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Condenser Coverings to Reduce Gin Emissi

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LINT FLY from condenser exhausts has been a nuisance problem for ginners for many years. The first abatement devices to clean these exhausts were dust houses or settling chambers and screen wire cages (Harrell and Moore, 1962). These devices collected much of the lint fly but very little dust and did not work very well in high humidity areas. In response to increasing pressure to clean the exhausts from gins, an inline filter was developed (Alberson and Baker, 1964). Research on the inline filters indicated that collection efficiencies for total particulates ranged from about 76 to 88 percent when used at gins processing spindle-harvested cotton (Wesley, et al., 1976). Baker and Parnell (1971) found a collection efficiency of about 81 percent for the inline filter when used on exhausts of gins processing machine-stripped cotton.

While the inline filter was an improvement over the dust houses and screen wire cages, it also had disadvantages such as initial cost, increased back pressure, frequently required maintenance and moisture collecting on the filter screen. Another development to reduce or eliminate dust and lint fly from condenser exhausts was to cover the existing condenser with fine mesh wire or perforated metal. McCaskill and Moore (1966) covered the condensers of unit lint cleaners with these materials and reported that the lint fly problem could be economically eliminated.

Proper installation and some of the operating parameters for covering condensers with fine screen and perforated metal are discussed in the Cotton Ginners Handbook (1977).

Most of the air pollution regulating agencies of the Cotton Belt states have written regulations stating that covering condensers with fine mesh wire or perforated metal is considered best available technology (BAT) for controlling emissions from condenser exhausts at cotton gins. However, gin manufacturers, ginners, and sheet metal shops are using different screen wire and perforated metal to cover condensers from the ones used which have been previously evaluated. Also, with the emphasis on particulates less than 10 microns (PM10) brought about by revisions to the Environmental Protection Agency's (EPA) national ambient air quality standards, additional data is needed regarding coverings for condensers. Thus, a test was designed to evaluate emissions from condenser coverings typically used in gins today and the data is reported herein.

Procedures

The battery condenser of a small-scale cotton ginning system was selected for evaluation, Figure 1. The condenser was covered with different combinations of fine perforated metal and wire mesh screen as follows:

Treatment 1. Condenser covered with perforated metal having 0.118 inch holes and an open area of 37.2 percent (reference).

Treatment 2. Condenser covered with perforated metal having 0.045 inch holes and an open area of 27.5 percent.

Treatment 3. Treatment 1 covered with 100-mesh wire with 0.0060 inch holes and an open area of 36.0 percent. The combined open area was 13.4 percent.

Treatment 4. Treatment 1 covered with 80-mesh wire with 0.0070 inch holes and an open area of 31.4 percent. The combined open area was 11.7 percent.

Treatment 5. Treatment 1 covered with 70-mesh wire with 0.0073 inch holes and an open area of 29.8 percent. The combined open area was 11.1 percent.

Cotton was ginned with two cleaning levels—no lint cleaners and two lint cleaners—to yield two trash levels and two levels of emissions from the condenser exhaust. The condenser exhaust was sampled and the emissions analyzed for total dust and lint fly captured as well as particle size distribution (PSD).

The ginning system was composed of a six-cylinder cleaner, stick machine, six-cylinder cleaner, 20-saw gin stand amd two saw-type lint cleaners. Design ginning rate for the system is about 8.6 lb/min of seed cotton. Actual ginning rate for the test ranged from 6.5 to 8.2 lb/min or 0.23 to 0.24 bale/hr/foot of width and was not significantly different for the treatments. Speed of the battery condenser was five rpm. The cotton variety was DES 119 and was grown on the Mississippi Agricultural and Forestry Experiment Station farm at Stoneville, MS.

Modified high-volume samplers were used to sample the dust-laden air from the battery condenser. All sampling was performed isokinetically by first measuring the velocity of the conveying air and then manually adjusting the voltage supply to the sampler motor to regulate the air flow rate. Air flow in the sampling probe was monitored by a flow meter and converted to velocity so that both the velocity in the conveying duct and sampling probe could be equilibrated. During the test, temperature, relative humidity (RH), barometric pressure, sampling time and sampling flow rate were recorded so that flow rates could be corrected to standard conditions (70° F, 50 percent RH and 14.7 psi). The filters used to capture the dust were a poly-web media manufactured by the James River Corporation. These filters were weighed to the nearest 0.00001 g before and after sampling. The PSD of the dust captured on the filters was determined using procedures with a Coulter Counter as described by Herber and Parnell (1988).

