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REDUCTION OF LINT CLEANER NOISE

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Abstract

Standard doffing brush cylinders in three Continental Eagle Model 24D lint cleaners were replaced with experimental solid-wound brush cylinders at a commercial gin in Marked Tree, AR. Noise levels caused by the doffing cylinders were reduced from 93.6 dBA to 78.0 dBA and worker comfort was dramatically improved. Over 40,000 bales of cotton were processed without any operational problems.

Introduction

As a result of the potential negative impact of noise on workers, Congress enacted the Occupational Safety and Health Act in 1970 for industry "to assure healthful working conditions and to preserve human resources" (Miller, 1976). Federal regulations have been imposed on many industries since the act was passed in 1970. Generally, sound levels above 85 decibels on the A-weighted scale (dBA) adversely impact worker safety and job performance. However, cotton gins are classified as agricultural operations, and as such, are not covered under the 1970 standard. OSHA regulations for general industry specify that measurements of steady-state noise exposures shall be made with a sound-level meter that conforms to American National Standards Institute (ANSI) Standard s1.4-1971, Type 2, and set to an A-weighting slow response or with and audio-dosimeter of equivalent accuracy and precision. Current regulations do not specify where sound-pressure readings are taken relative to the noise source. They do, however, indicate that the measurements should be taken at the location that approximates the worker's head during normal operations. Substantial deviation in sound-pressure levels (SPL's) can occur, depending on the relative horizontal and vertical location of the microphone. Sound-pressure levels vary inversely with the square of distance, thus the intensity perceived by the human ear decreases dramatically with distance.

Sound-pressure levels (dB) are logarithmic, rather that linear. For example, a 100-dB noise is over 300 percent more intense that a 90-dB noise, rather than about 11 percent more intense. The effect of multiple noise sources in a building such as a gin can be estimated if the sound-pressure level of each noise source is known. A simple method for estimating the increase in sound level that results from adding noise sources is shown below:

Sound level differences, dB	Amount to be added to the higher level, dB
0 to 1	3
2 to 3	2
4 to 10	1
11 or more	0

The response of the human ear to sound levels is estimated by adjusting instrument-measured sounds to reflect the attenuation of the human ear. The human ear is not adversely impacted by low frequency noises. Instruments convert actual sound levels at various frequencies and create a reference scale known as the "A-scale" which provides substantial attenuation in the low-frequency ranges. Noise sources with low frequencies do not increase the A-scale reading nearly as much as do noise sources with high frequencies (above 500 Hz). The sound level on the A-scale is obtained by using a correction factor for each octave-band-center frequency. The correction factors to be added to each octave-band-center frequency are shown below:

Octave-band- Center frequency, Hz	Correction to obtain A-scale value, dB
31	-39
63	-26
125	-16
250	- 9
500	- 3
1,000	0
2,000	+1
4,000	+1
8,000	- 1

The sound level meter uses this procedure to obtain the sound level in dBA from the octave-band pressure levels.

Cotton ginning systems contain numerous types of machinery, each a source of noise. Common gin machinery items are seed-cotton cleaners, gin stands, lint-cleaners, vane-axial fans, centrifugal fans, hydraulic pumps, motors, etc. (Anthony 1973, 1974). Each item of machinery contributes to the overall sound level at different frequencies. Cotton is conveyed from point to point in sheet-metal piping. The passage of seed cotton through piping also contributes significantly to the overall noise level in a ginning system, especially at elbows in the piping system. Sounds are created, amplified, and reflected by the many metal machines, pipes, and ducts. Consequently, a conglomeration of sounds from several noise sources makes up the overall sound level in ginning systems.

Noise surveys of gins in 1972 and 1973 indicated that the noise levels inside gins ranged from 95 to 99 dBA (Anthony, 1974). Some common sources of high noise levels were lint cleaners, gin stands, vane-axial fans, centrifugal fans, and blowers. The highest sound-pressure levels occurred at octave-band-center frequencies of 63, 125, and 250 Hz. However when the influence of the sound-pressure level at each frequencies band was considered relative to its effect on the A-scale readings, the range of frequency bands between 250 and 4,000 Hz was the most important. Further analysis of the frequency components of the noise from individual machines indicated that the high-speed brush cylinders in lint-cleaners and gin stands were a major problem (Anthony 1977).

