	0.292	cyc
	0.057	18200	0.445	0.074	cyc
	0.102	18200	0.796	0.384	cyc
	0.038	18200	0.296	0.220	cyc
	0.033	18200	0.257	0.302	cyc
	0.029	18200	0.226	0.300	cyc
	0.031	18200	0.242	0.240	cyc
	0.028	18200	0.218	0.122	cyc
	0.064	18200	0.499	0.164	cyc
	0.017	18200	0.133	0.090	cyc
		AVG.	0.374	0.231	
2	0.017	14000	0.102	0.241	cyc
	0.044	14000	0.264	0.390	cyc
	0.038	14000	0.228	0.248	cyc
	0.086	14000	0.516	0.160	cyc
	0.078	14000	0.468	0.223	cyc
	0.106	14000	0.636	0.825	cyc
	0.060	14000	0.360	0.550	cyc
	0.069	14000	0.414	0.242	cyc
	0.023	14000	0.138	0.076	cyc
	0.097	14000	0.582	0.560	cyc
	0.030	14000	0.180	0.066	cyc
	0.018	14000	0.108	0.267	cyc
	0.085	14000	0.510	0.391	cyc

Table 5.Continued

Picker

Gin Size 20 bph

Flowrate 7000 cfm/bale/hr

Total 140000 cfm

Process	**Emission Conc.**	**Process Flowrate**	**Air Flow Model Emission Factor**	**Source Sampling Emission Factor**	**Abatement Device**
	(gr/dscf)	**(cfm)**	**(lb/bale)**	**(lb/bale)**	
	0.061	11200	0.293	0.119	cyc
	0.029	11200	0.139	0.103	cyc
	0.037	11200	0.178	0.205	cyc
		AVG.	0.197	0.161	
5	0.190	5600	0.456	0.959	cyc
	0.041	5600	0.098	0.246	cyc
	0.035	5600	0.084	0.120	cyc
	0.019	5600	0.046	0.037	cyc
	0.089	5600	0.214	0.233	cyc
	0.110	5600	0.264	0.278	cyc
	0.078	5600	0.187	0.200	cyc
	0.059	5600	0.142	0.061	cyc
	0.054	5600	0.130	1.520	cyc
		AVG.	0.180	0.406	

Process	**Emission Conc.**	**Process Flowrate**	**Air Flow Model Emission Factor**	**Source Sampling Emission Factor**	**Abatement Device**
	(gr/dscf)	**(cfm)**	**(lb/bale)**	**(lb/bale)**	
6	0.026	9800	0.109	0.050	cyc
	0.038	9800	0.160	0.049	cyc
	0.035	9800	0.147	0.044	cyc
	0.007	9800	0.029	0.011	cyc
	0.015	9800	0.063	0.058	cyc
		AVG.	0.102	0.042	
7	0.033	8400	0.119	0.138	cyc
	0.052	8400	0.187	0.284	cyc
	0.123	8400	0.443	0.135	cyc
	0.106	8400	0.382	0.980	cyc
	0.008	8400	0.029	0.330	cyc
	0.051	8400	0.184	0.018	cyc
	0.000	8400	0.000	0.491	cyc
	0.025	8400	0.090	0.210	cyc
	0.026	8400	0.094	0.173	cyc
	0.057	8400	0.205	0.013	cyc
	0.015	8400	0.054	0.168	cyc
	0.087	8400	0.313	0.132	cyc
	0.033	8400	0.119	0.294	cyc
	0.000	8400	0.000	0.110	cyc
	0.017	8400	0.061	0.070	cyc
		AVG.	0.152	0.236	

Table 5. Continued

Picker

Gin Size 20 bph

Flowrate 7000 cfm/bale/hr

Total 140000 cfm

Process	**Emission Conc.**	**Process Flowrate**	**Air Flow Model Emission Factor**	**Source Sampling Emission Factor**	**Abatement Device**
	(gr/dscf)	**(cfm)**	**(lb/bale)**	**(lb/bale)**	
		AVG.	0.483	0.429	
	0.051	19600	0.428	0.103	cyc
	0.011	19600	0.092	0.081	cyc
		AVG.	0.260	0.092	
10	0.017	23800	0.173	0.220	cyc
	0.010	23800	0.102	0.966	cyc
	0.023	23800	0.235	0.280	cyc
	0.027	23800	0.275	0.420	cyc
	0.019	23800	0.194	0.246	cyc
	0.082	23800	0.836	0.432	cyc
	0.012	23800	0.122	0.082	cyc
	0.005	23800	0.051	0.036	cyc
	0.013	23800	0.133	0.040	cyc
		AVG.	0.236	0.302	

* cyc - cyclone abatement device
sb - screen basket abatement device

Table 6. Picker Gin Emission Concentration Estimation Using Air Flow Model and Modified AP-42.

PICKER

Gin Size 20 bale/hr

Flowrate 7000 cfm/bale/hr

Total 140000 cfm

Process	% Flow	Flow	Emission Factor	Emission Rate	Emission Conc.	Emission Conc.	Strategy Priority
		(cfm)	(lbs/bale)	(lbs/hr)	(gr/ft^3)	(mg/m^3)	
1	13%	18200	0.38	7.600	0.049	111	4
2	10%	14000	0.33	6.680	0.056	127	4
3	8%	11200	0.21	4.200	0.044	100	4
4	7%	9800	0.03	0.500	0.006	14	---
5	4%	5600	0.44	8.760	0.182	418	1
6	7%	9800	0.09	1.880	0.022	51	---
7	6%	8400	0.30	5.960	0.083	189	3
CF Total	**55%**	**77000**	**1.78**	**35.580**	**0.442**	**1011**	
8	14%	19600	0.93	18.540	0.110	253	2
9	14%	19600	0.17	3.400	0.020	46	---
10	17%	23800	0.17	3.480	0.017	39	---
AF Total	**45%**	**63000**	**1.27**	**25.420**	**0.148**	**338**	
Total	**100%**	**140000**	**3.05**	**61.000**	**0.589**	**1349**	

Table 7. Picker Gin Emission Concentration Estimation Using Air Flow Model and Modified AP-42.

