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## X-Dent Box Dust Collector: A Protection to Dental Technicians and Dental Students

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### **Abstract:**

Following the frequent case of asthmatic and allergies from the dental laboratory technicians in Faculty of Dentistry, University Sains Islam Malaysia (USIM) has tried to find a solution to handle this problem. An air pollution index was taken in the dental laboratory of USIM and it revealed that the environment was polluted with small particle and dust generated from the trimming and polishing process of denture appliances. It showed that the dust pollution reading ( $PM_{10}$ ) was  $0.262\text{mg}/\text{m}^3$  in the dental laboratory is higher than the Ashrae Standard 6.2 Indoor Air Quality Index ( $0.15\text{mg}/\text{m}^3$ ). The X-Dent Box, a dust collector box, was invented and used in the laboratory to help protect the dental technicians which has reduced the index reading to  $0.096\text{mg}/\text{m}^3$  and reduced the noise level from 83dBA to 69dBA. The box has been proved to give better protection to the dental technicians thus reduced the Sick Building Syndrome (SBS) as it reduced the IAQ index.

**Keywords:** Indoor Air Quality (IAQ), dust collector box, dental technicians

### **1. Introduction**

Within any dental laboratory, the dusts generated during routine procedures by dental technicians such as trimming and polishing acrylic dentures and orthodontics appliances can't be avoided (Ireland et al, 2011). The floating dusts in the dental laboratory created a dirty and dusty workplace. It has been worse reported that the dental technicians may be exposed to potentially harmful and hazardous workplace because of the materials used and the procedures done (Ireland et al, 2011; Taira et al, 2009; Hu et al, 2006).

The air in the dental laboratory is also polluted due to the floating concentration of silica to be up to  $0.051\text{mg}/\text{m}^3$ . These respirable crystalline silica (quartz and cristobalite) has been classified as a human carcinogen in 1997 by the International agency for Research on Cancer where many case reports have indicated that dust generated through grinding metallic dental materials have caused skin dermatitis (Rustemeyer and Frosch, 1996) and pneumoconiosis (Nayebzadeh et al, 1999; Kim et al, 2002). The study also stated that the concentration of respirable dust was  $725 \pm 414\ \mu\text{g}/\text{m}^3$  with highest concentration of  $1764\ \mu\text{g}/\text{m}^3$  which respectively 1.66% of the dust component during the polishing process. Thus, causing the frequent respiratory symptoms such as wheezing and rhinorrhea was higher among dental technicians especially to the smoking technicians. Besides that, it is also reported that 42% of dental technicians has foreign bodies in their eyes after 1 month working (Torbica et al, 2006) and 9.8% of dental technicians were diagnosed with pneumoconiosis in Crete (Petrovic D et al, 2013).

The precaution and standard operating procedures that is recommended to protect the technicians were by using proper and complete personal protective equipment (PPE) for such a face mask and face wiser (Petrovic D et al, 2013; Taira et al, 2009). Studies (Nayebzadeh et al, 1999; Shelden et al, 1995) has shown that a local exhaust ventilation has help to reduced the dust concentration particularly methyl methacrylate however it should be installed and used properly to be well function. The problem still occurs as there is no proper equipment or technique that can protect the technician was found and been proved to be effective in any study.

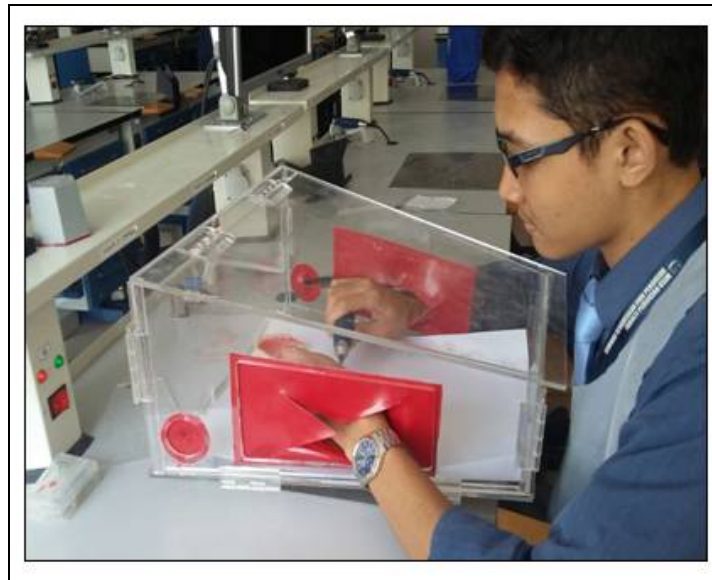
The problem encountered by the dental technicians in many years shows that a full protection to dental technician is very important. This study invented the X-Dent box to proved that it can help to reduce the dust exposure thus has improved the indoor air index as a dust collector. Furthermore, the box can protect the dental technicians from long term complications of respiratory diseases.

