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Control of Wood Dust from Horizontal Belt Sanding

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An auxiliary ventilation system has been developed to reduce the wood dust emission from horizontal belt sanders. This system consists of two devices: a hood and a jet stripper. The hood is a narrow low-volume, high-velocity slot hood located between a belt surface and a worktable; the push device is a jet stripper located inside a driven pulley hood opposite the operator site. In combination with a standard sander hood, both devices significantly reduced the wood dust emission into the workroom. Laboratory data were confirmed by field tests conducted at an oscillating edge belt sander at a wood furniture manufacturing plant. These devices work independently of each other and do not interfere with the operator's sanding activity. They do not require special maintenance and are economically feasible.

Introduction

A primary method of controlling wood dust is the use of local exhaust ventilation. The exhaust hoods are located as close as possible to an emission source, either on the wood working machinery itself, or near the machine. Generally, the control technology for horizontal belt sanders consists of one hood located at the driven pulley end, or two hoods located at both pulley ends.[1]

A fast moving sanding belt generates a boundary layer of flowing air which adheres to the belt. The velocity of this air layer is highest at the belt surface and decreases rapidly with the distance from the belt surface (Figure 1). This belt air layer depends on the speed and roughness of the belt surface. At identical belt speeds, the adhered air layer moves faster with increased belt surface coarseness.[2] The belt air layer may be considered as an inertial force holding wood dust within the air flow pattern and carrying the dust to the sander hood. Besides this hydrodynamic force, the dust adheres to the belt surface mechanically because of the belt surface character. To control the wood dust, these forces must be overcome by the hood capture velocity. Some heavier particles leave the belt air layer tangentially due to a sudden change of the belt direction at the pulleys and may be collected by the hood; however, smaller particles leave at a lower angle and may not be collected by the hood. Even smaller particles are trapped in the belt air layer and eventually are emitted outside the hood capture capability. The particles adhering to the belt surface are stripped from the belt surface by contact with the wood being sanded and then — if the wood piece is too far from the exhaust hood — may be emitted outside the collection capability of the exhaust hood.

There are several ways to avoid or reduce the wood dust emission into the workroom:

- increase the head-end hood velocity,
- cover the belt area,
- locate an additional hood close to the sanding area, and

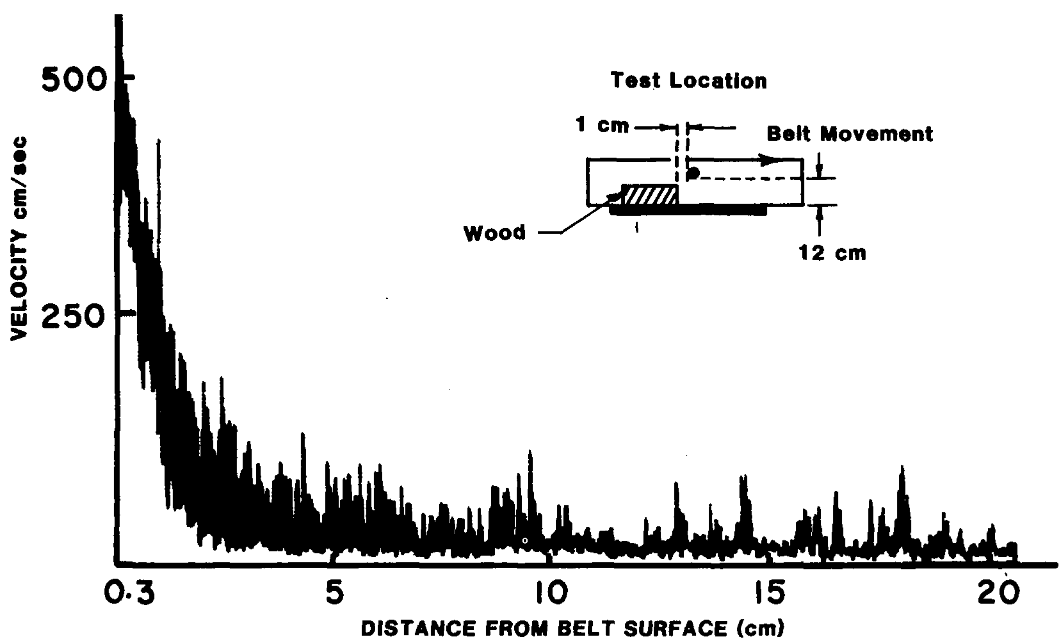

Figure 1—Belt air layer velocity vs. distance from belt surface

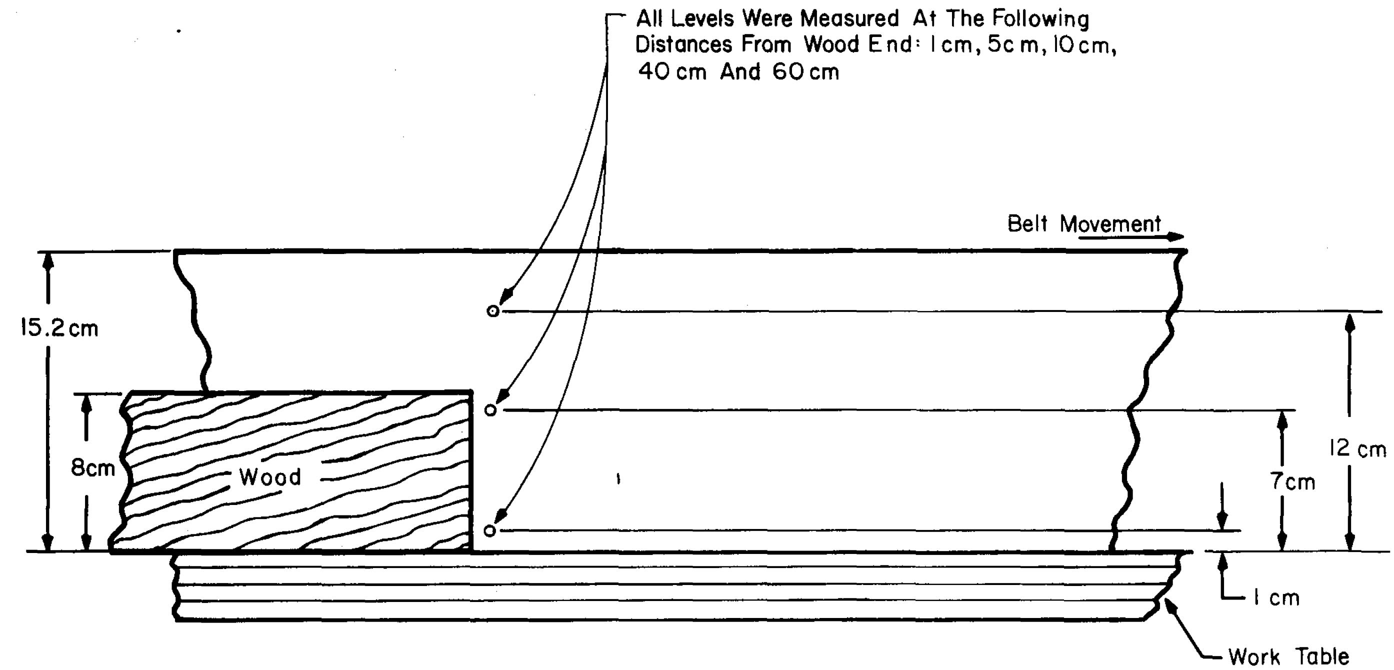

Figure 2—Levels of velocity measurements (front view)

- incorporate a localized mechanical or pneumatic stripping mechanism.

