# DEVELOPING NEW EMISSION FACTORS FOR THE TEXAS COTTON GINNING INDUSTRY

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## Abstract

The Texas Commission on Environmental Quality (TCEQ) is the regulatory authority that issues air quality permits in Texas. All cotton gins operating in Texas are required to obtain a permit from the TCEQ. The TCEQ is very experienced at permitting cotton gins, having rules in place requiring these permits since the 1970s. TCEQ also developed one of the first sets of emissions factors for cotton gins. These factors utilized emissions data developed by the USDA-ARS in the early 1970s.

In 2008, a team of researchers from the USDA-ARS developed a plan to sample emissions from seven cotton gins located across the cotton belt. (Buser et al., 2012). During the testing phase, one of these scientists relocated to Oklahoma State University, but remained active throughout the project. In this plan, each emission point from seven cotton gins was sampled for Total Suspended particulate (TSP), particulate less than or equal to ten microns in diameter ($PM_{10}$), and particulate less than or equal to 2.5 microns in diameter ($PM_{2.5}$). The sampling was performed using three different testing methods.

Data from this emission test is now available. The quality of this data is very high, and since the current TCEQ emission factors are based on much older data, it would seem appropriate to update the existing TCEQ emission factors with data from the seven gin study.

## Introduction

Scientists at USDA-ARS were among the first to quantify emissions from agricultural facilities and to develop emission control systems for these facilities. Some of these scientists remain at USDA facilities, others have moved to University positions. The current TCEQ stripper emission rates were developed using research provided by Dr. Calvin Parnell (now a Regents Professor at Texas A&M University) and Roy V. Baker (retired). The current TCEQ picker emission rates were developed using research provided by USDA-ARS researchers based on a commercial gin in New Mexico. (Kirk, 1974)

Science related to particulate matter emissions has evolved greatly in the last 40 years. At the time that the original data was collected, TSP was the only type of particulate matter collected. To develop the original emission factors, TSP emissions were measured. As regulations related to $PM_{10}$ and $PM_{2.5}$ were developed, conversion factors were used to develop an emission factor for both $PM_{10}$ and $PM_{2.5}$ from the original TSP data. No $PM_{10}$ or $PM_{2.5}$ data was collected in these early tests.

The TCEQ emission factors had several unique features. The most obvious is that TCEQ calculated a separate factor for each type of harvest method – stripper, picker, and burr extracted. In the permit application, the applicant would indicate the percentage of each type of cotton they expected to process. This percentage would be a basis for emissions calculations and would be reflected in the ultimate permit. TCEQ also developed a set of assumptions regarding the relative effectiveness of different control devices. For example, they built in assumptions that fine mesh screen had an efficiency of 50% while cyclones had an efficiency of 90%. If the original emission rate was based on an emission point controlled by fine mesh screen, and the plant being permitted was controlled by a cyclone, the original emission factor would be multiplied by a correction factor of 0.2 in order to account for the different controls.

TCEQ also chose a distinct set of emission points based on the original emission tests. These included, Unloading Fan, 1st Dryer Cleaner, 2nd Dryer Cleaner, Distributor Separator Fan, Burr & Stick Fan, Overflow Fan, 1st Lint Cleaner Fan, 2nd Lint Cleaner Fan, Battery Condenser Fan, Motes Fan, and Motes Cleaner Fan. Each of these points was assigned a discrete emission factor.

No two gins are alike. Differences in emission points require judgment on the part of the permit reviewer. For example, if a gin had three stages of lint cleaning, it was typical to double the emission rate of the Battery Condenser, as that point represented an emission rate that could be expected for a condenser handling lint that had been cleaned twice. On the other hand, it is common to make no adjustment for a gin with two trash fans, as the two fans combined loading is very similar to a single fan doing the same job.

