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The Generation Rate of Respirable Dust from Cutting Fiber Cement Siding Using Different Tools

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Abstract

This article describes the evaluation of the generation rate of respirable dust ($G_{APS,}$ defined as the mass of respirable dust generated per unit linear length cut) from cutting fiber cement siding using different tools in a laboratory testing system. We used an aerodynamic particle sizer spectrometer (APS) to continuously monitor the real-time size distributions of the dust throughout cutting tests when using a variety of tools, and calculated the generation rate of respirable dust for each testing condition using the size distribution data. The test result verifies that power shears provided an almost dust-free operation with a G_{APS} of 0.006 gram meter^{-1} (g m^{-1}) at the testing condition. For the same power saws, the cuts using saw blades with more teeth generated more respirable dusts. Using the same blade for all four miter saws tested in this study, a positive linear correlation was found between the saws' blade rotating speed and its dust generation rate. In addition, a circular saw running at the highest blade rotating speed of 9068 RPM generated the greatest amount of dust. All the miter saws generated less dust in the 'chopping mode' than in the 'chopping and sliding' mode. For the tested saws, G_{APS} consistently decreased with the increases of the saw cutting feed rate and the number of board in the stack. All the test results point out that fewer cutting interactions between the saw blade's teeth and the siding board for a unit linear length of cut tend to result in a lower generation rate of respirable dust. These results may help guide optimal operation in practice and future tool development aimed at minimizing dust generation while producing a satisfactory cut.

Keywords

aerodynamic particle sizer; crystalline silica; dust generation; fiber cement

Introduction

Occupational exposure to respirable crystalline silica causes silicosis, a fatal, progressive, fibrotic lung disease. Exposure to respirable crystalline silica has been linked to lung cancer, kidney disease, and autoimmune disorders (NIOSH, 2002). Exposure control through the use of engineering controls is crucial to disease prevention.

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Exposure to respirable crystalline silica has been documented in a variety of building and highway construction activities where silica-containing materials are cut, broken, drilled, ground, and cleaned up (Chisholm, 1999; Linch, 2002; Valiante et al., 2004). Fiber cement products, composed of Portland cement, sand, and wood fiber, are increasingly used in residential and commercial building construction (US Census Bureau, 2013). They are used in siding and trim boards, tile-backer boards, siding panels, and other building products. Exposures to respirable crystalline silica from cutting fiber cement siding have been documented by Lofgren et al. (2004) and Qi et al. (2013).

Fiber cement board is cut using three methods: scoring and snapping the board, cutting the board using shears, and cutting the board using a power saw. When scoring and snapping the board, a knife is used to score the board by scribing a deep line into the board. The board is bent, and it breaks along the scored line. This method should be relatively dust free. The score and snap method can be used when installing fiber cement board used for tile underlayment, but is not applicable to siding. Commercially available tools used to shear fiber cement siding include foot-powered shears and hand-held shears that may be manual or use a power source. These shears are reported to provide a relatively dust-free method of cutting fiber cement siding. However, slow production rates and low precision limit the use of shears by siding contractors (Bousquin, 2009). Power saws used to cut fiber cement siding, such as circular saws and compound miter saws, are normally used with four- to eight-tooth polycrystalline diamond-tipped (PCD) blades specifically designed to cut fiber cement siding and minimize dust generation.

Contaminant generation rate is an important factor in worker exposure because the generation of a particular contaminant directly contributes to exposure, and reducing the contaminant generation rate can often reduce exposure. Compared to assessing exposure, which often requires extensive field trials, characterizing the contaminant generation rate can easily be done in a laboratory setting with high repeatability. Therefore, comparing the contaminant generation rate under different testing conditions may result in rapid identification of optimal conditions and engineering control measures to reduce exposures. In addition, the contaminant generation rate is useful in ventilation system design (Flynn and Susi, 2012). However, there is no literature documenting the dust generation rate associated with the use of the aforementioned tools for cutting fiber cement products with varying operational parameters. This is largely attributed to the lack of reliable characterization methods. In a previous publication, Qi et al. (2016) demonstrated that a laboratory testing system, which was designed according to the European Standard EN 1093-3 (CEN, 2006) for characterizing the generation rate of airborne contaminants, provided reliable characterization of dust generation rate associated with cutting fiber cement products, and the characterization can be achieved by using a direct-reading instrument alone for dust measurement. In this current study, we used the same method and determined the dust generation rate from cutting fiber cement siding with compound miter saws, circular saws, and power shears. The knowledge gained from these experiments can potentially provide practical guidance to permit workers to choose desired tools and operational parameters that generate less dust, which could lead to reducing their exposures to respirable crystalline silica when cutting fiber cement siding, with or without the use of engineering controls.