An increase of the hood velocity may not be economically or technically feasible. A cut-off point for velocity increase has been reported,[(3)] and beyond this point, any additional increase may have a minimum effect on dust emission. A variety of work processes may not allow covering the belt area. Therefore, an additional hood and a pneumatic dust stripping mechanism were considered as feasible solutions for this problem.

Belt Air Layer Investigation

As mentioned previously, collection of wood dust originated from sanding is strongly affected by the belt air layer parameters, *i.e.*, speed and roughness of the belt. Therefore, first the belt air layer flow pattern was investigated thoroughly by measurements of the belt air layer velocity.

Instrumentation and Velocity Measurement

The measurements were conducted at a horizontal non-oscillating edge belt sander (Progress Machine Co., Model PMC — 152) with a platen length of 152.4 cm (60 in). The belt surface speed was 1.93×10^3 scm/sec (3800 sfpm). An exhaust hood was located at the driven pulley end. The sander was equipped with a large worktable for flat sanding and a small worktable at the idle pulley end for round sanding.

The belt air layer velocity was measured using an anemometer (TSI Inc., Co. Model 1050). The anemometer output signal was measured by a pulse height analyzer (Tracor Northern Co., Model TN 1710) and simultaneously recorded on a X-Y recorder (Hewlett Packard Model 704A).

The belt air layer velocity was measured with a wood piece in sanding position to simulate a real sanding operation. The measurements were conducted behind the wood piece at three levels of 1 cm (0.4 in), 7 cm (2.8 in) and 12 cm (4.7 in) above the worktable. All levels were measured at the following distances from the wood end: 1 cm (0.4 in), 5 cm (2 in); 10 cm (3.9 in); 20 cm (7.9 in); 40 cm (15.7 in); and 60 cm (23.6 in).

An automatically driven device allowed velocity sensor movement in the direction perpendicular to the belt surface so that the belt air layer velocity was obtained as a function of a distance from the belt of 0.3 cm (0.12 in) to 20.3 cm (8 in). Location of the measurement points are shown in Figure 2. Two sanding belt surfaces were used for the measurements: coarse, using belt #40; and smooth, simulated by the non-abrasive side of the belt.

As an example, the belt air layer velocity profiles measured at 1 cm (0.4 in), 7 cm (2.8 in), and 12 cm (4.7 in) above the worktable are presented versus distance from the wood as a function of the distance from the belt surface (Figure 3) for belt grade #40. In addition, capture capability of the sander hood was investigated. The belt air layer velocity profiles were measured at the sander hood face and at various distances from the hood face, with and without the sander hood operating. The belt air layer velocity profiles, as a function of distance from the belt surface measured at 0.3 cm (0.1 in) and 5 cm (2 in) from the sander hood face, are shown in Figure 4. The measurements revealed the following results:

1. As shown in Figure 3 a and b, the profiles of the belt air layer velocity behind the wood are different from those above the wood (Figure 3c). Immediately behind the wood piece, the belt air layer velocity decreased almost to background velocity. With increasing distance from the wood, the belt air layer velocity increased, resuming its usual profile at a distance of 40 cm (15.7 in) to 60 cm (23.6 in) from the wood. A similar trend in the velocity profile was also found with the smooth belt. The velocity

