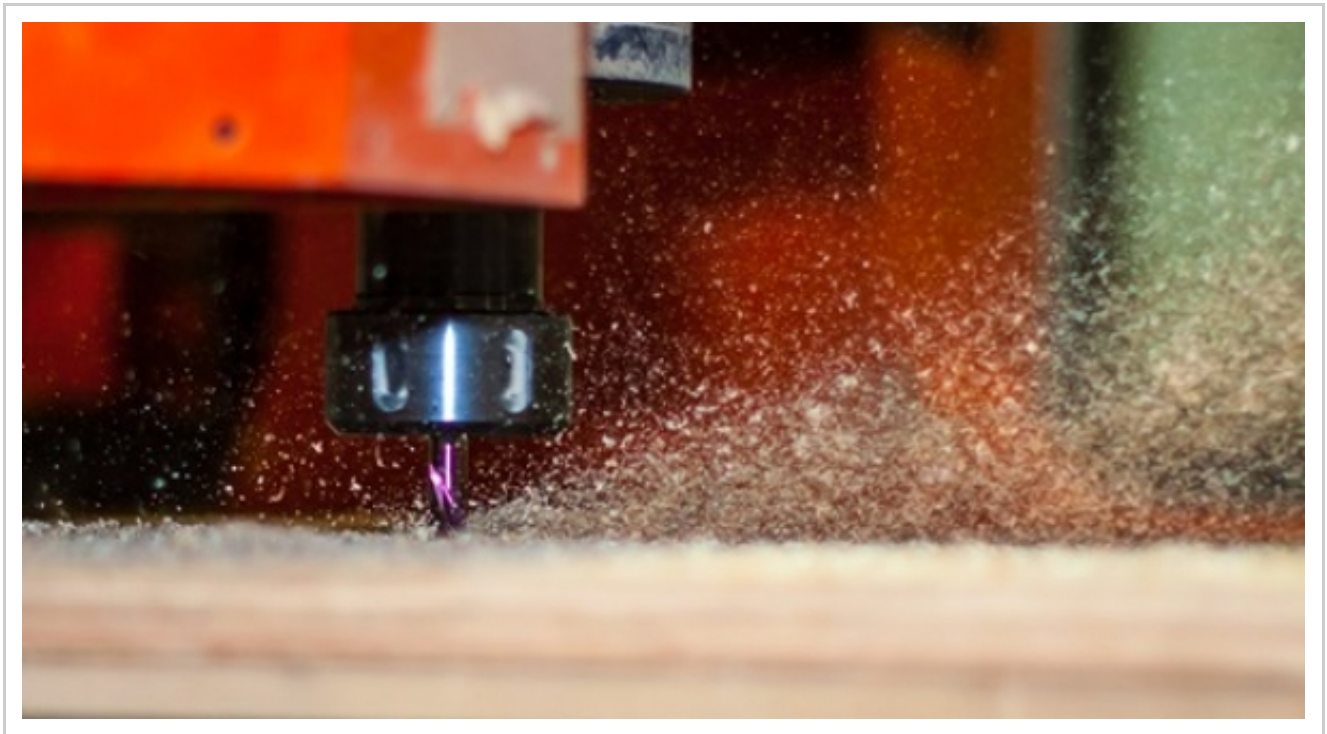


# Rethinking Wood Dust Safety Standards



**The current universal work safety and health standards pertaining to wood dust in factories lack the localisation required. As a study has shown, there is a urgent need to re-evaluate the current guidelines and practices. By Jegatheswaran Ratnasingam, Lim Tau Wai and Geetha Ramasamy, Universiti Putra Malaysia, Florin Ioras, Buckinghamshire New University, and Ishak Tadin, Centre for Occupational Safety and Health Singapore**

Many industrial activities are associated with some kind of occupational hazard that can cause injury in an insidious manner. The adverse effects of exposure to wood dust include nasal carcinoma, allergic and irritant cutaneous and respiratory reactions and chronic respiratory impairment.