Furthermore, the results from this study can be utilized by tool manufacturers to reduce the dust generation rates from tools designed to cut fiber cement siding.

Methods

Laboratory testing system

The laboratory testing system used in this study, described in Qi et al. (2016), is also illustrated in Supplementary Figure S1. The results documented in the previous publication demonstrated that this system provided automatic, uniform, and repeatable cutting of fiber cement siding boards and representative dust sampling. It uses an air-handling unit to draw room air into the system at a flow rate of 0.64 m^3 s^{-1}). The airflow that enters the system first passes through a filter panel to remove all the particles in the room air so that they did not interfere with the analysis of the dust generated inside the testing system. The filters also help to ensure that the air that entered the system had a uniform velocity profile across the panel's cross section. After the filtration section is the automatic tool-testing chamber, which is specifically designed and constructed for the cutting of fiber cement siding using a variety of tools. The air-handling unit collects the dust generated in the testing system with two filter cartridges before the cleaned air is discharged outdoors.

The tool-testing chamber features automatic control using programmable logic controller (PLC) and human machine interface (HMI). The tool operation is controlled using a two-dimensional actuator through the PLC. Up to six fiber cement siding boards can be mounted on a chain-driven feed plate, and the feed rate is automatically controlled through the PLC. Board feed rate and tool operation are programmed through the HMI so that automatic and repeatable cuts are achieved.

Power tools

The specifications for the power tools used for cutting fiber cement siding in this study are listed in Table 1. Each tool was mounted in the chamber using a specially designed fixture and tested separately. These tools were categorized into three groups: compound miter saws, circular saws, and power shears. Each of the power saws had an exhaust port designed to be attached to an external dust collector. Since the objective was to evaluate dust generation, we did not attach any dust collectors to the saws in this study. The specified no-load rotating speed listed in Table 1 for each saw was taken from the manufacturer's technical specification. We also measured the actual no-load speed for each saw using a pocket tachometer (Model TAC2K, Dwyer Instruments Inc., Michigan City, IN, USA) and the results are also listed in Table 1. A unique identifier was assigned to each power tool and is listed in Table 1 so that these tools can be more easily referred to in the subsequent text. For all the saws, the first letter in the identifier represents its type ('M' for miter saws and 'C' for circular saws), and the second letter is the initial of its manufacturer.

For a circular saw or power shears, the cut was made only by sliding the tool through the boards. A compound miter saw can make a cut by either chopping and/or sliding. In this study, we tested the miter saws in both the 'chopping only' and 'chopping and sliding' modes. In the 'chopping only' mode, the miter saw was configured to make a cut by chopping its blade through the board by descending vertically and then raising the blade. Miter saws in the chopping mode were unable to cut boards ≥ 21-cm wide, so the actual widths cut were recorded. In the ‘chopping and sliding’ mode, the miter saws was configured to cut ~9 cm by chopping vertically and then sliding the blade through the board horizontally to complete the cut. The sliding speed for all the tools can also be varied and regulated by the PLC, and it is referred to as the cutting feed rate.

A limited number of saw blades were tested in this study to evaluate their effects on the dust generation. The specifications for the tested saw blades are listed in Table 2. Qi et al. (2016) reported similar dust generation rates from using the same tool to cut fiber cement siding boards made by different manufacturers. Since the aim of this study is to evaluate the dust generation rate using different tools and under different operational parameters, fiber cement siding boards from the same manufacturer (CertainTeed, Valley Forge, PA, USA) were used throughout.

Sampling methods

The results in the previous publication (Qi et al., 2016) identified a consistent linear correlation between the dust generation rates obtained from an aerodynamic particle sizer spectrometer (APS; Model 3321, TSI Inc., Shoreview, MN, USA), i.e., G_{APS}, and a respirable cyclone sampler, i.e., G_{Cyc}: $G_{Cyc} = 1.6345G_{APS} + 0.0006$ with a R^2 of 0.9883. Thus, the APS alone was used in this study to facilitate the test with its direct-reading feature. Since the main objective of this study is to compare the dust generation rates under various experimental conditions, the data of G_{APS} for each condition are reported without converting to G_{Cyc} using the conversion equation above. The APS took air samples through an isokinetic sampling probe from a sampling port on the duct connecting the automatic tool-testing chamber and the air-handling unit. The APS provided real-time measurement of the size distribution of the dust generated with a 1-s time resolution. An aerosol dilutor (model 3302A; TSI Inc.), configured to provide a 100 to 1 dilution, was used with the APS so that measurement uncertainty caused by a high-concentration aerosols was minimized. The APS data have taken into account the dilution ratio and particle loss inside the dilutor. The dust size distribution directly measured by the APS is based on number concentration. The mass-based dust size distribution was calculated by assuming all the particles are spherical and the dust density is the same as the board density. Following the same procedure described in the previous publication (Qi et al., 2016), the mass concentration of respirable dusts ($C_{m,t}$) from one set of the APS data (1-second) was calculated by multiplying the respirable fraction from the convention curve (CEN, 1993; ISO, 1995) for the mass-based dust size distribution and summing them up for all the size channels. Thus, the generation rate of respirable dust (G_{APS}) is defined as the mass of respirable dust generated per unit linear length cut, and it can be derived by the following equation:

$$G_{APS} = \frac{\sum_{t=1}^{T_s} (C_{m,t} Q)}{n_c n_b W} \quad (1)$$

where, T_s is the total sampling time of the APS for one cut; Q is the volume flow rate in the testing system, 0.64 $m^3\ s^{-1}$; n_c is the number of repeated cuts during each test; n_b is the number of board in the stack; and W is the actual board width per cut. These APS data contain one set of dust size distribution for every second during the test, which leads to a $C_{m,t}$ data point for each second. Assuming $C_{m,t}$ is the average concentration across the duct's cross section, the value of $C_{m,t}Q$ corresponds to the total mass of respirable dust in each particular second during the test. The summation of $C_{m,t}Q$ during the sampling time T_s results in the total mass of respirable dust generated for one cut. Thus, the generation rate of respirable dust defined in equation (1) represents the mass of respirable dust generated per unit linear length cut. Linear length cut is commonly used in practice to account for cutting productivity.

Analysis of the APS data from a trial test with 15 cuts under the same testing condition (the same power saw, the same saw blade, and the same operational parameters) revealed that the relative standard deviation (RSD, the ratio of the SD to the mean) for the G_{APS} calculated from each of the 15 cuts was only ~3.1%, demonstrating excellent repeatability of the test. With this high repeatability, three or more repeated cuts under the same testing condition were considered sufficient to provide statistically reliable results. The small RSD was consistently observed in the data from all of the tests in this study. Thus, error bars were omitted for clarity from the figures presenting the results.

Results

The result of G_{APS} for the power shears was 0.006 ± 0.0008 g m^{-1} (mean and SD of 3 replicate cuts) at a feed rate of 2.54 cm s^{-1}, verifying that it is indeed an almost dust-free operation. However, as mentioned earlier, its use in siding installation is limited by slow production rates and low cutting precision.

The particle size distributions (PSD) monitored by the APS for each test using the power saws have almost the same shape as that reported in the previous publication (Qi et al., 2016) for a typical PSD of the dust from cutting fiber cement siding. The number-based PSD typically has a lognormal distribution with a geometric mean diameter near 1.0 µm and a geometric SD of ~1.5. The total particle concentration, of course, varies for each test. Therefore, about half of the particles in terms of number are in the submicron range. The mass-based PSD typically has a bimodal lognormal distribution with a larger mode at ~13 µm and another mode at <5 µm.

Dust generation from cutting fiber cement siding using different saw blades

The results of G_{APS} (mean and SD of 5–10 replicates) for the tested saw blades are also listed in Table 2. An 8-tooth PCD blade and a 60-tooth carbide-tipped blade were tested on the M-M saw, which was used in the 'chopping and sliding' mode with a saw cutting feed rate of 2.54 cm s^{-1}. Both of those blades were 30.5 cm in diameter. In addition, three 18.4-cm-diameter saw blades, including a 4-tooth PCD blade, and a 28- and a 6-tooth carbide-tipped blades, were tested on the C-M saw. Only one saw blade of 12.7 cm (5 inches) diameter with six carbide-tipped teeth was tested on the C-R saw. A saw cutting feed rate of 2.54 cm s^{-1} was used in these tests with the C-M and C-R saws. Among the three 18.4-cm-diameter blades, the Makita blade with 28 carbide-tipped teeth generated significantly more dusts than the other two blades (1.02 ± 0.04 g m^{-1} versus 0.41 ± 0.01 g m^{-1} and 0.42 ± 0.02 g m^{-1}), which have four PCD-tipped teeth and six carbide-tipped teeth, respectively. The G_{APS} of these two blades with 4 PCD-tipped teeth and 6 carbide-tipped teeth were not significantly different ($P = 0.192$). Comparing the two 30.5-cm-diameter blades, the blade with 60 carbide-tipped teeth generated 62% more dust than the blade with 8 PCD-tipped teeth (0.86 ± 0.03 g m^{-1} versus 0.53 ± 0.02 g m^{-1}). These results indicate that fewer teeth on a blade may lead to lower dust generation, possibly due to fewer interactions between the blade's teeth and the board during one complete cut.