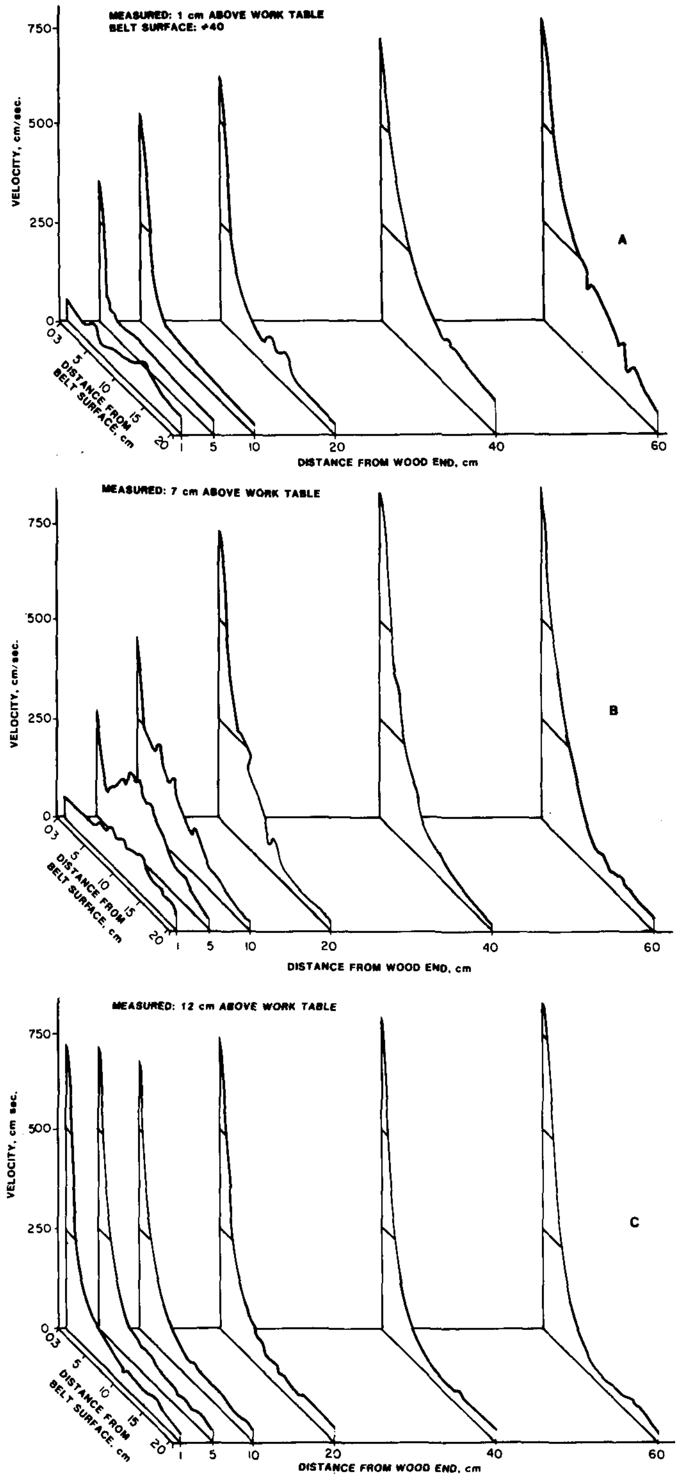

Figure 3—Belt air layer velocity vs distance from belt surface and wood end

peaks measured at 7 cm (2.8 in) above the worktable (Figure 3b) and at distances of 5 cm (2 in) and 10 cm (3.9 in) from the wood apparently were caused by the air blowing above the wood, as this level was only 1 cm (0.4 in) below the wood top. The reduction of the belt air velocity indicates that the belt air layer is disturbed in this area.

2. The measurements revealed (Figure 1) a turbulent character of the belt air layer, which may contribute to or affect the dust emission.
3. As shown in Figure 4, the sander hood contributes to the velocity of the belt air layer close to the hood. At a distance of 5 cm (2 in), the velocity profiles were almost identical, regardless of whether or not the sander hood was operating (Figure 4b). This indicates that at this distance the sander hood capture is minimal and that the belt air layer velocity is a dominant factor in carrying the wood dust toward the hood.

Improvement of Control Technology

Pull System

As mentioned previously, a wake in the belt air layer velocity exists behind the wood piece. Consequently, the belt air layer may not trap the wood dust generated in this area and the dust may be emitted into the workroom. Since most of the wood dust is generated behind the wood, the contribution to the dust emission by this phenomenon may be substantial. Therefore, an auxiliary hood located in this area may help improve the dust control.