As a result, the standard brush cylinder in a lint cleaner was replaced with a solid-face, spiral-wound brush cylinder that effectively eliminated the dominant passage frequency of brush sticks on the standard cylinder (Anthony 1977). Sound levels 5 feet from the lint cleaner and 5 feet above floor level were reduced from 92 dBA to 70 dBA. The lint cleaner with the spiral-wound brush cylinder produced 90 percent less sound pressure than the lint cleaner with the standard brush cylinder. Similar results were achieved with the gin stand brush although the actual "ginning" noise from the fiber-seed separation process was still present. Comparison of several types of brush cylinders in a reduced-width lint cleaner produced similar results (Anthony and McCaskill, 1978).

Laird et al. (1977) used similar spiral-wound, long-bristle brush cylinders in a small-scale gin stand and achieved significant reductions in sound pressure of about 50 percent. The reductions they achieved were smaller than those achieved in the lint-cleaner study. Differences between results from the two studies were due to the different operational characteristics of the two types of machines and to the noise of equipment other than the gin stand, such as the extractor-feeder. Brush noise is much less dominant in gin stands than in lint cleaners.

Normally, one gin stand and two lint cleaners sequentially remove the seed and clean the small trash from cotton. The cotton is conveyed between the gin stand and lint cleaners in air streams produced by one or more vane-axial fans. The arrangement of gin machinery that consists of a gin stand with an extractor-feeder, one or two lint cleaners with condensers, and one or two vane-axial fans may be called a "setup." Gins normally contain from 1 to 5 setups processing 5 to 15 bales of cotton/hour each. Brush cylinders in seed-cotton cleaners operate at relatively low speeds (600 to 1,000 r/min) and normally contribute little to the noise level. Brush cylinders in gin stands and lint cleaners operate at relatively high speeds (1,200 to 2,200 r/min) and exert a dominant influence upon the sound-pressure levels generated by the equipment. They generally have about 28 brushes stick creating sound pulses at 560 to 1,026 Hz. These pulsations occur at frequencies that irritate human ears.

Purpose

The purpose of this study was to determine the noise reduction achieved by replacing the standard brush cylinder in the lint cleaners in a commercial gin with solid-wound brush cylinders.

Procedures

Two types of cylinders were evaluated:

1. Standard brush. Brush cylinder (18-inch diameter outside by 94 inches long) with the conventional wooden brush sticks equipped with 1-inch long nylon bristles (Figure 1). The cylinder speed was 1,640 r/min.
2. Solid brush. Brush cylinder with 18-inch outside diameter with 8-inch inside diameter core, and nylon bristles 0.025 inches in diameter by 5 inches long (Figure 2). The strips were spirally wound with minimum lead. The brush face was 94 inches long. The cylinder speed was 1,640 r/min.

Sound-pressure levels and A-weighted noise levels were measured with a Bruel and Kjaer Impulse Precision Sound Level meter, Type 2209/S, equipped with a Type 1613 Octave Band Filter set and the following accessories: windscreen, extension cable, random incidence corrector, 2.5-cm condenser microphone, flexible extension microphone, 1.3- to 2.5-cm adapter, and tripod.

Sound-pressure levels were measured to the nearest 0.5 dB in 10 octave bands, and noise levels were measured on the A-weighting scale at the locations shown in Figure 3. The microphone positions were located 10 feet from the center of the lint cleaner brush and 5 feet above the floor level.

The test sequence for each brush cylinder was as follows with the brush cylinders operating at 1,640 r/min without the condenser and feed rollers.

1. The brush cylinder was installed according to manufacturer's recommendations. A cutoff clearance of 0.13 inch was used, and the wind board was fully open.
2. Sound-pressure levels were measured in 10 octave bands, with center frequencies from 31.5 to 16,000 Hz, and noise levels were measured on the A-weighting scale. The measurements were made at four locations.
3. The measurements in steps 1 and 2 were repeated on two occasions for both type brush cylinders.

Results

The average noise levels and SPL's for three replications at four microphone locations are shown in Table 1 for the A-scale as well as octave band center frequencies from 31.5 to 16,000 hertz. As clearly demonstrated in Figure 4, a dramatic difference occurred at 250, 500 and 1,000 hertz. The solid-face brush cylinder reduced the noise perceived by the human ear from 93.6 to 78 dBA, or about 80%. Over 40,000 bales were processed by the three lint cleaners without any operational problems. Improved worker comfort in the lint cleaner operational areas strongly support adoption of this technology for all gins.