Seed cotton moisture and foreign matter samples were taken before processing, and fiber samples were taken after battery condenser for foreign matter and High Volume Instrument (HVI) analyses. Other data taken included ginning time, seed cotton weight, and lint weight. Statictical comparisons were made at the 5 percent and 1 percent levels of probability, and Duncan's Multiple Range Test (DMRT) was used to separate treatment means.

Results

Analysis of variance performed on the data indicated that none of the seed cotton or lint parameters measured were significantly affected by the condenser coverings. The parameters measured included seed cotton moisture and foreign matter, lint moisture and foreign matter, and HVI analyses. Ginning rate and turnout was statistically equal for all treatments.

Analysis of variance performed on the total dust data showed differences in the emissions as a result of the various condenser coverings. Table 1 shows the total emissions from the exhaust of the battery condenser by covering treatments as well as the size holes in each covering, percent open area and the ginning rate. Total emission concentrations prior to any lint cleaning ranged from 5.03 to 3.22 gr/1000 ft³ for the reference condenser covering only and the 80-mesh wire over the reference covering, respectively. Emissions rates after two lint cleaners were about one-third of those prior to lint cleaning. These emission concentrations ranged from 1.80 to 1.20 gr/1000 ft³ for the reference covering, and the 70-mesh wire over the reference covering, respectively. From these data it appeared that covering the condenser with any of the coverings other than the 0.118 perforated metal substantially reduced the emission rate. Total emissions were reduced 22 to 36 percent by the fine perforated metal and mesh wire coverings, respectively. The emission rate for all fine mesh wire over the reference covering was lower than the 0.045 perforated metal covering but the differences were not statistically significant.

After the PSD analysis had been performed, the lint fly on the filters was removed and weighed. Using these weights and the total weights, concentrations for lint fly and dust were calculated. These data are presented in Table 2. Lint fly concentration from the battery condenser exhaust prior to lint cleaning ranged from 1.47 to 0.15 gr/1000 ft³ for the reference covering and 80-mesh wire over the reference covering, respectively. Mean separation indicated that the three wire mesh coverings over the reference condenser reduced the emission rate of lint fly significantly. These means were also significantly lower than the emission rate from the condenser covered with the fine perforated metal with holes of 0.045 inches. The same trend was seen for the emissions after the lint had

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Table 1. Emissions from a battery condenser with various coverings.*

Type covering and mesh or hole size	No. holes per in^2 or hole size, in.	Open area, %	Total emission concentration, $gr/1000\ ft^3$, after	
			Zero lint cleaners	Two lint cleaners
Perforated metal 0.118 in. dia. (ref)	34	37.2	5.03 a	1.80 a
Perforated metal 0.045 in. dia.	172	27.5	3.94 b	1.57 ab
100-mesh screen over reference covering	.0060	36.0/13.4**	3.23 b	1.39 ab
80-mesh screen over reference covering	.0070	31.4/11.7**	3.22 b	1.43 ab
70-mesh screen over reference covering	.0073	29.8/11.1**	3.30 b	1.20 b

*Means not followed by the same letter are significantly different at the 5% level of probability as judged by Duncan's Multiple Range Test.

**First number is the open area of the mesh wire and the second number is the final open area or the reference covering open area times the screen open area.

Table 2. Lint fly and dust concentrations for a battery condenser with various coverings.*

Type covering and mesh or hole size	Lint fly concentration, $gr/1000\ ft^3$, after		Dust concentration, $gr/1000\ ft^3$, after	
	Zero lint cleaners	Two lint cleaners	Zero lint cleaners	Two lint cleaners
Perforated metal 0.118 in. dia. (ref)	1.47 a	0.49 a	3.56 a	1.31 a
Perforated metal 0.045 in. dia.	0.85 b	0.32 b	3.09 a	1.25 a
100-mesh screen over reference covering	0.16 c	0.15 c	3.07 a	1.24 a
80-mesh screen over reference covering	0.15 c	0.10 c	3.07 a	1.33 a
70-mesh screen over reference covering	0.24 c	0.08 c	3.05 a	1.13 a

*Means not followed by the same letter are significantly different at the 5% level of probability as judged by Duncan's Multiple Range Test.