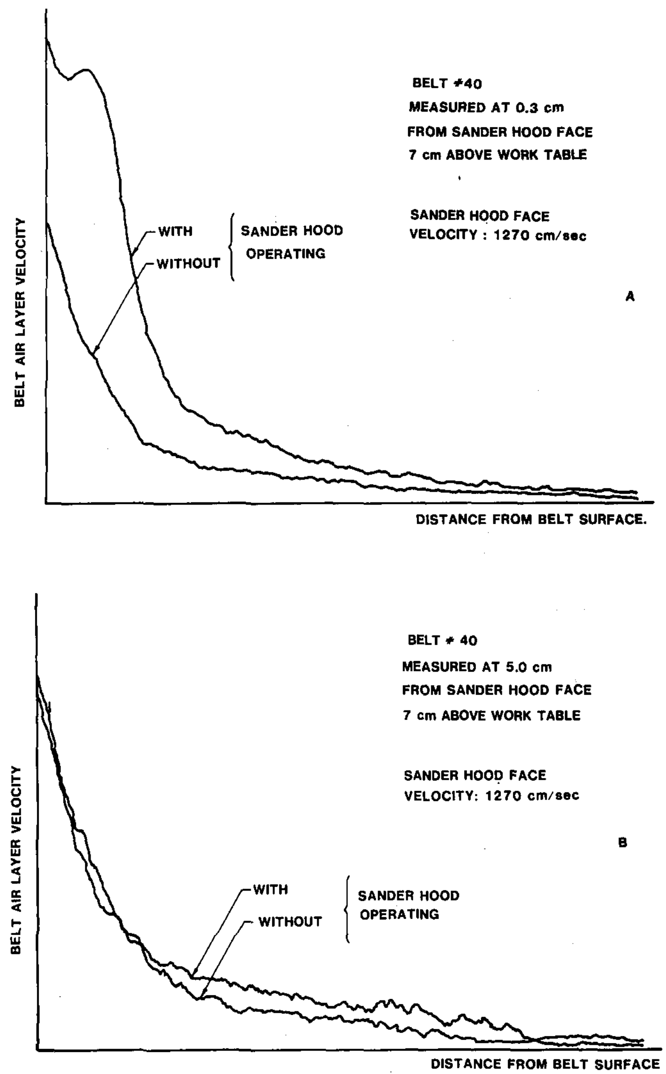

Figure 4—Belt air layer velocity profile vs. distance from belt sander

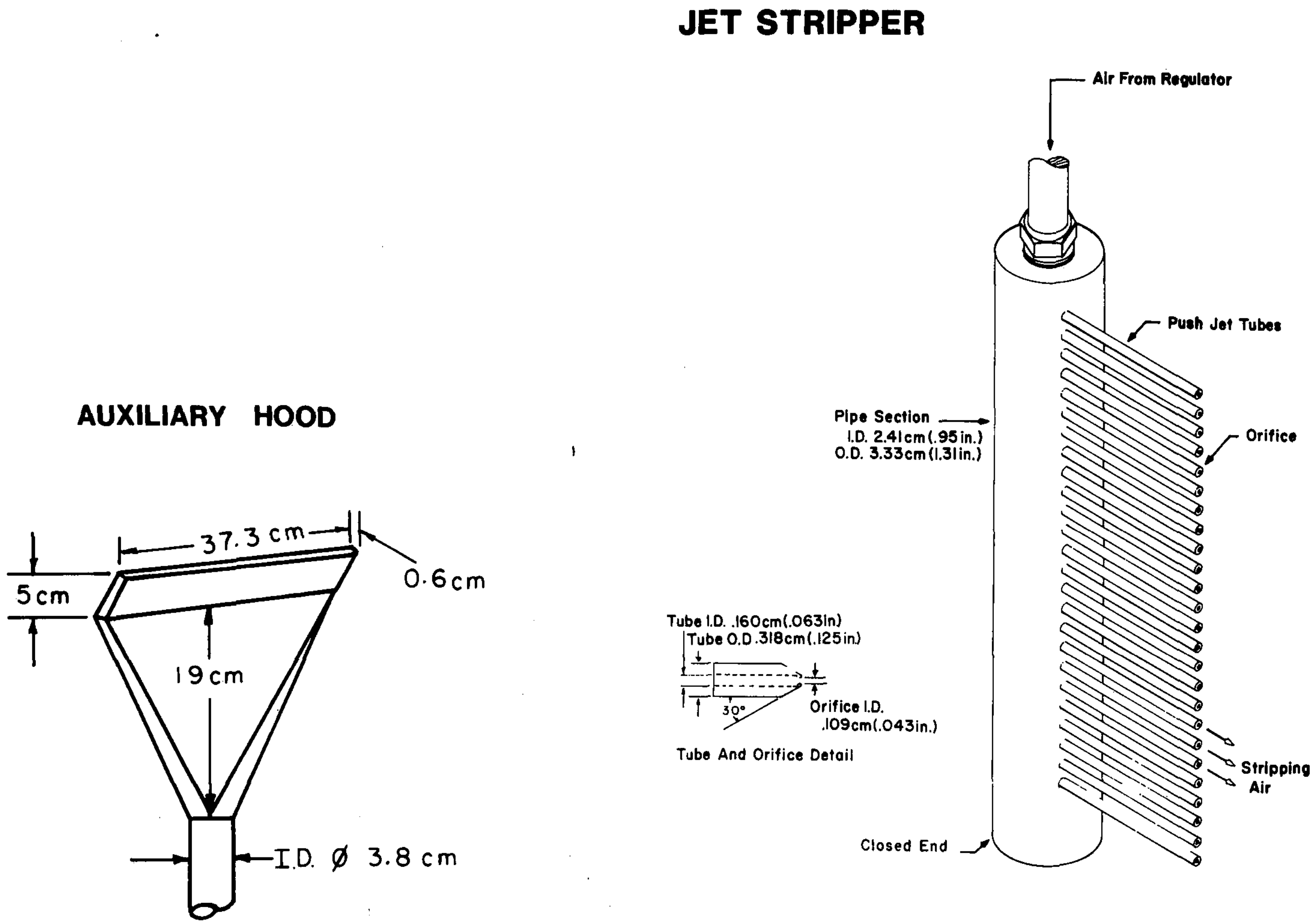

Figure 5—Auxiliary ventilation systems

There are two basic requirements for an auxiliary hood:

- The hood should be as close as possible to the wood dust origin.
- The hood should not interfere with the worker's sanding operation.

After several locations were considered the hood was positioned between the belt surface and the worktable. This location fulfilled both requirements.

Auxiliary Hood Description

The auxiliary hood, shown in Figure 5, was a simple low-volume, high-velocity hood with a slot opening of 0.6 cm × 37.3 cm (0.25 in × 14.7 in) to fit between the belt and the worktable. The dimensional stability of the slot opening was maintained by bracing five spacers vertically in the slot opening. The hood was located downstream from the sanding operation; the hood face was leveled with the worktable plane (Figure 6).

Measurements of Auxiliary Hood Performance

Evaluation of the auxiliary hood performance was based on a reduction ratio of wood dust particle number emitted into the work area. Since the auxiliary hood is an additional control to the standard belt sander hood, the reduction ratio, RD, was defined as follows:

$$\text{RD}\,(\%) = 1 - \left(\frac{\text{particle number concentration with aux. hood operating.}}{\text{particle number concentration without aux. hood operating.}} \right) \times 100.$$

The measurements of the particle number were taken with and without the auxiliary hood operating.

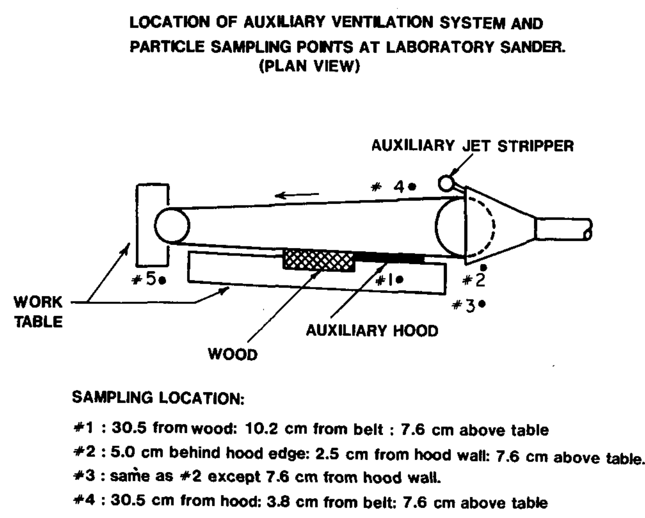

Figure 6—Location of auxiliary ventilation system and particle sampling points at laboratory sander (plan view)

TABLE I
Average Reduction in Wood Dust Particle Number Emission (%) by Auxiliary Hood at Positions 1-5

Sanding Belt Grade: #100

Auxiliary Hood Face Velocity	Position #1	#2	#3	#4	#5	Sander Hood Face Velocity
1420 cm/sec (2800 ft/min)	40	68	61			
2540 cm/sec (5000 ft/min)	51	76 +89	65			860 cm/sec (1700 ft/min)
3360 cm/sec (6600 ft/min)	63	83 +96	69	28	32	
1420 cm/sec (2800 ft/min)	43	37 +30	42			
2540 cm/sec (5000 ft/min)	65	49 +87	75			1270 cm/sec (2500 ft/min)
3360 cm/sec (6600 ft/min)	70	67 +84 B79 A60	75		18	

AMeasured by aerodynamic particle sizer APS 3300
BIncreased sanding pressure by 50%
+Oak

The wood dust particle number concentration was measured by a light scattering analyzer (Climet Instrument Co., Model Cl - 208A). Output signal from the particle analyzer was measured by a pulse height analyzer (Tracor - Northern Co., Model TN 1710). The experiments were conducted using the edge belt sander described previously. The sanded piece had the same dimensions for all measurements. The wood was pushed against the belt surface with constant pressure using a constant force applied mechanically to the wood surface. For the experiments, the following particle sampling method was used:

The particle background concentration was first measured without sanding. Then the sander was started. Since the particle cloud was unbalanced at the beginning of the sanding, the samples were taken one minute after the sanding started.

Generally, a sequence of five or more samples were collected in 10 or 20 second intervals to simulate industrial sanding practice. The samples were collected at five different sampling locations (shown in Figure 6).

Since preliminary measurements showed that reduction in wood dust emission at points #4 and #5 was significantly lower than that at other points, sampling at these points was minimized.

Table II
Average Reduction in Wood Dust Particle Number Emission in (%) by Auxiliary Jet Stripper

Effect of Applied Air Pressure

Applied Pressure	Sander Hood Face Velocity: 860 cm/sec (1700 ft/min)	1270 cm/sec (2500 ft/min)	Belt Grade
	71	72	#40
0.68 atm	81	76	#100
(10 PSI)	41	57	#220
	73	72	#40
1.02 atm	87	82	#100
(15 PSI)	43	50	#220

Measured at sampling position #5.
Auxiliary hood face velocity: 3360 cm/sec (6600 ft/min).
Distance of jet ends from belt surface: 0.64 cm (¼ in).