STRIPPER

Gin Size 20 bale/hr

Flowrate 8000 cfm/bale/hr

Total 160000 cfm

Process	% Flow	Flow	Emission Factor	Emission Rate	Emission Conc.	Emission Conc.	Strategy Priority
		(cfm)	(lbs/bale)	(lbs/hr)	(gr/ft^3)	(mg/m^3)	
1	14%	22400	0.38	7.600	0.040	91	4
2	11%	17600	0.33	6.680	0.044	101	4
3	9%	14400	0.21	4.200	0.034	78	4
4	7%	11200	0.03	0.500	0.005	12	---
5	5%	8000	0.44	8.760	0.128	292	1
6	7%	11200	0.09	1.880	0.020	45	---
7	7%	11200	0.30	5.960	0.062	142	3
CF Total	**60%**	**96000**	**1.78**	**35.580**	**0.333**	**761**	
8	12%	19200	0.93	18.540	0.113	258	2
9	12%	19200	0.17	3.400	0.021	47	---
10	16%	25600	0.17	3.480	0.016	36	---
AF Total	**40%**	**64000**	**1.27**	**25.420**	**0.149**	**341**	
Total	**100%**	**160000**	**3.05**	**61.000**	**0.482**	**1102**	

Table 8. Comparison of Model Emission Concentration Estimations and Source Sampling Emission Concentrations.

Process	Source Sampling Average Emission Conc. (gr/dscf)	Picker Model Emission Conc. (gr/dscf)	Stripper Model Emission Conc. (gr/dscf)
1	.048	.049	.040
2	.058	.056	.044
3	.041	.044	.034
4	---	.006	.005
5	.075	.182	.128
6	.024	.022	.020
7	.042	.083	.062
8	.068	.110	.113
9	.047	.020	.021
10	.023	.017	.016

Table 9. Comparison of Source Sampling, Air Flow Model, 1988 AP-42, 1996 AP-42, and Modified Ap-42 Emission Factors (lb/bale).

Process	Avg. Source Sampling	Air Flow Model	AP-42 1988	AP-42 Modified
1	0.23	0.37	0.32	0.38
2	0.33	0.35	0.18	0.33
3	0.16	0.20	0.10	0.21
4	---	---	0.04	0.03
5	0.41	0.18	0.17	0.44
6	0.04	0.10	0.08	0.09
7	0.24	0.15	0.20	0.30
8	0.71	0.57	0.81	0.93
9	0.43	0.48	0.15	0.17
10	0.30	0.42	0.19	0.17
Total	2.84	2.83	2.24	3.05

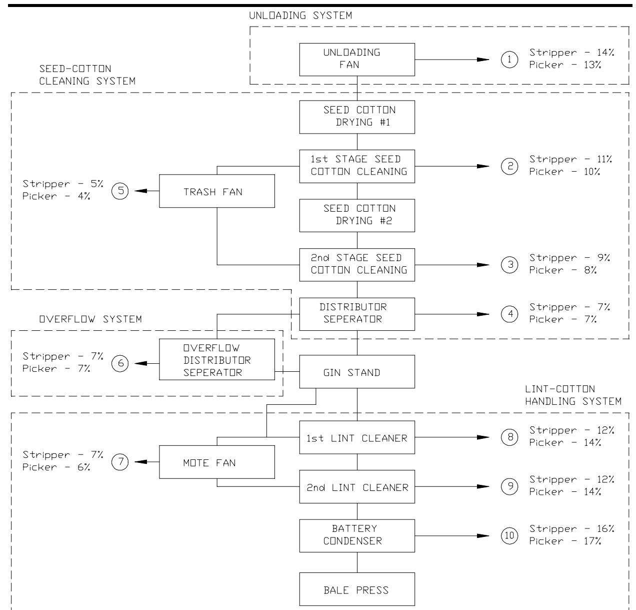

Figure 1. Distribution of the Total Volume Rate of Flow (Q_T) for Picker and Stripper "Standard" Gins.

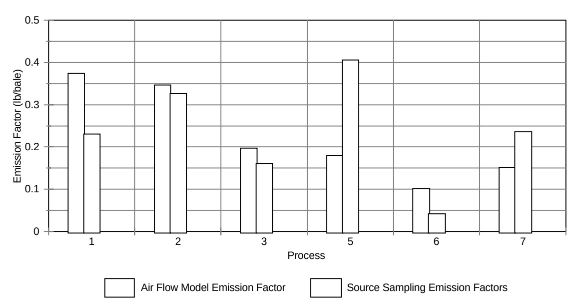

Figure 2. Centrifugal Fan Emission Factor Comparisons.

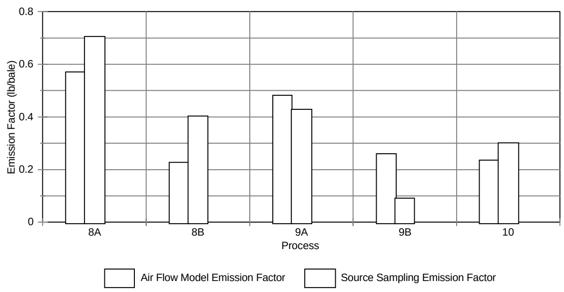

Figure 3. Axial Fan Emission Factor Comparisons.