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THE EVALUATION OF DIFFERENT SAMPLING METHODS OF WOOD DUST

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Key words: *Total dust , inhalable dust , 7-Hole samplers , open face samplers , close face samplers*

Abstract

In order to compare sampling efficiencies of total and inhalable dust methods , three airborne dust sampling systems , 7-Hole sampler , close and open face filter cassette were compared side-by-side , as stationary and personal samplers , in a wood working industry to evaluate their relative efficiency. A total of 162 samples were collected.

The study of particle size distribution by cascade impactor indicated that the particles smaller than 4.7 and 11 μ comprise about 13% and 30% of total dust respectively and therefore about 70% of particles are greater than 11 μ.

The 7-Hole gave a higher dust concentration measurement than open face and close face filter cassettes , in all processes , $P<0.05$. This significant elevated concentration is probably due to higher sampling efficiency of 7-Hole sampler for particles diam>11 , compared to the open face and close face filter cassettes. Open face and close face filter which were expected to give equivalent results measured statistically equivalent dust concentrations.

Introduction

Althugh the TLV's value for approx. 99% of the substances have been expressed on the basis of the measurement of total dust (4) , the samplers used today for measurement of total dust are very inaccurate and inappropriate because no attention was paid to the effects resulting from the

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geometry configuration of samplers entrance for large particles. The concept of total dust itself is basically under question and no accurate definition of it has been made. For example , should the particle of 250 μ in the sample be weighted or eliminated (4)? With respect to classification of dusts , one of the solutions to the problem , specially for the dusts , which their depostion in any portion of respiratory system could be dangerous , is that the measurement should be made so that reflects the dust concentration entered into human's mouth and nose Inhalable Particulate Mass (IPM).

Recently , a technique for IPM sampling through 7-Hole sampler have been presented by Health and Safety Executive (2). Sampling efficiency by this instrument is consistent with ACGIH's definition of inhalable particles.

The present project has taken place aimed at evaluation of inhalable and total dusts sampling methods in one of wood working industries , and the basis of the above evaluation is the comparison of 7-Hole , open and close face filter cassettes with each other.

Materials and methods

The comparison of sampler's performance in assessment of wood particles has taken place by simultaneous sampling through inhalable and total dust sampling methods. Doing this , sampling of total dust took place on the basis of NIOSH's and that of inhalable dust upon Health & Safety Executive's proposed method.

Three different types of samplers including 7-Hole , open face and close-face were compared simultaneously as static samplers in a side by side arrangement for a variety of locations and tasks in a wood working industry. For the elimination of probable errors resulting from samplers' head being far from or near to dust generation sources , the arrangement of samplers' head would change randomly (using random numbers table) according to sampling methods recommendations (6). During sampling , the head of close face and open-face cassettes have been downward and 7-Hole slightly has been upward.

All three samplers would turn on and off simultaneously and all instruments were calibrated with a soap bubble flowmeter before and after sampling.

Various types of wood processes (including sampling , sawing ,...) have been sampled owing to the inclusion of dust generation processes.

Sampling duration had been sellected so that sufficient quantity of dusts was prepared. A total of 105 sample were collected in breathing zone and 57 from general environment. All samples were collected on PVC filters (5μ pore size) and weighted to 5μg on a calibrated Mettler Electro balance (Mettler AE 240) before and after sampling. Filters were allowed to equilibrate with laboratory atmosphere for 24 hr prior to weighing.

During the whole process , wind speed was routinely measured at the sampling assembly by an anemometer , Model TA2/Air flow Co.

Results

Upon 162 samples whose results reflected in Table 1 , it was indicated that average concentration obtained from each process as well as the concentration obtained by different samplers in a certain process showed statistically significant difference with each other ($P<0.05$).

The results of 54 series of sampling ($N= 54 \times 3 = 162$) show that performance of samplers for inhalable and total dusts are highly correlated (Tab. 2). Pair T Test shows that inhalable dust concentration is more than that for total dust ($P<0.05$). The mean of the differences in the concentration obtained from each of personal and environmental samplers were calculated (Tab. 3) and studied in two ways:

A: Table 3 illustrates that the cocnetration obtained from 7-Hole sampler in personal and environmental sampling , after carrying out Pair- T Test , shows significant differences with close face F.C and open face F.C values ($P<0.05$). While open face F.C and close face F.C amounts have not shown any significant differences.