The 12.7-cm-diameter Freud blade was the only blade of its size tested in this study, and its G_{APS} was the highest among all the blades tested. Specifically, its G_{APS} was 148% higher than the 18.4-cm-diameter Freud blade (1.04 ± 0.03 g m^{-1} versus 0.42 ± 0.02 g m^{-1}). These two Freud blades both have six carbide-tipped teeth and a kerf width of 1.7 mm. They were used with two different circular saws with different saw blade diameters (12.7 cm versus 18.4 cm) and blade rotating speeds (9068 RPM versus 5500 RPM). This resulted in a difference of 13.7% on the linear speed of the blade's tooth cutting through the board (60.3 m s^{-1} versus 53.0 m s^{-1}). Based on the comparisons of these specifications, the higher G_{APS} for the 12.7-cm-diameter blade was likely due to its higher blade rotating speed, as a higher blade rotating speed leads to proportionally more interactions between the blade's teeth and the board during one complete cut. It should be noted that the blades used in these tests were brand new so the G_{APS} results may be different for aged blades. Since the PCD blades were designed to last much longer than the carbide-tipped blade, only the PCD blades were used in the rest of this study if not specified otherwise, except for the C-R saw, which only had the 12.7-cm-diameter Freud blade available for it.

Dust generation from cutting fiber cement siding using different miter saws

Figure 1 shows the G_{APS} (mean of 10 replicates) for the four miters saws tested in this study, which used the same eight-tooth PCD saw blade (Hitachi 18109; Hitachi Power Tools, Valencia, CA, USA). It was apparent that all the miter saws generated significantly less dust in the 'chopping mode' (ranging from 0.23 to 0.34 g m^{-1} compared to ranging from 0.53 to 0.77 g m^{-1} in the 'chopping and sliding' mode; $P < 0.001$ from a *t*-Test for the two groups of samples of each miter saw). Since the test CertainTeed board is only 0.76-cm thick, it took considerably less time to conduct one cut in the 'chopping mode' than in the 'chopping and sliding mode'. Thus, there were fewer cutting interactions between the blade's teeth and the board during one chopping cut. This was likely the reason for the lower dust generation rate in the 'chopping mode'. The comparison of the G_{APS} among the four miter saws was consistent for both modes, with the M-H saw having the highest G_{APS} and the M-M saw having the lowest. The differences were likely due to their different specifications, especially the blade rotating speed, which is also presented in Fig. 1.

Furthermore, Fig. 2 plots the G_{APS} against the saws' blade rotating speed and a linear correlation was found with a R^2 of 0.99 for both modes. In the 'chopping mode', the higher G_{APS} of the M-H saw (4200 rpm) over that of the M-D saw (3922 rpm) was found to be not statistically significant ($P = 0.06$). For all other comparisons of the data plotted in Fig. 2, the higher G_{APS} from a higher blade rotating speed was found to be statistically significant [$P = 0.014$ for the comparison between the M-D saw (3922 rpm) and the M-B saw (33714 rpm), and $P \leq 0.001$ for all the other cases]. The high correlation between the dust generation rate and the saws' blade rotating speed is also consistent with the previous observation that the C-R saw with the 12.7-cm-diameter Freud blade operated at the highest rotating speed led to the highest G_{APS} among all the test. These results suggest that a lower blade rotating speed might be preferred for cutting fiber cement boards as long as it provides similar cutting quality.

Note that saw cutting feed rate was fixed at 2.54 cm s^{-1} for these tests with miter saws. The cutting tests for sliding the saw blades of the miter saws through fiber cement board (no chopping motion) at different saw cutting feed rates were not investigated in this study.