TABLE III
Average Reduction in Wood Dust Particle Number Emission in % by Auxiliary Jet Stripper

Effect of Jet End Distance from Belt Surface

Distance	Reduction	Remarks
0.32 cm (⅛ in)	74	
0.64 cm (¼ in)	83	Applied pressure of 1.02 atm (15 PSI)
1.27 cm (½ in)	85	

Measured at sampling position #4.
Auxiliary hood face velocity: 3360 cm/sec (6600 ft/min).
Applied pressure: 0.68 atm (10 PSI).
Belt Grade: #100.

TABLE IV
Average Reduction in Wood Dust Particle Number Emission (%) at Breathing Zone

Sander Hood Face Velocity	Auxiliary Hood Only Operating	Auxiliary Jet Stripper Only Operating	Both Auxiliary Systems Operating
860 cm/sec	56	55	89
(1700 ft/min)	55*	57*	82*
1270 cm/sec	49	76	82
(2500 ft/min)	46*	75*	78*

Measured at auxiliary hood face velocity: 3360 cm/sec (6600 ft/min). Auxiliary jet stripper pressure: 0.68 atm (10 PSI). Belt Grade #100.

*Measured by aerodynamic particle sizer APS - 3300.

Most of the experiments were conducted using cherry wood; however, for comparison, some measurements were performed using oak wood.

Three sanding belt grades — #40, #100, and #220 — were investigated. The auxiliary hood face velocities used were: 1420 cm/sec (2800 ft/min); 2540 cm/sec (5000 ft/min); and 3360 cm/sec (6600 ft/min).

Selected sander hood velocities of 860 cm/sec (1700 ft/min) and 1270 cm/sec (2500 ft/min) corresponded to air flow rates of 2.08×10^5 cm^3/sec (440 ft^3/min) and 2.83×10^5 cm^3/sec (600 ft^3/min) recommended by the Industrial Ventilation Manual for belt sanders up to 15.2 cm (6 in) and over 15.2 cm (6 in) to 22.9 cm (9 in), respectively. As an example, the average data of reduction in particle number emission into the work room at positions 1 - 5, for belt grade #100, are shown in Table 1. Similar data were obtained for belt grades #40 and #220.

Stripping System

From Table 1, it is evident that the auxiliary hood did not significantly reduce the wood emission at sampling points #4 and #5. The emission was reduced when the sander hood face velocity was increased; however, a substantial number of wood particles were still emitted into the workroom. As previously explained, this may be caused by the flow pattern of the particles leaving the belt air layer outside the sander hood. It was felt that a perturbation of the belt air layer inside the sander hood might change this particle flow pattern, resulting in an increased collection of the particles by the sander hood. Therefore, an auxiliary jet stripper was constructed to perturb the belt air layer.

Auxiliary Jet Stripper Description

The auxiliary jet stripper consisted of a manifold and 25 jets connected to the manifold. The manifold was supplied by pressurized air. The jet orifice ID was 0.11 cm (0.043 in) to achieve a very high velocity. The jets were distributed along the manifold to cover the whole width of the belt. The jet stripper is shown in Figure 5. The jets were located inside the sander hood close to the belt surface at an angle of 45° to the belt surface. The location of the auxiliary jet stripper is shown in Figure 6.

Measurement of Auxiliary Jet Stripper Performance

Instrumentation and Methodology

The instrumentation and sampling method used for measuring the auxiliary hood performance was also used for the evaluation of the jet stripper performance.

Effects of the following parameters on the jet stripper performance were investigated: manifold air pressure and distance of jet ends from the belt surface.

All experiments were conducted with the auxiliary hood operating at a face velocity of 3360 cm/sec (6600 ft/min) at belt grades of #40, #100 and #220. The effect of the applied pressure is shown in Table II; the effect of the jet end distance from the belt surface is demonstrated in Table III.

Several samples were also taken above the hood piece at a breathing zone, with and without both auxiliary ventilation systems operating. The same instrumentation was used; however, some particle number concentration measurements were conducted using an aerodynamic particle sizer (TSI, Inc., Model APS 3300). This instrument evaluates the particle size by measuring velocity of particles accelerated through a nozzle. This instrument was used to compare the reduction results obtained by two different particle detection methods. The results are shown in Table IV.

Field Tests

Laboratory results were verified by field tests conducted at a plant manufacturing wood furniture. The experiments were conducted at a horizontal oscillating edge belt sander (Oakley Co. Inc., Model H-5) with a platen of 152.4 cm (60 in). Dimensions of the sanding belt were 17.8 cm × 421.6 cm (7 in × 166 in). The belt surface speed was 1600 scm/sec (3150 sfpm). The edge belt sander was equipped with two hoods controlling wood dust emission. One hood was located at a driven pulley and the other hood was located at an idle pulley end. The face velocity of the driven pulley end hood averaged 1680 cm/sec (3300 ft/min) at the operator site; the average face velocity of this hood at the site opposite the operator was 1320 cm/sec (2600 ft/min). The idle pulley end hood was disconnected during the field tests to simulate the laboratory conditions.

The auxiliary hood was a simple narrow slot hood manufactured by the plant personnel. The slot opening was 0.5 cm × 73.7 cm (3/16 in × 29 in). The hood was located between a worktable and the belt surface downstream from the sanding operation. At this sander, the belt operation declines from its direction before entering the sander hood. At the beginning of the experiments, the auxiliary hood was bent to follow the belt surface line. The auxiliary hood was equipped with two exhausts connected to the exhaust serving the edge pulley end hood. The average auxiliary hood face velocity was 1970 cm/sec (3870 ft/min). Since the auxiliary hood face level was slightly below the worktable, the working auxiliary hood velocity at the sander table level was lower than the face velocity, averaging 1870 cm/sec (3670 ft/min).