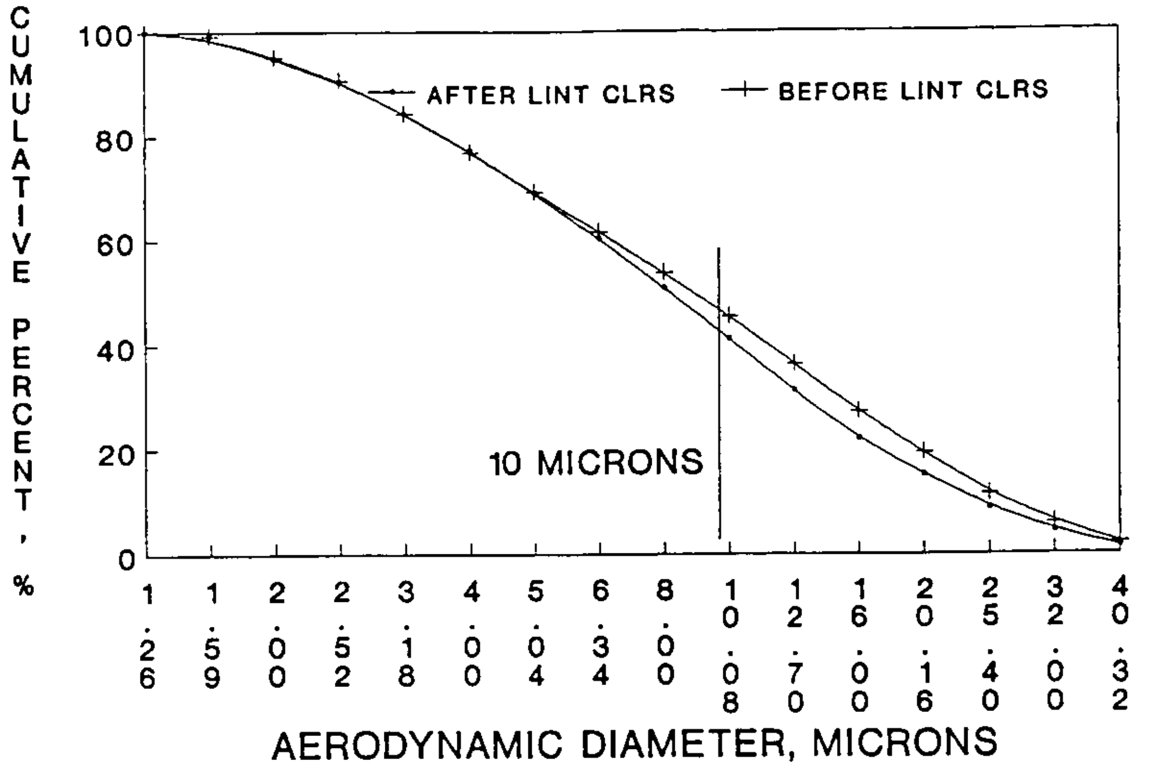

Figure 3. Particle size distribution of emissions from a battery condenser covered with perforated metal having 0.045 inch diameter holes.