Exposure to wood dust may cause various diseases, including extrinsic allergic alveolitis, the organic dust toxic syndrome, occupational asthma, non-asthmatic chronic airflow obstruction and simple chronic bronchitis (mucus hyper-secretion).

Of these, simple chronic bronchitis and non-asthmatic chronic airflow obstruction occur most often. The level and pattern of disease varies with the type of wood dust, climatic conditions and the manner in which it is handled, being particularly influenced by the use of chemicals commonly found in wood coating operations.

In the manufacture of value-added wood products, such as furniture, the application of wood

coating is an integral manufacturing process, which provides the necessary aesthetic appeal as well as protection to the wood product. Although studies on the properties of different types of wood coatings are ample, the sanding and dust emission characteristics of the common wood coatings have not been well researched.

These aspects are important as it has far reaching manufacturing cost implications and affect workers' productivity in terms of their health and safety. Previous studies have shown that lung function of the woodworkers is severely affected after long-term exposure to wood dust, but reports on the effects of coating dust has not been well documented.

### Regional Dust Emission Study

Therefore, a study was undertaken to evaluate the dust emission characteristics of the common wood coatings and wood substrates used in the Southeast Asian furniture industry and its effects on the lung function of workers.

In the first part of the study, 100 pieces of kiln dried rubberwood sawn timber of 25 mm x 100 mm x 200 mm in dimensions, obtained from a local supplier, were used. In a parallel experiment, 100 pieces of medium density fibreboard (MDF) and particleboard (PB) of similar dimensions were obtained from a commercial supplier to carry out comparative experiments.

All the samples were pre-sanded to a grit size of 150 and had an average moisture content of  $12 \pm 2$  percent. The samples were stored in a conditioning room at  $20 \pm 2$  deg C and 65 percent relative humidity, until testing commenced.

Three different types of sealer or undercoat of wood coatings, nitro-cellulose (NC), urea-based acid curing (AC) and poly-urethan (PU), were obtained from a commercial wood coating supplier for this study. The volume solid content of the different coatings was 35, 45 and 55 percent respectively. The coatings were prepared for application by adhering strictly to the supplier's specifications using the necessary solvents to ensure the desirable application viscosity at all times.

The coatings were applied on the sample boards using an experimental roller coater to achieve a final coating film thickness of  $400 \mu\text{m}$ . The samples were then placed on a conveyor which passed through a drying oven at a temperature of 40 deg C for 30 minutes and were left aside to condition for a period of seven day before further testing.

A total of 20 samples were prepared for each type of coating used in the study. Ten of the coated samples from each wood coating type were used for the sanding test carried out using a wide-belt sander. The sander had a single head with rubber roller of 70 deg shore in hardness. Aluminium oxide abrasive belts with sanding grits of the size 180 were used in this study.

The feed speed, sanding belt speed and depth of cut were maintained at three and 1,000 m/min and 0.5 mm respectively. The power consumed during the sanding operation was determined directly through a watt meter attached to the drive-spindle of the machine. The average surface roughness of the sanded surfaces was evaluated using a roughness recorder over a measurement length of 50mm.

A further test on dust emission during the sanding process of the remaining five uncoated and

five coated samples was conducted using an orbital sander attached with a 180 grit aluminium oxide sand paper. The dust concentration was measured using gravimetric isokinetic air sample, while the dust particle size distribution was ascertained using an aerodynamic particle sizer.

## Health Impact On Woodworkers

The second part of the study evaluated the lung function of workers subjected to different levels and duration of exposure to wood and coating dust. A total of 2,500 woodworkers from 25 furniture factories with similar working conditions were invited to participate in the study.

Five factories of comparable size and production conditions were selected from the major furniture-producing countries in the region—Malaysia, Indonesia, Thailand, Vietnam and the Philippines, with the assistance of the respective national furniture trade associations.

From the total of 2,500 workers engaged, 2,449 (89.8 percent) accepted the invitation to participate in the study. Excluded from the study were those who had never been exposed to wood and coating dust. An additional group of 88 subjects was also excluded because they were unable to perform pulmonary function tests correctly and because of previous exposure to substances known to induce bronchial hyper-responsiveness, such as smoking.