For stripping, the laboratory auxiliary jet stripper was used, operating at a pressure of 1.02 atm (15 PSI). The

TABLE V
Average Reduction in Wood Dust Particle Emission (%) as Measured by Particle Number Measurements and Industrial Hygiene Sampling (Field Testing)

Sampling Position	Reduction in Emission in (%) As Measured By: Particle Number Measurement	I.H.+	Laboratory Data	Sampling Date	Remarks
1	79		82 (Belt #220)	12/13	Belt # 100; sanding oak drawer front door (long and short ends)—straight hood.
	65		65 (Belt #100)	12/14	Belt # 200; sanding maple blocks (small) & various wood types—bent hood.
	92			12/15	Belt # 100; sand-pine posts—bent hood.
2	73	93	49 (Cherry)	12/13	Belt # 100; sanding oak drawer front door; (short ends) — straight hood.
	71	74	87 (Oak) (Belt #100)	12/14	Belt # 100; sanding oak drawer front door and various wood types (short ends) — bent hood.
	96	98		12/15	Belt # 100; sanding pine posts
4	31	67		12/13	Belt # 100; sanding oak drawer front doors (long and short ends)—straight hood.
	43		84*	12/14	Belt # 100; sanding oak drawer front doors (short ends) & various wood pieces of different shape.
	68	42		12/15	Belt # 100; sanding pine posts.
5	67	95		12/13	Belt # 100; sanding oak drawer front doors (short ends)—straight hood.
	21	No Reduction	76*	12/14	Belt # 100; sanding oak drawer front door (short ends).
	70	64		12/15	Belt # 100; sanding pine posts.
		51		12/13	Belt # 100; sanding oak front doors (long and short ends).

TABLE V (cont.)
Average Reduction in Wood Dust Particle Emission (%) as Measured by Particle Number Measurements and Industrial Hygiene Sampling (Field Testing)

Sampling Position	Reduction in Emission in (%) As Measured By: Particle Number Measurement	I.H.+	Laboratory Data	Sampling Date	Remarks
Operator (breathing zone)		No Reduction	80* (Belt #100)	12/14	Belt # 100; sanding oak drawer front doors & various types of wood.
		16		12/15	Belt # 100; sanding small maple blocks and pine posts.

*Laboratory auxiliary hood face velocity: 3360 cm/sec (6600 ft/min)
+Industrial hygiene sampling

stripper was located on the worktable downstream from the driven pulley end hood at a site opposite the operator.

The wood dust particle number concentration emitted with and without the auxiliary ventilation system operating was measured at sampling points #1, 2, 4 and 5 (Figure 6). Along with these measurements, wood particles were collected on membrane filters at the same sampling points and at an operator breathing zone, with and without the auxiliary ventilation systems operating (industrial hygiene area and personal sampling). The results obtained during the three-day measurements are shown in Table V.

Results and Discussion

As seen from Table I, a significant improvement in wood dust control at sampling points #1-3 was achieved using the auxiliary hood in the laboratory. The average reduction in wood dust particle emission at all three sampling points for each belt grade and each sander hood face velocity is presented in Figures 7 and 8 as a function of the auxiliary hood face velocity. The looped standard deviations were calculated from standard deviations of measured particle number concentrations. The reduction in wood dust particle emission increased with an increase in the auxiliary hood face

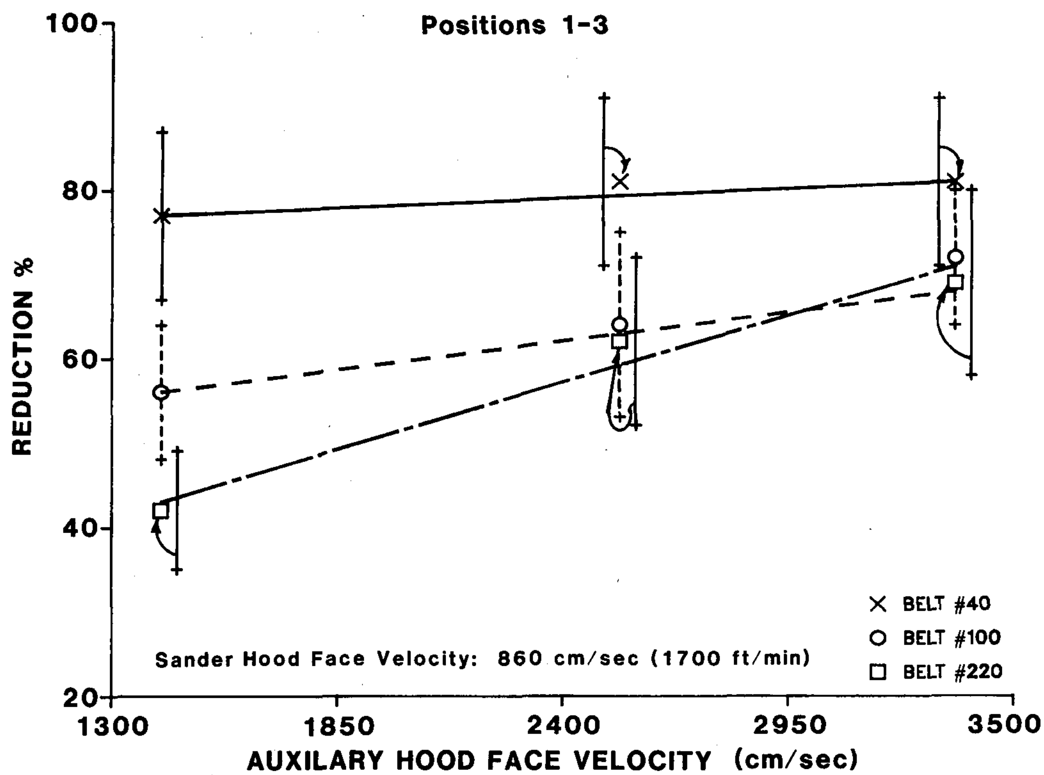

Figure 7—Average reduction in wood dust particle number emission vs. auxiliary hood face velocity