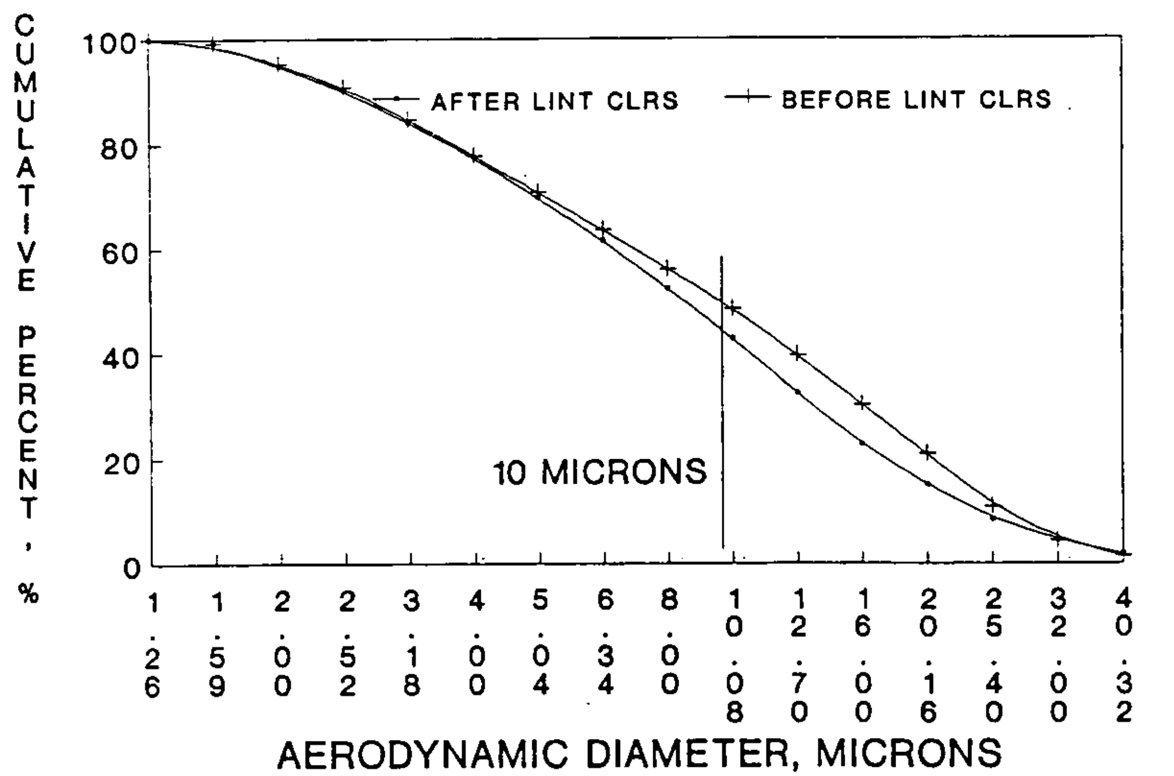

Figure 4. Particle size distribution of emissions from a battery condenser covered with 100-mesh wire over the reference perforated metal.

Table 3. Mass median diameter (MMD) and percent particles less than 10 microns (PM10)*

Type covering and mesh or hole size	MMD, microns, after: Zero lint cleaners	MMD, microns, after: Two lint cleaners	PM10 particles, %, after: Zero lint cleaners	PM10 particles, %, after: Two lint cleaners
Perforated metal 0.118 in. dia. (ref)	9.0 a	8.6 a	54.5 a	57.0 a
Perforated metal 0.045 in. dia.	9.0 a	8.2 a	54.6 a	58.9 a
100-mesh screen over reference covering	9.7 a	8.5 a	51.6 a	57.2 a
80-mesh screen over reference covering	8.6 a	8.3 a	56.3 a	58.4 a
70-mesh screen over reference covering	8.8 a	8.4 a	55.6 a	58.3 a

*Means not followed by the same letter are significantly different at the 5% level of probability as judged by Duncan's Multiple Range Test.