Of the 2,324 remaining workers, 51 percent were exposed to wood dust, while the rest were exposed to wood coating dust. Since the aim was to examine the occurrence of pulmonary abnormalities as a function of exposure, a homogeneous split of the sample across the observed range of exposure was planned.

The socioeconomic status of all subjects were recorded to ensure its comparability and personal information such as age, working hours a day, work duration and occupational history were also collected. Written, informed consent was given by all subjects prior to participation in the study.

The subjects were selected with the cooperation of the respective national trade association, which ensured that their family background and work-history were properly recorded and no misinterpretation occurred due to communication and language barrier.

Efforts were also made that similar number of subjects were selected from each of the participating countries and the subjects were examined according to the protocol identical to that used in other studies.

Measurement of concentrations of airborne dust was carried out in the factories on the basis of weight different of glass microfiber filter with a flow rate of 1 L/min. The average inhalable particulate concentration was measured from the increased filter weight and rates, and duration of airflow.

In order to evaluate the effects of dust on the lung functions of the subjects, detailed histories of respiratory disease of the subjects were recorded to capture information on the manifestation of chronic bronchitis, asthma and other respiratory related ailments. Furthermore, lung function assessments were carried out on subjects by a trained medical technologist using a spirometer.

The following indices were obtained by the subject expiring forcefully and maximally after a maximal inspiratory manoeuvre: forced vital capacity (FVC) and forced expiratory volume after

one second (FEV1). The ratio of FEV1/FVC provides a reflection of the extent of obstruction in the airways of the subjects, which in turn allows the assessment of lung function. The results were expressed as the difference between the observed and predicted values of the European Respiratory Society

### Insufficient Universal Standard

The results obtained from this study questions the application of a single inhalable exposure standard for dust to all woodworking scenarios. Firstly, the dust emission levels from the sanding of uncoated and coated samples obtained in this study exceeds the permissible exposure limit of five mg/m based on the eight hour time weighted average.

Secondly, sanding of the MDF samples results in the highest dust concentration compared to PB and solid wood samples, and the proportion of the coarser inhalable dust was about ten times greater than the amount of the finer respirable dust.

Thirdly, the higher the solid content of the wood coating used, the harder is the cured coating film. Consequently, surface roughness reduced in the order of PU<AC<NC wood coatings, which was attributed to the different coating film hardness. The harder the surface of the coating film, the lesser is the scratching depth during the sanding operation, which explains the lower surface roughness observed. On the contrary, the power consumed during the sanding process was inversely proportional to the coating film hardness.

Fourthly, the softer the coating film the higher was the amount of sanding dust particles produced and the total concentration of dust particles increased in the order of NC>AC>PU wood coatings. However, from the size distribution analysis, it was also apparent that harder coating films produce more fine dust particles compared to the softer coating films.

The different stock removal rate as well as the polymeric characteristics of the coatings could explain the variations observed in the sanding dust particle distribution. In fact, the current industrial air filtration practice of capturing dust above 50µm in average particle diameter in the industry is not optimum to minimise the health risks posed by these dust particles.

A detailed analysis of these exposure data from the twenty five factories showed that wood coating sanding operations were consistently associated with higher exposure levels compared to wood substrates sanding task. On the basis of these measurements, the sanding task was assigned an estimated dust exposure based on the mean value of all dust measurements for that task.

Therefore, an estimated average dust exposure of 27mg/cubic metre was assigned to all workers performing sanding operations on wood-based substrates, whereas an estimated dust exposure of 12mg/cubic metre was assigned to those in areas of sanding of wood coatings.

To assess lifetime exposures, the cumulative exposure index was calculated for each worker by multiplying the years mg/cubic metre of work with the assigned exposure intensity. Of the exposed population, 51 percent had a cumulative exposure to wood dust between 61-109 years mg/cubic metre whereas 159 subjects (49 percent) had a cumulative exposure to wood coating dust between 33-47 years mg/cubic metre.

It is therefore apparent that the mean cumulative dust exposure levels in the furniture factories in

the Southeast Asian region were much higher than the allowable exposure level, which in turn will negatively impact woodworkers safety and health.