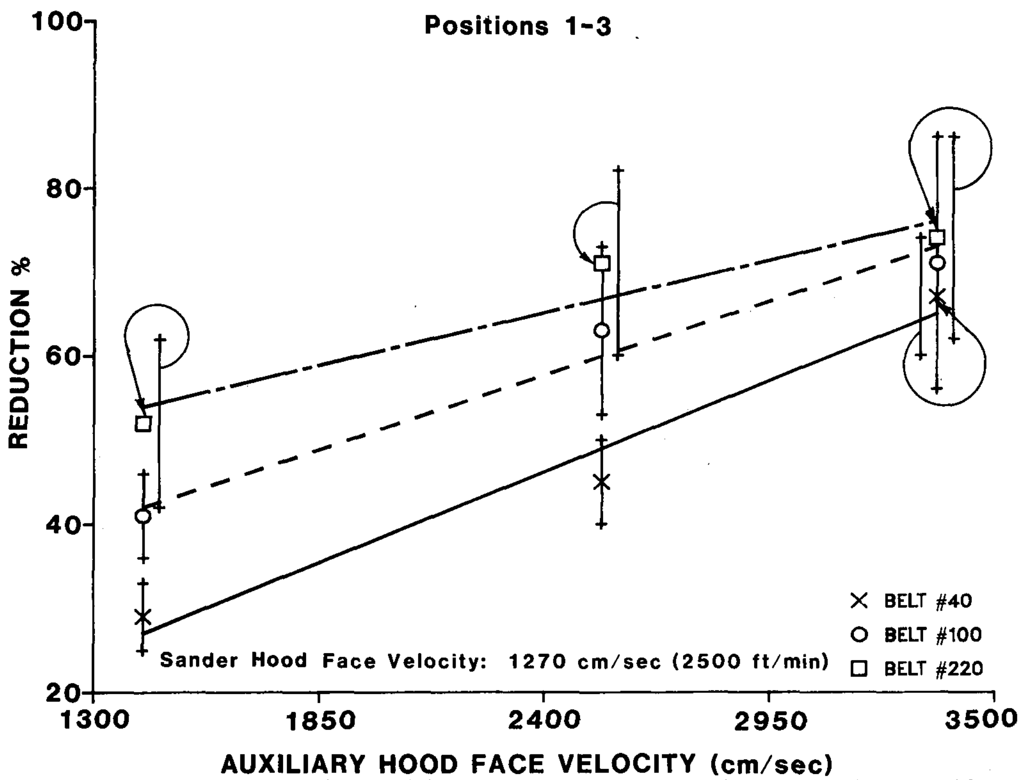

Figure 8—Average reduction in wood dust particle number emission vs. auxiliary hood face velocity

velocity, except at belt #40 and a sander hood face velocity of 860 cm/sec (1700 ft/min), where almost no increase in reduction was obtained. A statistical difference, calculated from 90% confidence limits and 90% confidence F-tests, was found between the particle number emission reduction data obtained at the auxiliary hood face velocities of 1420 cm/sec (2800 ft/min) and 3360 cm/sec (6600 ft/min) for both sander hood face velocities and all belt grades except at belt #40 and the sander hood face velocity of 860 cm/sec (1700 ft/min). As shown in Figures 7 and 8, the reduction in the wood dust particle number emission for all three belt grades is generally the same at the auxiliary hood face velocity of 3360 cm/sec (6600 ft/min) regardless of the different sander hood face velocities. No statistical difference was found between the emission reduction data obtained at all belt grades at this auxiliary hood face velocity, but these data statistically differed at the auxiliary hood face velocity of 1420 cm/sec (2800 ft/min) at both sander hood face velocities. This may indicate that the belt surface effect diminishes with increasing auxiliary hood face velocity and that — at a certain velocity of the auxiliary hood — the reduction in wood dust emission depends only on the auxiliary hood face velocity. The average reduction in wood dust particle number emission data at sampling points #1-3 for all belt grades was plotted versus face velocity ratio of both hoods (auxiliary hood/sander hood) as shown in Figure 9. A straight line calculated by the least squares method indicates that the auxiliary hood should operate at a higher face velocity ratio to achieve a significant reduction in wood dust emission.

At sampling points #4 and #5, the reduction in the wood dust emission was very low compared to sampling points #1-3. This indicates that the auxiliary pull system is efficient only between the sanding area and the sander hood; it does not affect the dust emission downstream from the sander hood. There is a reduction in particle number concentration when the sander hood face velocity increases, but a substantial wood particle number is still emitted into the workroom. As previously stated, this may be caused by the belt air layer carrying the particles outside the sander hood. The jet stripper located inside the sander hood perturbed the belt air layer and significantly reduced the wood dust particle emission in that area.

As seen from Table II, at sampling point # 5, average reduction in the wood dust particle number emission of 70% or better was achieved at belt grades #40 and #100, and 50% at belt grade #220. At sampling points #4 (Table III) the reduction in particle number emission averaged in the 80%s for belt grade #100. All measurements were conducted with the auxiliary hood operating at the face velocity of 3360 cm/sec (6600 ft/min). Experiments showed that the distance of the jets from the belt is not critical as expected (see Table III). The jet position between 0.6 - 1.3 cm (¼ in - ½ in) resulted in the same particle emission reduction (see Table III). Surprisingly, when the jets were close to the belt surface (0.32 cm - [⅛ in]), jet efficiency somewhat decreased. This may be caused by the construction of the jet stripper. Since the jet tubes are located at a certain distance from each other, the air jet cones may still be separate if the device is very close to the belt so that some spots on the belt are not controlled. At larger distances, the air jet cones overlap, resulting in a continuous air curtain along the entire belt width.

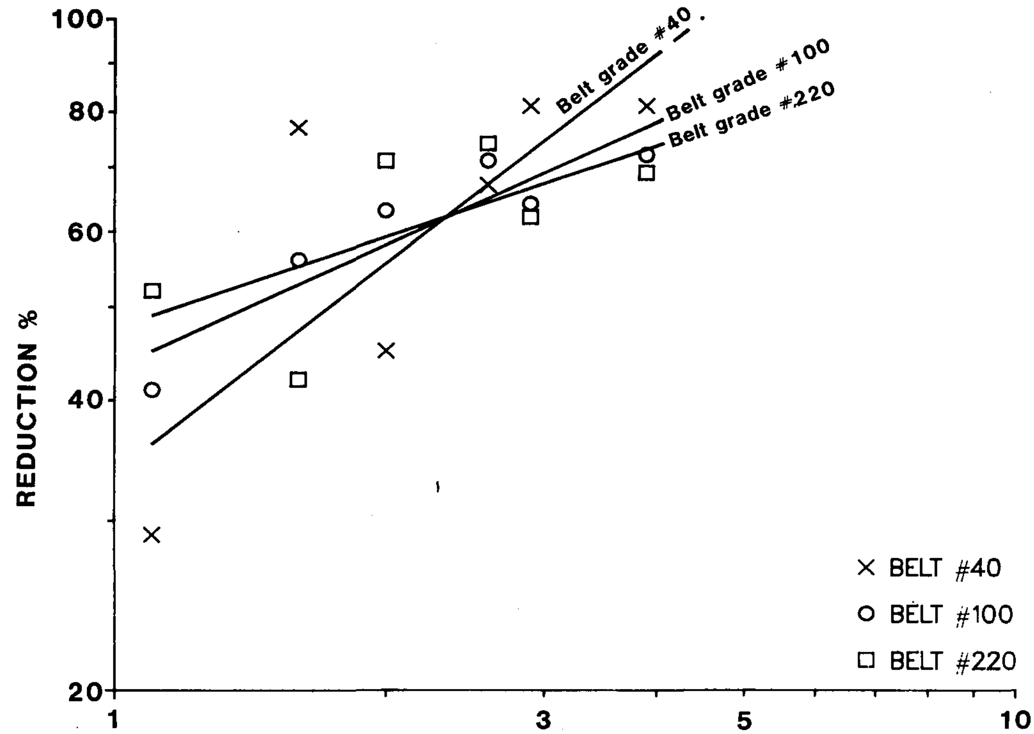

Figure 9—Average reduction in wood dust particle emissions vs. velocity ratio

An increase of applied pressure by 50% did not affect the reduction in particle number emission as expected; however, the calculated orifice velocities for pressures of 0.68 atm (10 PSI) and 1.02 atm (15 PSI) resulted in orifice velocities of 2.6 × 10^4 cm/sec (5.1 a 10^4 ft/min) and 2.9 × 10^4 cm/sec (5.7 × 10^4 ft/min) respectively. This is an increase in the orifice velocity of only about 10%. Evidently, a higher increase in the orifice velocity should be applied to affect significantly the reduction in particle emission.