Disclaimer

Mention of a trade name, propriety product or specific equipment does not constitute a guarantee or warranty by the United States Department of Agriculture and does not imply approval of a product to the exclusion of others that may be suitable.

References

Anthony, W. Stanley. 1973. Unpublished annual report, U. S. Cotton Ginning Research Laboratory, Stoneville, MS.
Anthony, W. Stanley. 1974. Noise level in cotton ginning systems. ASAE Paper No. 74-5508, ASAE, St. Joseph, MI. 49085.

Anthony, W. Stanley. 1977. Reduction of lint cleaner brush noise. Proceedings of the Technical Program of the National Noise and Vibration Control Conference, Chicago, IL. Pp. 181-189.

Anthony, W.S. and O.L. McCaskill. 1978. Low-noise versus standard brush cylinders for gin machinery. Transactions of the ASAE 21(6):1045-1050.

Anthony, W.S. R.A. Wesley and O.L. McCaskill. 1978. Noise levels of cotton ginning systems. Transactions of the ASAE 21(2):574-580.

Laird, Weldon, and Joe D. Anderson. 1977. Better doffing: less noise. The Cotton Ginners' Journal and Yearbook. 45(1):30-37.

Miller, R.K. 1976. Handbook of Industrial Noise Management. Atlanta, GA: The Fairmont Press.

Table 1. Noise levels for the standard and solid force brush cylinder in a Continental Eagle Model 24-D lint cleaner at E. Ritter Gin.

Brush treatment	**Microphone location**	**Noise Level, dBA**	**Sound Pressure Level, dB, Out Octave Band Center Frequency, Hz, of**									
			31.5	63	125	250	500	1000	2000	4000	8000	16000
Solid	1	77.7	74.5	77	81	76.5	75.3	72.4	69.1	65.6	60.2	52.9
Standard	1	89.9	77.4	87	89	91.4	88	83.5	77.5	71.3	64	55.5
Solid	2	79.2	78.3	79	83	82	78.1	73.8	69.5	65.3	63.1	58.1
Standard	2	96.4	81.9	84	89	99.3	92.3	95.3	82.1	71.9	65.9	61
Solid	3	78.9	79.5	78	82	81.7	77.7	72.9	68.7	65.7	62.7	57.4
Standard	3	96.8	74.9	88	88	98.6	93.8	96.2	79.5	72.2	65.6	60.1
Solid	4	76.2	75.1	77	82	78.9	74	71.1	66.7	61.7	57.2	50.2
Standard	4	91.5	70.7	86	87	93.6	91.4	88	77.3	67.6	60.3	52.6
Solid	average	78	76.8	78	82	79.8	76.3	72.6	68.5	64.6	60.8	54.6
Standard	average	93.6	76.2	86	88	95.7	91.4	90.8	79.1	70.8	64	57.3