## Use of the New Emissions Data

The Seven Gin test referenced above has produced a large quantity of very high quality data, which is being reported in a series of 68 papers. Several issues must be addressed if this new data is to properly update the old emission factors. The first is the matter of emission points. Since no two gins are alike, the emission points tested in the 1973 test are not the same as the ones tested in 2008 – 2011. In addition, there have been changes in the basic design of gins. For example, Distributor Separators are no longer in common use in cotton gins. In addition, with the increasing installation of cyclones on the exhausts of lint cleaner and battery condensers, there are more transfer fans being used to pull material from these new large cyclones.

Several emission points remained the same. These include Unloading Fan, 1st Dryer Cleaner, 2nd Dryer Cleaner, Overflow, 1st Lint Cleaner, 2nd Lint Cleaner, and Battery Condenser. Other points were replaced with an equivalent system. For example, the Distributor Separator point was replaced by 3rd Dryer Cleaner. The motes fan was replaced by a #1 Mote and a #2 Mote, and the mote cleaner was replaced with a mote trash fan. The Burr and Stick Machine fan was replaced by a Master Trash fan. Additional points added include a cyclone robber and a mote robber system.

Cyclone and mote robber fans were unheard of in the 1970s. The cyclone robber fan is used to pull material from the cones of lint cleaner condenser cyclones, and convey it to the trash handling system. Similarly, the mote robber system is used to pull material from the cones of lint cleaner trash cyclones, or mote cyclones, and convey it to the mote system.

In the current emission factors, there are three different emission factors for three different harvest methods. The new data does not support this type of differentiation. While the gin data has not been reported by location, discussions with authors of the papers indicate that during these tests, the processing of stripper harvested cotton did not result in emission rates higher than the range of the rest of the group. There are several possible explanations for this, including improved efficiency of modern control equipment, and improved harvest methods. The effect of the improved harvest methods can be seen in the process weight calculation. In the original spreadsheet, it was assumed that 2,300 lb of incoming stripper cotton was required to produce a bale of cotton. The average weight has now been reduced to 1,750 to account for the much cleaner incoming cotton seen from today's harvesting systems.

## Emission Points with Special Considerations

The gins tested had a larger combination of emission points than the tests used for the original emission factors. In general, one assumption made was that it is best to have the most emission points possible, so that there is a maximum potential for the permit reviewer to be able to most closely match the emission factor combination to the individual gin being permitted. For example, although most gins do not have a #3 Dryer Cleaner, this point is included in the list. It can easily be zeroed out if the reviewer deems that to be appropriate. On the other hand, had this point not been included, it would have become very difficult to account for this factor in a gin that did have three stages of precleaning.

This decision to represent as many points as possible led to the addition of several emission points, as discussed above. The original emission factor set included eleven emission points. The new factors include 14. Two of these are the robber fans discussed above, and the third is the splitting of the combined mote fan into the separate #1 and #2 mote fans.

The lint cleaner condenser and mote fan data were handled in a different manner than the rest of the data, as both the lint cleaner condenser and mote fan had a similar issue. As an example, some of the gins were equipped with combined lint cleaner condenser fan, and some with a #1 lint cleaner condenser fan, and a separate #2 lint cleaner condenser fan. Mote fans were the same, with some having a combined fan versus a separate #1 and #2 mote fan. For both of these points, there was a significant difference between the combined points, and the separate points. For example, the combined lint cleaning factor was 0.466 lb/bale TSP, as compared to a 0.155 lb/bale for the #1 lint cleaner, and a 0.050 lb/bale for the #2 lint cleaner. Motes had a similar discrepancy between the factors. It is good to have separate points for the motes and lint cleaners, as there are times when the controls are different on these points. In order to get the most representative number for these two emission points, however, data from all seven gins were used on these points.

To combine the data, the data from each gin with a separate point was summed, so that a combined lint cleaner condenser or a combined mote data point was developed for each gin. These seven factors were averaged. To re-split the combined data into the #1 and #2 points, actual data was used. For example, for the lint cleaner condensers, four of the seven gins had separate #1 and #2 lint cleaner exhausts. For these four gins, the #1 Lint Cleaner Condenser factor was 75.61% of the total factor. This percentage was multiplied by the combined average emission factor for the seven gins of 0.317 lb/bale to get a composite #1 lint cleaner condenser emission factor of 0.240 lb/bale. This same process was used to find an emission factor for the #1 and #2 mote exhausts that also accounted for the data from all seven gins.