Measurement results at the breathing zone (Table IV) demonstrate that an average reduction in particle emission of 50% was achieved by operating either auxiliary device. When both auxiliary systems were operating, the average reduction in wood dust particle emission increased to 80%.

The experiments with the auxiliary ventilation system were conducted mainly using cherry wood; however, several measurements were also conducted with oak wood for comparison. Generally, a higher reduction in wood dust particle emission was achieved with the oak wood which may be caused by its different structure.

During the field tests the operator worked normally; no special or reduced activity was required. Since the industrial hygiene sampling required a longer sampling time, the technique of immediate comparative measurements with and without the auxiliary ventilation system could not be used. Therefore, during half of the working time, the measurements without the auxiliary ventilation system operating were conducted at all sampling points. The second half of the working time was devoted to the measurements with the auxiliary system in operation. This strategy, however, required special conditions such as sanding the same type and shape of wood, which was not possible in some cases. The improvement in wood dust control obtained from field particle number measurement data (Table V) is generally comparable or better than the laboratory data at sampling points #1 and #2 and somewhat lower at the sampling points #4 and #5, namely, on the second day of experimentation. During this period, the measurements with the auxiliary ventilation system in operation were conducted in the morning, when the sander was running continuously. The measurements without the auxiliary ventilation in operation were conducted in the afternoon when the operator was sanding intermittently, changing the belts or type of wood or changing the sanding position on the belt (sanding on the upper part of the belt). Several measurements had to be repeated when he suddenly stopped sanding during the sampling.

Another reason why the improvement in the wood dust particle emission at points #4 and #5 was lower is that the

TABLE VI

Manufacturing of Auxiliary Ventilation System (All cost data related to 1983 prices)

Laboratory auxiliary hood:	Material	$ 30.00
	Labor	$ 90.00
	Total	$120.00
Laboratory jet stripper:	Material	$ 30.00
	Labor	$120.00
	Total	$150.00
Field auxiliary hood:	Material	$ 30.00
	Labor	$ 40.00
	Total	$ 70.00

laboratory jet stripper was also used for the field measurements. This jet stripper controlled the belt width of 15.2 cm (6 in), while the belt width used during the field test was 17.8 cm (7 in). Therefore, a portion of the belt was not controlled by the stripper. The best results were obtained on the third day, when the operator was sanding the same type of wood long enough to obtain reliable sampling data. The data obtained by the particle number measurements are fully supported by the data obtained by the area industrial hygiene sampling. The personal industrial hygiene sampling data were lower than those obtained at the breathing zone in the laboratory. This may be due to the operator's changing his position, leaving the sander, transporting wood to and from the sander, *etc.*, while the data measured in the laboratory were obtained at a fixed position. Nevertheless, the results from the field tests showed a significant reduction in wood dust emission and confirmed the laboratory data showing the effectiveness of the auxiliary ventilation system. This innovative concept of auxiliary control may be considered as a substantial contribution to the improvement of wood dust emission control at belt sanders.

Used for the majority of the particle number measurements, the light scattering particle analyzer was calibrated by special latex particles. It is recognized that the measurements of wood dust particles may differ from the calibration curve because of the irregular shape of wood particles. The reduction data, however, are based on a comparison of the particle number emitted with and without the auxiliary ventilation system operating. Since it was assumed that the shape of the wood particles would not change whether or not the auxiliary system operated, this error may be minimized. Moreover, as evident from Table IV, the results obtained by the aerodynamic particle sizer were comparable with those obtained by the light scattering particle analyzer, indicating that the use of this instrumentation is justified.

Since emphasis in this research was on technical effectiveness, a detailed economic analysis of the auxiliary ventilation system was not generated. Some cost data are added, however, to illustrate the economic feasibility of the auxiliary system (Table VI).

The calculated orifice velocity of the jet stripper at applied pressure of 1.02 atm (15 PSI) was 2.9×10^4 cm/sec (5.7×10^4 ft/min), resulting in an air flow rate of 226 cm^3/sec (0.48 ft^3/min) per jet. The air consumption for 25 jets is 5650 cm^3/sec (12 ft^3/min). At a 1983 cost for pressurized air of \$0.21/1000 ft^3/min (estimated by plant personnel), the cost for air consumption would be \$1.20/8 hr of operation. The auxiliary hood air flow rate was 2.1×10^5 cm^3/sec (460 ft^3/min). At a 1983 cost for air consumption of \$1.67/$1 \times 10^6 ft^3$/min (estimated by plant personnel), the cost for air consumption is \$0.37/8 hr.

The data above apply only to the given devices and the given experimental conditions. No calculation regarding annual cost, maintenance or depreciation, *etc.*, was applied.

Conclusion

An auxiliary ventilation system has been developed to improve the wood dust emission control at horizontal belt sanders. The auxiliary ventilation system consists of two devices: a low-volume, high-velocity slot hood and a jet stripper. The slot hood, located between the belt surface and a worktable downstream of the sanding operation, improved the wood dust control between the sanding area and the sander hood. The jet stripper, located inside the driven pulley end hood (opposite the operator), improved the wood dust control downstream from the sander hood. In combination with the standard hood, both devices significantly reduced the wood dust emission into the workroom.

Laboratory data obtained concerning the performance of the auxiliary ventilation system showed that a significant reduction in the wood dust emission into the workroom was achieved. The field tests conducted at the oscillating horizontal edge belt sander at the wood furniture manufacturing plant agreed very well with the laboratory data.

This auxiliary ventilation system is an innovative control technology concept and has the following advantages. Both devices:

- reduce wood dust emission into the workroom,
- do not interfere with the operator's sanding activity,
- work independently of each other,
- are economically feasible, and
- require minimal maintenance.

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