Dust generation from cutting fiber cement siding using circular saws under different saw cutting feed rates

Fig. 3 shows the G_{APS} results (mean of 5 replicates) for three tested circular saws under different saw cutting feed rates. It is apparent that the G_{APS} decreased with the saw cutting feed rate for all the saws tested. For the same saw, the lower G_{APS} under a higher saw cutting feed rate was found to be statistically significant ($P < 0.001$). This was likely due to fewer cutting interactions between the blade's teeth and the board during one cut when the saw cutting feed rate was higher. Under the same saw cutting feed rate, circular saw C-R (used with the 12.7-cm-diameter Freud blade) generated significantly more respirable dust than circular saw C-H ($P < 0.001$), which also generated significantly more respirable dust than circular saw C-M ($P < 0.001$). Both the C-H and C-M saws used the same blade with four PCD-tipped teeth in these tests. The differences of G_{APS} among these circular saws under the same saw cutting feed rate were likely due to their different blade rotating speeds (9068 rpm for the C-R saw, 5663 rpm for the C-H saw, and 5500 for the C-M saw).

Dust generation from cutting different numbers of fiber cement siding boards at once

Up to six boards were stacked and cut in this study for the M-B, C-H, and C-M saws, and their G_{APS} results (mean of 5 replicates) are presented in Fig. 4. For all three saws, the G_{APS} decreased with the number of boards in the stack. For the same saw, the lower G_{APS} that resulted from more boards in the stack was found to be statistically significant ($P < 0.001$). Since the saw cutting feed rate was fixed at 2.54 cm s^{-1} for these tests, it took about the same amount of time for the same saw to cut the stack of boards no matter how many boards were in the stack. Therefore, fewer cutting interactions occurred between the blade's teeth and the siding material per unit linear length of cut when a larger number of boards were in the stack, which likely contributed to the lower G_{APS} defined in equation (1) as the mass of respirable dust generated per unit linear length of cut. The C-R saw uses a 12.7-cm-diameter blade, so it cannot cut a stack of six boards, thus that saw was not tested in this part of the study. Miter saws other than M-B were not tested either, but they would be expected to follow the same trend of lower G_{APS} with more boards in the stack.

With the same number of stacked boards, miter saw M-B generated significantly more respirable dust than circular saw C-H ($P < 0.001$), which also generated significantly more respirable dust than circular saw C-M ($P < 0.001$).

Discussion

The G_{APS} of the two 18.4-cm-diameter blades with four PCD-tipped teeth and six carbide-tipped teeth are not significantly different ($P = 0.192$). This result suggests that the PCD-tipped teeth alone may not lead to a lower dust generation rate compared to carbide-tipped teeth. Thus, the significantly lower G_{APS} from the 30.5-cm-diameter blade with eight PCD-tipped teeth (0.53 ± 0.02 g m^{-1}) compared to that from the blade with 60 carbide-tipped teeth (0.86 ± 0.03 g m^{-1}) is most likely attributed to fewer teeth. However, the use of blades with PCD-tipped teeth may still be preferred in practice since they were designed to last much longer than carbide-tipped blades.

All the experimental results in this study point out that fewer cutting interactions between the saw blade's teeth and the siding board for a unit linear length of cut tended to result in a lower respirable dust generation rate. This was consistently observed with the lower G_{APS} under the test conditions of fewer teeth on the saw blade, lower blade rotating speed, higher saw cutting feed rate, and more boards stacked for each cut. All the miter saws generated less dust in the 'chopping mode' that in the 'chopping and sliding' mode, possibly for the same reason. Therefore, if the cutting quality remains satisfactory, in order to minimize dust generation, operators of power saws to cut fiber cement siding may want to 1) select saw blades with fewer teeth and power saws with slower blade rotating speeds; 2) choose to operate the saws at a higher cutting feed rate; and 3) stack more boards for each cut when possible. These practices may reduce exposures to respirable silica dust when cutting fiber cement siding. Additional research may be considered to develop blades and power saws specifically for cutting fiber cement siding with fewer teeth and lower blade rotating speeds than those tested in this study. These improvements could help reduce workers' exposures to respirable crystalline silica when cutting fiber cement siding with or without the use of engineering control measures.

Conclusions

The laboratory test of the generation of respirable dust from cutting fiber cement siding boards verified that using power shears to cut fiber cement siding provided an almost dust-free operation. When power saws were used, fewer cutting interactions between the saw blade's teeth and the siding board for a unit linear length of cut resulted in a lower respirable dust generation rate. This can be achieved by using a saw blade with fewer teeth, power saws with lower blade rotating speeds, a higher saw cutting feed rate, and by stacking more boards for each cut. The results obtained in this study may help guide optimal operation in practice and future tool development aimed at minimizing dust generation while producing a satisfactory cut.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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References

Bousquin, J. [Accessed 2 August 2016] Fiber cement's aesthetics and durability continue to gain fans. Building Products Magazine. 2009. Publication date: February 13, 2009 Available at http://www.ebuild.com/articles/875202.hwx

CEN. Centre European de Normalisation Workplace atmospheres: size fraction definitions for measurement of airborne particles in the workplace, EN 481. Brussels, Belgium: CEN; 1993.