The only emission point not used from the test was the Mote Cleaner emission point. There were two reasons for not including this point. First of all, this emission point is basically a combination of the Mote Robber and Mote Trash fan, so the inclusion of this emission point would be akin to using the #1 & #2 Lint Cleaner exhausts in combination with the Combined Lint Cleaner exhausts. In addition, this emission point was only present at two of the gins, and at one of these gins, the point was combined with another significant emission source, so the data quality from this point was very limited.

## Use of the most appropriate test method

In the original tests, TSP was the only type of particulate measured. For the seven gin test, three test methods were used, and each test method has benefits and challenges. The first test method is commonly referred to as Method 17. This method is the simplest procedure, involving a sampling probe inserted into the emissions stack and taking a reading of TSP. To obtain the $PM_{10}$ and $PM_{2.5}$ from Method 17, a particle size analysis is performed on the TSP sample. The second set of point source tests were measured using Method 201a. In this method the sampling probe is equipped with a sizing cyclone that is designed to remove all particles greater than $PM_{10}$ from the airstream, leaving only $PM_{10}$ remaining on the filter. In a similar manner, the third set of point source tests were performed using OTM 27, which was promulgated and combined with Method 201a in 2010. For this test method, the sampling probe is equipped with two sizing cyclones, one separating particulate larger than $PM_{10}$ and one separating particulate larger than $PM_{2.5}$, leaving $PM_{2.5}$ on the filter.

The TSP numbers from these different test methods varied slightly, but were fairly consistent. The $PM_{10}$ and $PM_{2.5}$ numbers from the different methods varied considerably. There is much discussion in the scientific community regarding the best use of these different test methods. Without restating the many arguments related to these different test methods, for the purpose of selecting the best data to use in updating the TCEQ emission factors, the Method 17 data was chosen combined with $PM_{10}$ and $PM_{2.5}$ data developed using the particle size distribution (PSD) analysis.

The main reason for choosing this set of data is that two leading scientists in Texas have been on record in the past in their support of the PSD method of assessing emissions from TSP data. One of these two scientists is Dr. Calvin Parnell, a former member of the Texas Air Control Board (the predecessor agency of the TCEQ), and the author of one of the original papers upon which the current emission factors are based. The second is Dr. Brian Shaw, the current Chairman of the TCEQ.

## Updating the worksheet

To update the emission factor worksheet, several changes were made. First of all, the new emission factors were inserted into the sheet. The separate factors for Stripper, Burr Extracted, and Picker were removed, being replaced with three other sets of data: TSP, $PM_{10}$ and $PM_{2.5}$. The process weight table has been re-worked. With the old factors, it made sense to treat the gin as one big process. With these factors, it makes more sense to break the gin into three distinct processes; precleaning system, trash system, and lint system. The factors are being fed onto an updated list of emission rates.

The old emission rates were reported in terms of a total emission rate for the gin, followed by a second emission rate for the trash handling system. The new emission rates are reported from the spreadsheet broken into five elements: Precleaning system, trash system, lint system, burner emissions, and trash handling. The first three items are broken out due to the process weight considerations. The burner emissions are listed separately, as this is a more typical way to address burner emissions in a TCEQ permit. Trash handling reporting has not changed.

## Summary

The scientists from the USDA-ARS Ginning Laboratories and Oklahoma State University have completed a very comprehensive point source sampling campaign. Data from these tests has been compiled into an updated set of emission factors for use in the permitting of cotton gins by the Texas Commission on Environmental Quality.

This data will replace existing data that was also developed by the USDA-ARS for essentially the same purpose about 40 years ago. The new tests directly measured emissions of TSP, $PM_{10}$ and $PM_{2.5}$ from each of the facilities being tested. These new test use modern testing techniques, and are being performed on modern plants that are more representative of the current industry.

The updated emission factors should be a much more accurate representation of the typical emission rate for the cotton ginning industry in Texas.

## References

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