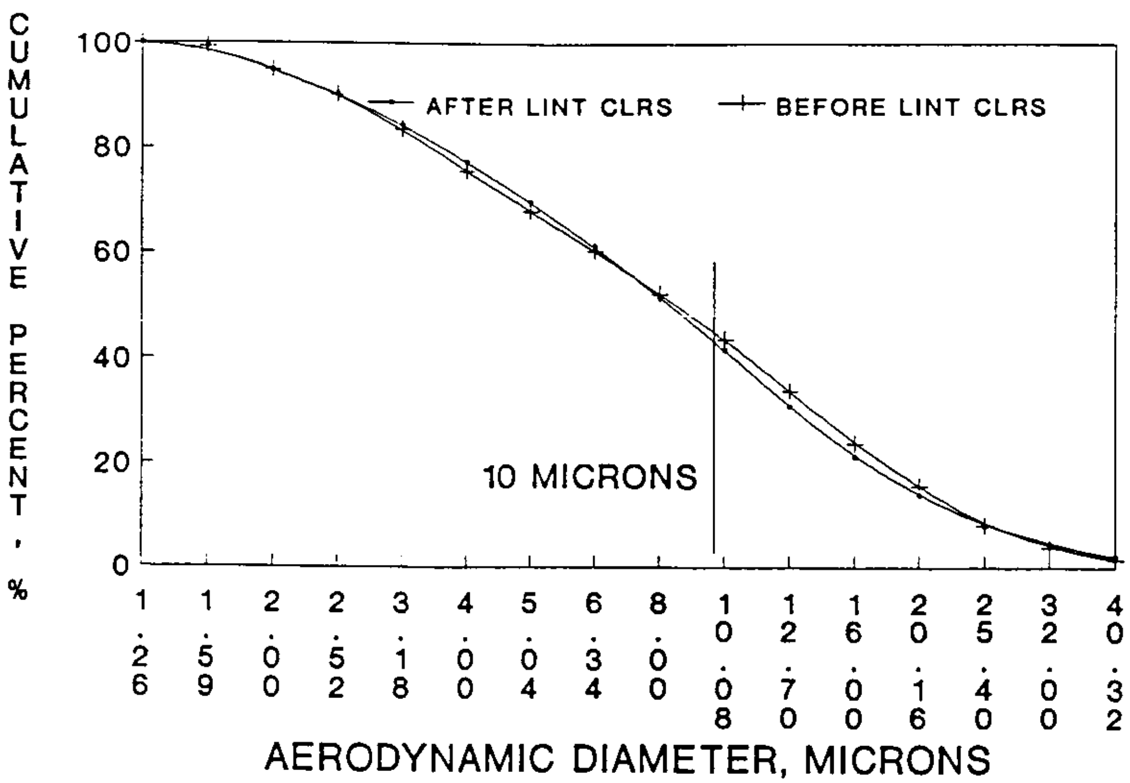

Figure 5. Particle size distribution of emissions from a battery condenser covered with 80-mesh wire over the reference perforated metal.

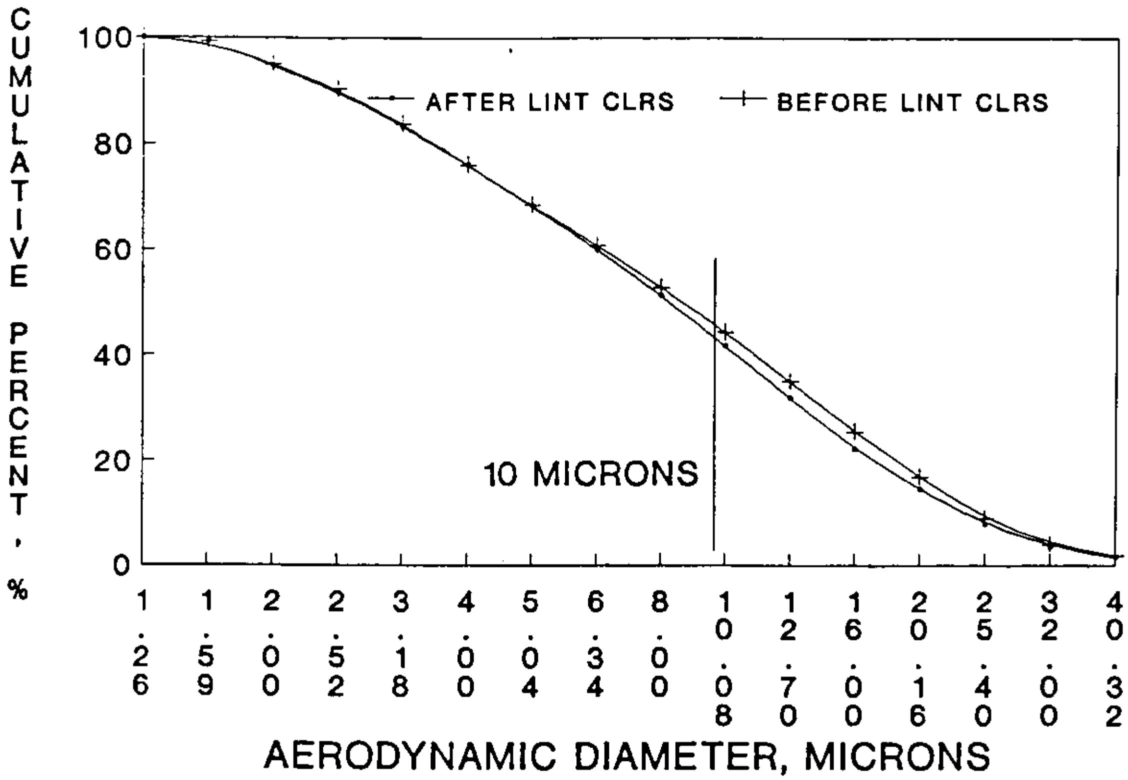

Figure 6. Particle size distribution of emissions from a battery condenser covered with 70-mesh wire over the reference perforated metal.