B: In this stage , assuming three above mentioned samplers have similar function , the differences in quantities obtained from personal and environmental assessments were analyzed for one-way variance analysis separately , where after doing Tuki Test , it was indicated that there is a significant difference between the results of different samplers ($P<0.05$). This test also indicated that in personal samples , the above difference exists between the average difference resulting from open face , 7-Hole ,

and open face , close face , and in environmental samples a difference is found between average difference of open face , close face and (close face, 7-Hole) ones ($P<0.05$).

Conducting a study on the concentration obtained from 7-Hole sampler and its comparison with the concentration resulting from open face and close face ones , it was indicated that their relative variations with respect to each other varies in different preocesses. For its determination the following procedure was carried out:

The concentration obtained from 7-Hole sampling instrument in each process is divided by the quantity obtained from " open face " and " close face" in the same process and the result was multiplied by 100. The mean of the observed variations in each process is shown in Tab 4.

Since particle size distribution is an important parameter in airborne dust samplers performance evaluation , a comprehensive study using 8-stages cascade impactor made by Ogave Co. (OSK 8891) was carried out as a part of the project. The results indicated that particle distribution in various wood working processes have an average size as in Fig 1.

Discussion

Particle size distribution results indicated that the particles with aerodynamic diameter smaller than 4.7 (Respirable dust) comprises about 13% of wood particles only , and the major portion of wood dust mass is contributed by particles larger than 11 μm (70%). Therefore it could be concluded that respirable dust sampling is not an appropriate method for determination of hazards in wood working workshops (3).

The sampler comparison made it possible to evaluate the IPM and total sampling method and the selection of optimum instrument for sampling of wood dust (and perhaps other particles). The results of personal and environmental sampling showed that the concentration of particles collected by 7-Hole is considerably higher than that obtained from total samplers. Regarding that the particles smaller than 11 μm comparises about 30% of total particles , it could be said that the elevated concentration measured with the 7-Hole sampler, is probably due to the higher sampling efficiency of the 7-Hole sampler for particles with diam>11 μm , compared to the open and close face

filter cassettes (7). Concerning the comparison of an IPM (IOM) sampler with a total sampler of wood dust.

Overviewing the results obtained and the reasons presented here , it can be stated that applying 7-Hole sampling method can provide better results than those of open face F.C and close face F.C for the evaluation of hazards of wood particles in wood working workshops.

Results' variation coefficient in IPM method is smaller than the quantities obtained through total methods (except for environmental samples related to open face F.C which is because of low concentration of dusts and fast settling of large particles after release).

Considering the sampling took place just in the hottest months (Summer) of the year and when the workshops' doors and windows were open as well as the air current was flown from cooler devices in the field. The measurement of wind speed taken during the investigation ranged from 0.05-0.7 m/s with an average of 0.2 m/s. Smaller variation coefficient could be considered as 7-Hole sampler being more independent from air velocity and direction , in comparison with the other two samplers ; since as we know , one of the greatest disadvantage of open face F.C and close face F.C samplers is their high sensitivity to air velocity and direction.

As notad earlier sampling by cascade impactor showed (Fig 1) that on average , about 70% of the particles has diameter greater than 11 μm.

Since sampling efficiency taken by open and close face cassettes significantly decreases by increase in the particle diameter especially for particles with diameter higher than 10 μm, open and close face cassettes lacks appropriate efficiency for wood particles sampling and hence provides a lower response than that of real quantity.

The study of variation mean (Tab. 4) indicates that this index is greater in all processes than in sanding. Therefore knowing the particles generated in sanding process is the smallest particles found in any wood working workshops , it could be anticipated that the samples collected by 7-Hole in other processes has higher percent of large particles.Influenced

such particles generated in the processes except for sanding process , has caused greater difference between 7-Hole and open and close face filter cassettes.

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Table 1- Mean of dust concentration in different processes for three types of samplers

Process \ Type of sampler	Open F.F.C			Close F.F.C			7-Hole		
	N	$\bar{X}$	S	N	$\bar{X}$	S	N	$\bar{X}$	S
Sanding. M.	7	63.784	32.088	7	90.068	42.079	7	129.048	51.298
Circular saw	7	4.186	2.128	7	5.454	2.355	7	11.610	3.820
Planing. M.	7	4.473	1.522	7	4.685	1.538	7	8.900	4.273
Jointing. M.	7	10.227	6.183	7	5.835	1.560	7	13.973	5.263
Band saw	7	6.984	7.317	7	5.979	3.539	7	24.217	27.349
Stationary. S.	19	8.279	6.053	19	8.183	6.733	19	12.308	9.681
Total	54			54			54		

Table 3 - Mean of differences in the concentration obtained from different samplers