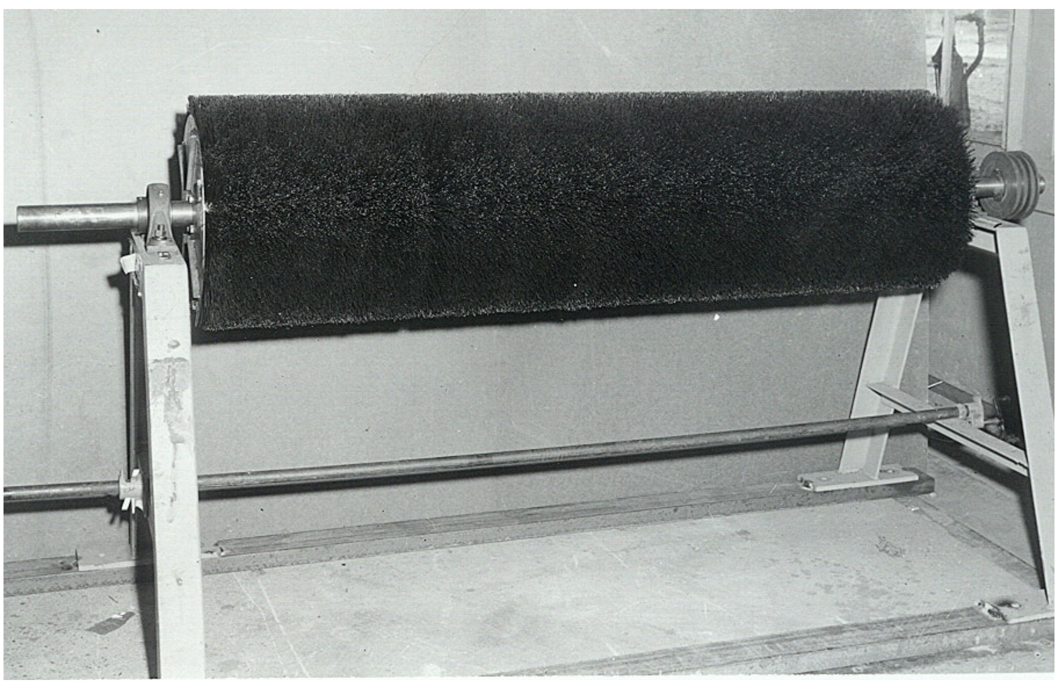

Figure 1. Solid brush cylinder used experimentally in gin lint cleaners.

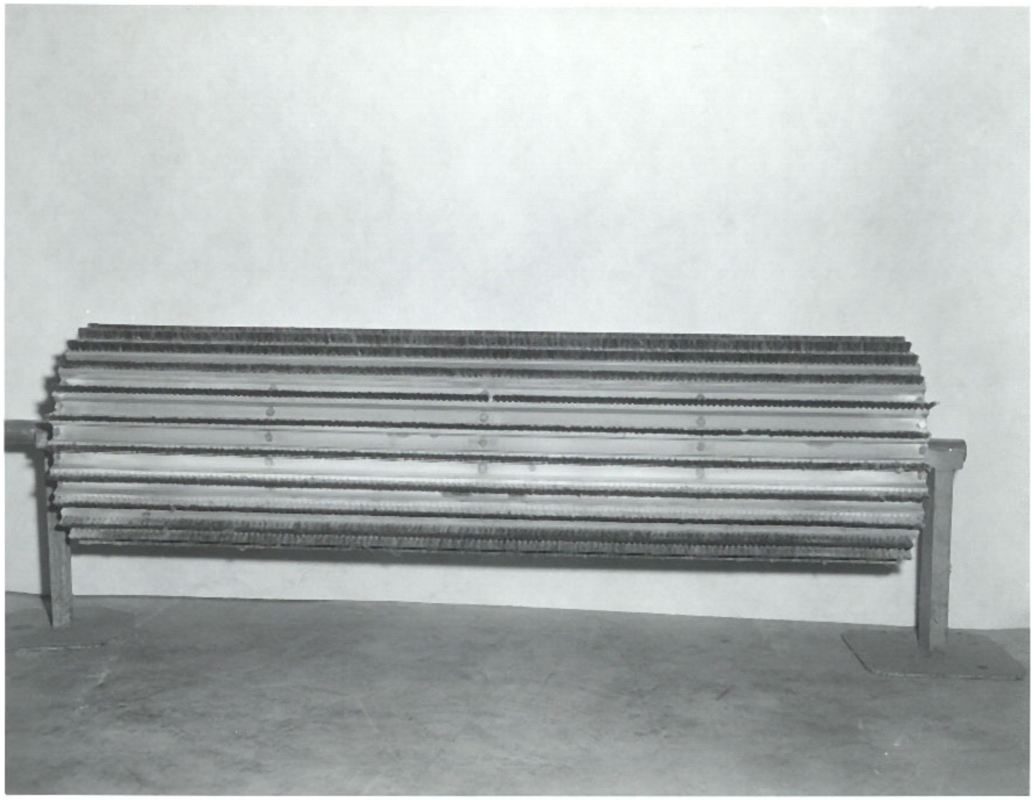

Figure 2. Standard brush cylinder used in gin lint cleaners.