## Respiratory Ailments

Overall, the prevalence of chronic respiratory symptoms due to cumulative exposure tended to be low, ranging from two percent for chronic bronchitis, three percent for bouts of bronchitis, four percent for asthma and five percent for dyspnoea, especially among woodworkers exposure to wood dust.

On the other hand, the prevalence of chronic cough or phlegm was as high as 32 percent while subjects with irritant symptoms such as red (burning) eyes tend to be highest at 54 percent of the subjects. However, only the prevalence of sore throat increased significantly with increasing exposure, a finding compatible with a dose response relation observed in other studies.

The outcome is markedly different among workers exposed to wood coatings dust in the factories. This population showed a higher prevalence of chronic respiratory symptoms with five percent for chronic bronchitis, eight percent with bouts of bronchitis, nine percent with asthma and 11 percent with dyspnoea.

It was apparent that exposure to wood coating dust results both higher chronic respiratory symptoms as well as irritant symptoms, suggesting that wood coating dust was more potent as a health hazard compared to wood dust. This could be attributed to the finer particle sizes of the wood coatings dust, which is easily respired deeper into the lungs.

It was obvious that the exposure to wood coating dust have a more pronounced effect on the pulmonary function of the workers compared to wood dust. The overall reduction in the FEV1/FVC ratio of below than 0.7 indicates a pronounced obstructive airway which suggests a deteriorated lung function.

The results of this study provide new evidence to suggest that contrary to common belief, wood dust is a more potent cause of irritant respiratory symptoms rather than chronic respiratory diseases. However, wood coating dust is more potent than wood dust in causing chronic respiratory disease and there, its exposure control must be more stringent.

## Far Reaching Implications

The results support the findings of earlier studies which reported that exposure to wood dust often lead to irritant respiratory symptoms among carpentry apprentices. The results of this study have several far reaching implications to the workers of the furniture industry.

Firstly, the use of one single standard for minimum exposure level (MEL) for wood and wood coating dust is not appropriate and compromises the safety and health of the woodworkers. Secondly, wood dust is more harmful as a cause of respiratory irritant symptoms rather than chronic respiratory diseases. However, wood coating dust is more harmful than wood dust as the cause of irritant symptoms as well as chronic lung diseases.

Thirdly, the lung function of woodworkers is severely affected by shorter duration exposure to

wood coating dust compared to longer duration exposure to wood dust, which suggests the need to re-evaluate the dust emission standards in the wooden furniture industry in Malaysia.

Fourthly, the proportion of subjects with an FEV1/FVC ratio below 70 (chronic) in the exposed workers who had been subject to coating dust was more than double compared to workers exposed to only wood dust.

Despite the prevailing exposure dust standards within the Southeast Asian region, it is apparent that their enforcement in the wood products industry is poor, often compromising the workers' health. Inevitably, the lack of commitment from the management of wood products manufacturers towards the safety and health agenda appear to have a profoundly negative effect on the workers' health, which confirms the status of the industry as being unhygienic and unsafe.

Furthermore, as reported earlier, the prevailing safety culture within the wood products manufacturing industry is rather poor, which explains the preference of employers for foreign workers who could be easily manipulated to forego safety and health issues at the expense of monetary gains.

It must also be enunciated that occupational safety and health (OSHA) standards among the different countries in the Southeast Asia region is inconsistent and this poses a serious challenge to its enforcement. In most instances, even the development of the prevailing standards has been riddled by ambiguous practices that lack fundamental data upon which these standards are built.

Inevitably, the adoption of threshold values for dust exposure based on existing standards from Europe and North America appears to be misconceived as it does not reflect actual conditions on the ground.

The study has revealed an urgent need to re-examine the current single dust exposure standard applied to all woodworking environments, as the standard may be insufficient to mitigate the safety and health effects posed by the dust emitted from the different wood coatings and wood substrates in the value-added wood products manufacturing environment. Furthermore, the current air filtration standard in use will have to be modified to include multi-level filtration to capture dust particles of different average diameters so as to minimise its ill effects on woodworkers.

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