CEN. Safety of machinery-Evaluation of the emission of airborne hazardous substances-Part 3: Test bench method for measurement of the emission rate for a given pollutant, EN 1093-3. Brussels, Belgium: CEN; 2006.

Chisholm J. Respirable dust and respirable silica concentrations from construction activities. Indoor Built Environ. 1999; 8(2):94–106.

Flynn MR, Susi P. Local exhaust ventilation for the control of welding fumes in the construction industry - a literature review. Ann Occup Hyg. 2012; 56(7):764–776. [PubMed: 22459321]

ISO 7708. International Organization for Standardization (ISO) 7708: particle size definitions for health related sampling. Geneva, Switzerland: ISO; 1995.

Linch KD. Respirable concrete dust - silicosis hazard in the construction industry. Appl Occup Environ Hyg. 2002; 17(3):209–221. [PubMed: 11871757]

Lofgren DJ, Johnson DC, Walley TL. OSHA Compliance issues: silica and noise exposure during installation of fiber-cement siding. J Occup Environ Hyg. 2004; 1:D1–D6. [PubMed: 15202147]

NIOSH. NIOSH Hazard Review: Health Effects of Occupational Exposure to Respirable Crystalline Silica. Cincinnati, OH: National Institute for Occupational Safety and Health; 2002. Publication No. 2002-129

Qi, C., Echt, A., See, M. In-Depth Survey Report: partnering to control dust from fiber-cement siding. Cincinnati, OH: DHHS/CDC/NIOSH; 2013. Report No. EPHB 358-11aAvailable at http://www.cdc.gov/niosh/surveyreports/pdfs/358-11a.pdf [Accessed 2 August 2016]

Qi C, Echt A, Gressel MG. On the Characterization of the Generation Rate and Size-Dependent Crystalline Silica Content of the Dust from Cutting Fiber Cement Siding. Ann Occup Hyg. 2016; 60(2):220–230. [PubMed: 26391971]

US Census Bureau. [Accessed November 9, 2016] SURVEY OF CONSTRUCTION, Principle Type of Exterior Wall Material of New One-Family Houses Completed. 2013. http://www.census.gov/const/C25Ann/sftotalexwallmat.pdf

Valiante DJ, Schill DP, Rosenman KD, Socie E. Highway repair: a new silicosis threat. Am J Public Health. 2004; 94(5):876–880. [PubMed: 15117715]

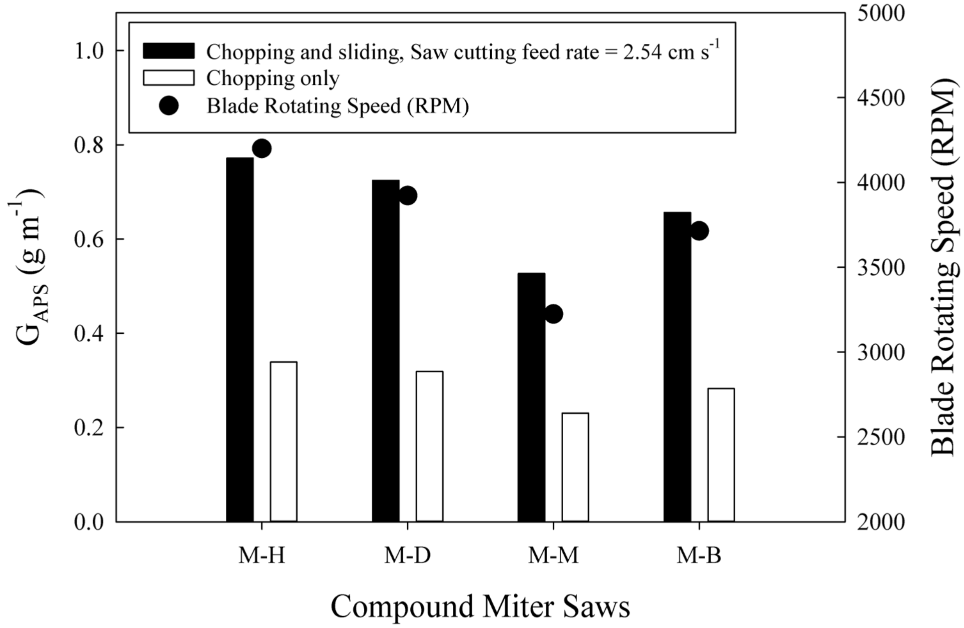

Figure 1.