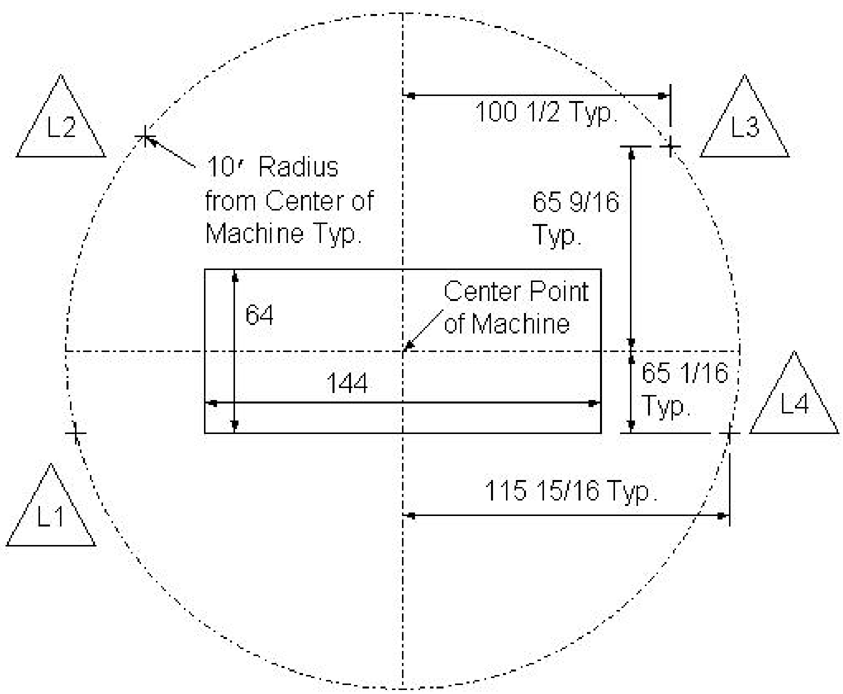

Figure 3. Microphone locations in relation to the lint cleaner.

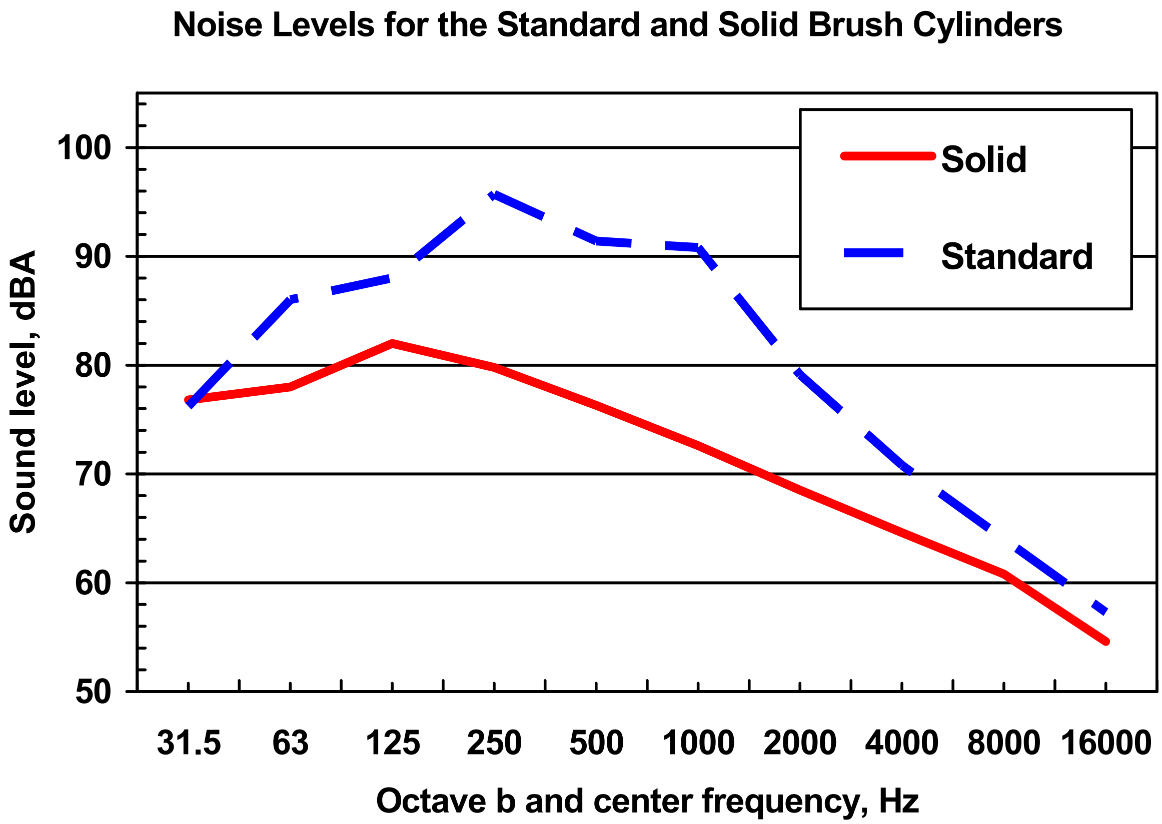

Figure 4. Sound levels at octave band center frequencies for the standard and solid-wound brush cylinders.