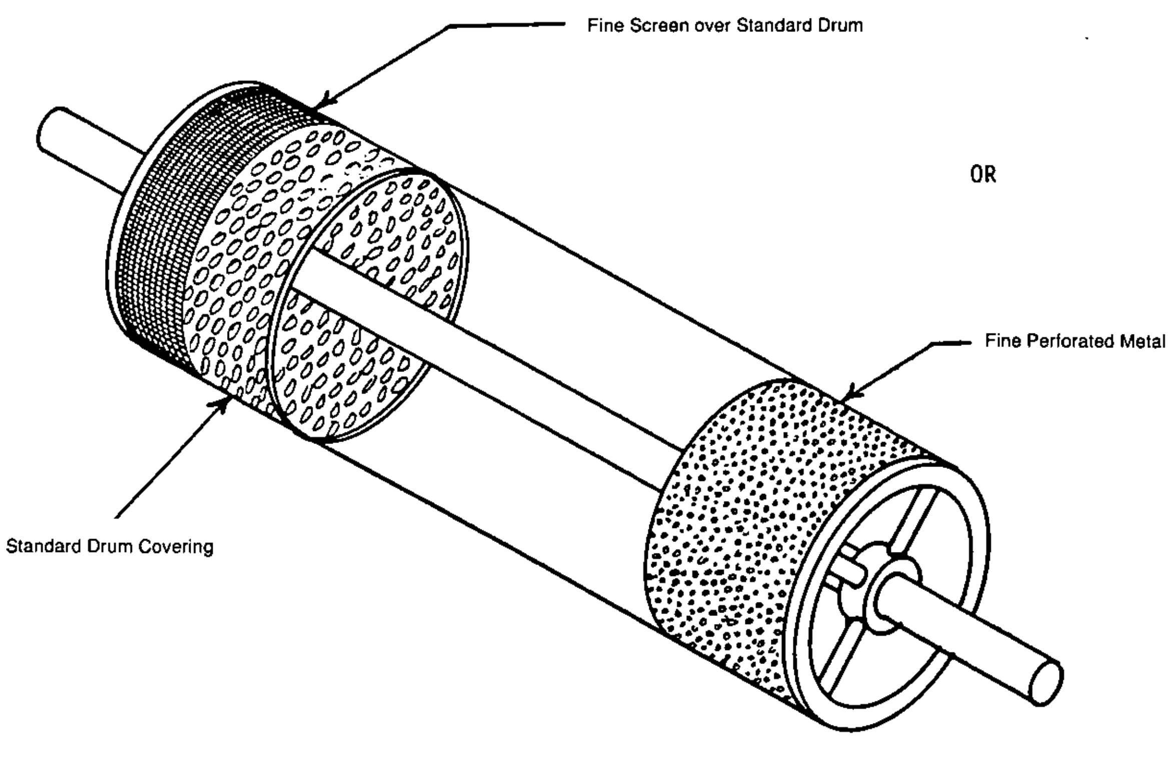

Figure 1. Condenser showing different coverings.