Generation rate of respirable dust (G_{APS}) for the miter saws. Blade: Hitachi 18109; Siding: CertainTeed.

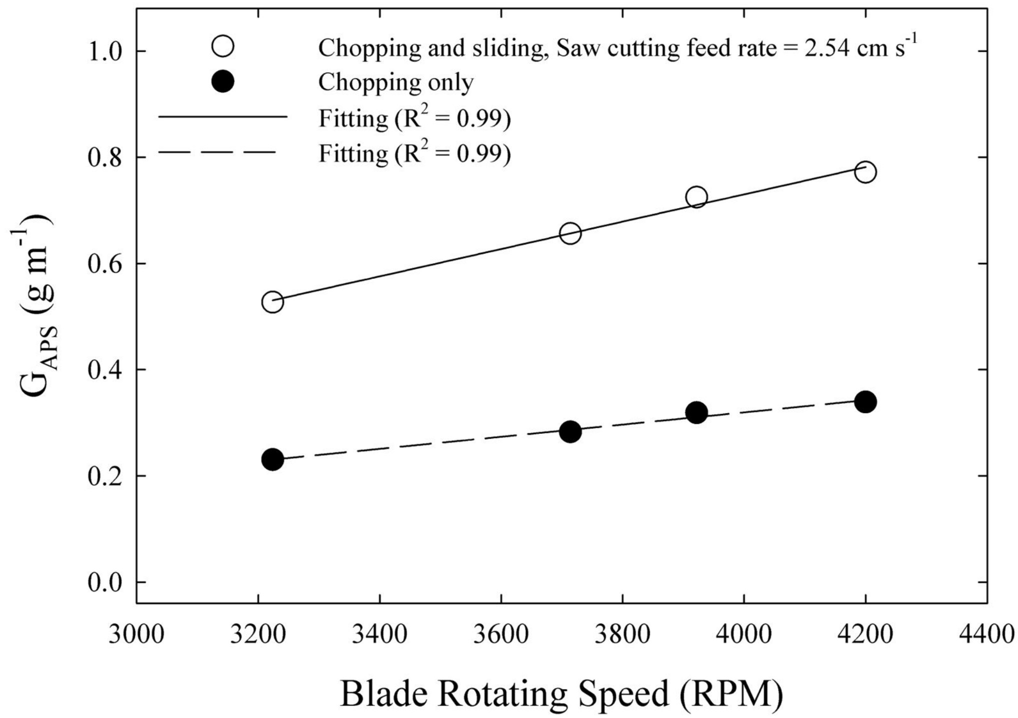

Figure 2.

Comparison of the generation rate of respirable dust (G_{APS}) and the blade rotating speed for the miter saws. Blade: Hitachi 18109; Siding: CertainTeed.

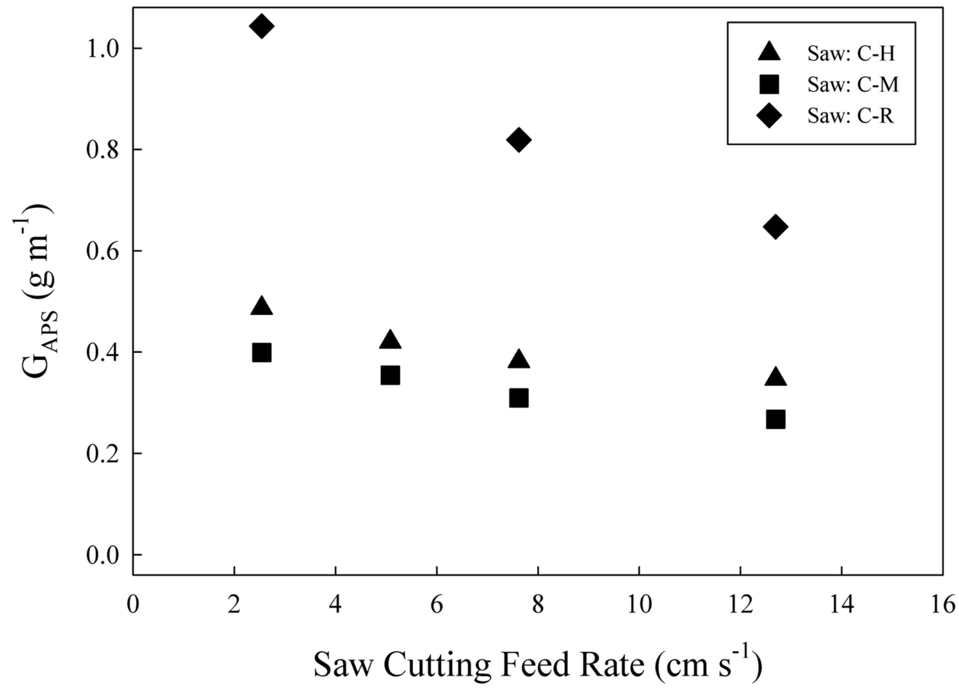

Figure 3.
Generation rate of respirable dust (G_{APS}) at different saw cutting feed rate. Siding: CertainTeed.