Type of sampling	Samplers	N	Average of Mean differences	S	T Test
Personal	Open face , close face	35	-5.939	17.998	N.S
	Close face , 7 Hole	35	-17.034	23.299	S
	Open face , 7-Hole	35	-21.116	32.671	S
General	Open face , close face	19	-0.276	3.825	N.S
	Close face , 7 Hole	19	-4449	4.303	S
	Open face , 7-Hole	19	-4.939	6.191	S

N.S = Non significant
S = Significant

Table 2 - Regression coefficient of different processes

	Personal Stationary	Personal Stationary	Personal Stationary
Open F. F. C	1		
Close F. F. C	0.934 0.822	1	
7- Hole	0.914 0.799	0.941 0.924	1
	Open F. F. C	Close F. F. C	7- Hole

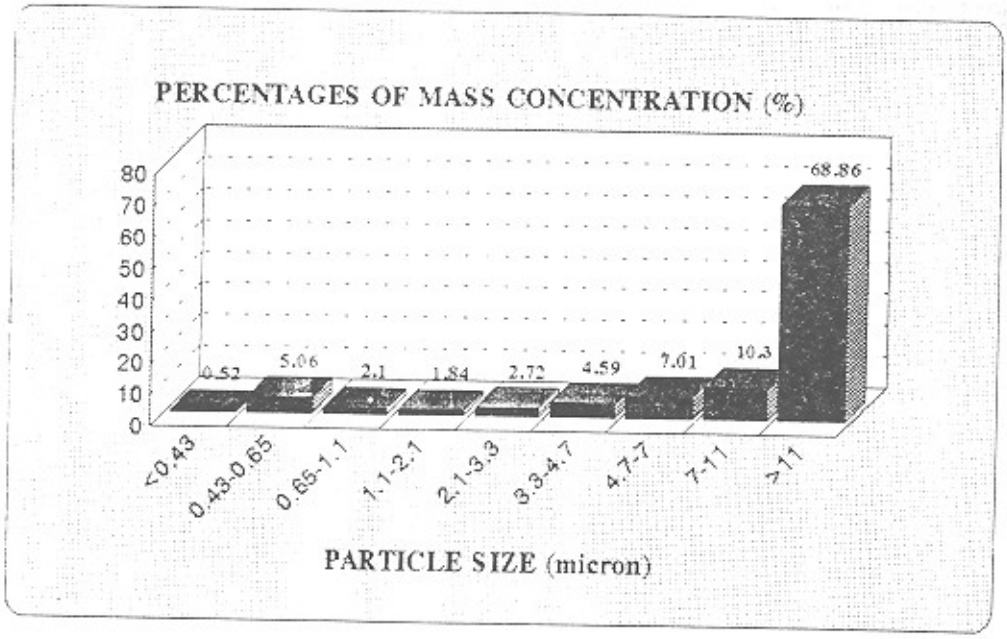

Fig. 1 - Particle size distribution in wood working industry

Table 4 - Mean of variantion in open and close F.F.C concentration in relation to 7-Hole.

Processes	Samplers	Relative variantion %	Variation Mean
Sanding . M	Open face , 7 - Hole Close face , 7 - Hole	103 43.2	73.1%
Circular . S	Open face , 7 - Hole Close face , 7 - Hole	177.35 112.87	145.11%
Planing . M	Open face , 7 - Hole Close face , 7 - Hole	98.97 89.96	94.47%
Jointing . M	Open face , 7 - Hole Close face , 7 - Hole	36.6 39.5	88.05%
Band . S	Open face , 7 - Hole Close face , 7 - Hole	246.7 305.03	275.87%

ıole , S.C. and Tillery , M.I. (1986): Aerosol Sampling
ter Cassettes. Am. Ind. Hyg. Assoc. J. , 47(12): 825-831.
cutive (HSE) (1993): General Method for Gravimetric
atory and Total Inhalable Dust , (MDHS 14) , January.
ımitsaris , P. , Strahlendor , P.W. , Contala , A. and
) : Wood dust exposure in ontario industry : The
pects. Vol. 1-2.
ırkett , J.L. (1978): An Inhalable - Dust sampler , for
'rom total airborn particulate , Ann. Occup. Hyg. , Vol.

, Connell , E. and Muriale , L. (1991) : Wood
furniture manufacture-Results from an australian survey
ıreshold limit value development. Am. Ind. Hyg. Assoc.

d Bothan , R.A. (1990): Field comparison of personal
lust , Ann. Occup. Hyg. , Vol. 34 , No. 6 , PP. 553-573.
Personal sampling of total and inspirable dust. J.
, No. 7 , PP. 1437-1439.