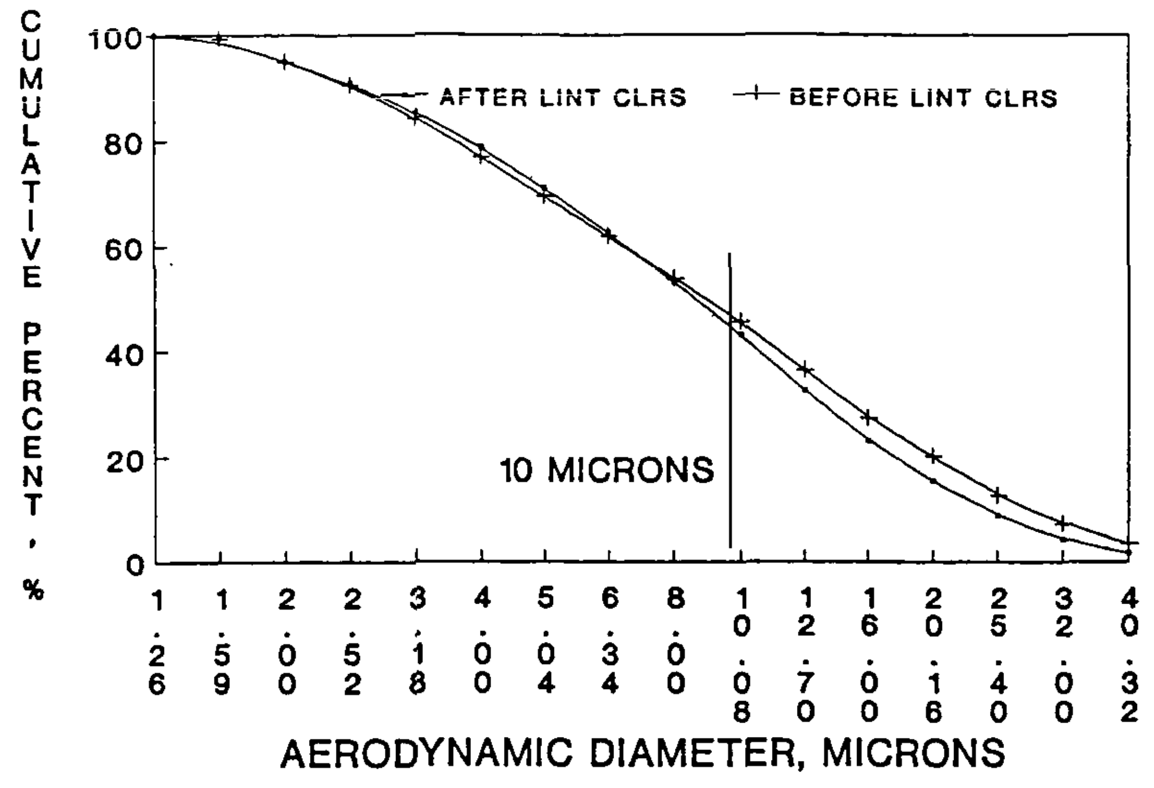

Figure 2. Particle size distribution of emissions from a battery condenser covered with perforated metal having 0.118 inch diameter holes (reference).

been subjected to two lint cleaners. Lint fly emission concentrations after two lint cleaners were about one-third of the emissions prior to lint cleaners for all but the 80- and 100-mesh wire treatments. Emission concentrations for lint fly ranged from 0.49 to 0.08 gr/1000 ft^3 for the reference covering and 70-mesh wire over the reference covering, respectively.

The dust (total weight minus lint fly weight) concentration in the condenser exhaust was not statistically different due to the coverings. This was true for the zero lint cleaner and two lint cleaner data. However, the dust concentration from the cotton processed with zero lint cleaners was roughly three times greater than the dust concentration from cotton processed with the two lint cleaners. Thus, from this data it appears that covering the battery condenser with fine perforated metal or fine mesh wire reduces only the lint fly emissions.

Results of the PSD analysis is presented in Table 3. Analysis of variance indicated no significant differences in the means for any of these data as a result of the condenser coverings. There was, however, a slight reduction in the mass medium diameter (MMD) of the dust particles after the cotton was processed through two lint cleaners. The percentage of particles less than 10 microns (PM10) remaining in the emissions increased as a result of being processed through two lint cleaners. This was a result of the larger particles escaping from the exhausts of the two lint cleaner condensers. These findings were as expected since the holes in all the condenser coverings are larger than 10 microns.

Figures 2 through 6 show the PSDs for emissions from the battery condenser for different coverings. These curves indicate that there was very little difference in the PSD of the emissions as a result of the cotton being processed through two lint cleaners. A comparison of the curves also indicates that the PSDs for the various coverings are very similar which was alluded to above.

Summary

An experiment designed to determine the effects of five condenser coverings on the dust concentrations and the PSD in the battery condenser exhausts was conducted using a small-scale ginning system. None of the seed cotton and lint parameters measured were significantly affected by the condenser coverings prior to or after two lint cleaners. Total emissions from the battery condenser were significantly reduced, 22 to 36 percent as a result of covering the reference condenser with fine mesh wire or by using fine perforated metal instead of the reference covering. This was true for lint processed with zero lint cleaning, however, while a reduction in emissions was seen for all treatments over the reference covering for lint processed through two lint cleaners, only the 70-mesh wire was statistically different. There were no differences between the 70-, 80-, or 100-mesh wire coverings.

Dividing the total emissions into lint fly and dust revealed that covering the reference condenser with fine mesh wire significantly reduced the lint fly emissions over the reference condenser and the fine perforated metal coverings for lint processed with zero and two lint cleaners. However, while dust emissions were lowered by the various coverings, the differences were not significant. Particle size distributions were not affected by the condenser coverings. Processing the lint through two lint cleaners tended to lower the MMD of the particles. The PM10 particles in the emissions were not affected by the condenser coverings but the percentage of PM10 particles tended to increase after the lint had been processed through two lint cleaners.

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