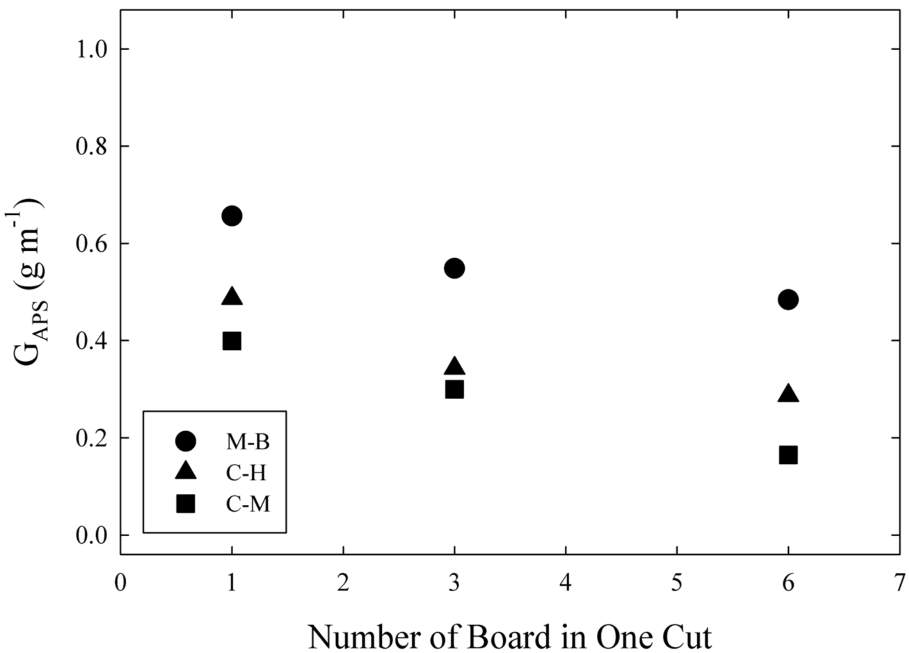

Figure 4.

Generation rate of respirable dust (G_{APS}) when cutting different numbers of siding board in the stack. Saw cutting feed rate 2.54 cm s^{-1}; Siding: CertainTeed.

Table 1

Power tools used in the study and their specifications

Manufacturer	Model #	Type	Blade Diameter (cm)	Specified No Load Rotating Sped (RPM)	Measured No Load Rotating Sped (RPM)	Abbreviation
Bosch	GCM12SD	Compound Miter	30.5	3800	3714	M-B
Dewalt	DW718	Compound Miter	30.5	3600	3922	M-D
Makita	LS1216L	Compound Miter	30.5	3200	3224	M-M
Hitachi	C12LSH	Compound Miter	30.5	3800	4200	M-H
Hitachi	C7YAH	Circular	18.4	5500	5663	C-H
Makita	5057KB	Circular	18.4	5800	5500	C-M
Ridgid	R3400	Circular	12.7	9250	9068	C-R
PacTool International	404	Power Shears	DNA	DNA	DNA	DNA

Note: RPM — Revolutions Per Minute; DNA — Does Not Apply

Table 2

Saw blade used in the study and their specifications, Saw cutting feed rate 2.54 cm s^{-1}

Manufacturer	Model #	Blade Diameter (inch)	Number of Tooth	Tooth Type	Kerf Width (mm)	Test Saw	Generation Rate of Respirable Dust G_{APS} (g m^{-1})
Hitachi	18109	12	8	PCD-tipped	2.2	M-M	0.53±0.02
Makita	A-93712	12	60	Carbide-tipped	2.3	M-M	0.86±0.03
Hitachi	18008	7.25	4	PCD-tipped	1.8	C-M	0.41±0.01
Makita	A-90451	7.25	28	Carbide-tipped	2.0	C-M	1.02±0.04
Freud	D0706CH	7.25	6	Carbide-tipped	1.7	C-M	0.42±0.02
Freud	D0506CH	5	6	Carbide-tipped	1.7	C-R	1.04±0.03