### **2. Material and Methods**

The X-Dent box is a dust collector box that being invented in the Faculty of Dentistry, USIM. It is made from the Perspex material at 5mm thickness so that it is lightweight but strong enough to resist the splashing effect from the small particles formed from the trimming and polishing of the dental appliances. It is connected to the vacuum underneath the technicians' workbench during the trimming procedures to make sure that the dust collected in the box is directly and immediately suctioned into the vacuum bag (Figure 1).

The study was started by distributing a standard questionnaire from the Occupational Safety and Health Association (OSHA) Malaysia, ICOP IAQ 2010, to all the dental technicians in Faculty of Dentistry, USIM dental laboratory in order to determine the problem that always exist due to poor IAQ index. It consists about questions to assess their medical status and any related medical problem that they usually affected or has been affected since they work as dental technicians. The questionnaire also comprises of the procedure and any protection equipment that they been used during trimming and polishing procedures.

The air conditioner and ventilation system were off function a day before the measurement to make sure that the indoor environment is not influenced by these two components. The indoor air quality (IAQ) measurement was taken two separate times within February 2016 to July 2016 at four sampling points in the dental laboratory (at the roof of the dental laboratory, on the floor, and in front of and back of the box). The measurement of IAQ at the first intake was taken twice at each location before and after the used of X-Dent Box (Figure 2). Then the average reading was presented as the final IAQ index measurement before and after the used of X-Dent Box. The Direct Sense IAQ GrayWolf and DustTrack TSI, USA were used as the IAQ monitor equipment to measure a set of contaminants to characterize the IAQ inside dental laboratory, such as air temperature (T), relative humidity (RH), carbon dioxide (CO<sub>2</sub>), carbon monoxide (CO), total volatile organic compounds (TVOC), ozone (O<sub>3</sub>) and dust particulate matter (PM<sub>10</sub>). Besides that, the sound level is also measured as part of the procedures of IAQ measurement. Instruments were all run together based on the standard procedure of ICOP-IAQ (Ministry of Human Resources Malaysia, 2010). The result of the final IAQ measurement is showed in Table 1.



*Figure 1: Photo show the X-Dent Box was used during denture trimming and the setting of X-Dent Box connected to the vacuum suction at the dental laboratory workbench.*



*Figure 2: Photos show the procedures of the Indoor Air Quality (IAQ) measurement using the Direct Sense IAQ GrayWolf and DustTrack TSI, USA equipment during the denture trimming process using the X-Dent Box.*

### 3. Results and Discussions

Table 1 showed the result from pre-assessment of the questionnaires distribution to 6 dental technicians in the Faculty of Dentistry, USIM. It revealed that most of the dental technicians have sign and symptoms of the Sick Building Syndrome (SBS) which are asthma, headache, tiredness, coughing, skin rash and eye irritation. The highest SBS problem in this report was eye irritation (75%) and tiredness (58%).

Table 2 represent the result from the measurement of IAQ including the sound level. From the table, it shows that there is a significant reduction of all the component of pollutants measured for IAQ index. The temperature and carbon monoxide has reduced by 0.1 °C and 0.1ppm, relative humidity by 13.9%, total volatile organic compound by 0.04ppm, carbon dioxide by 126ppm, dust particulate matter by 0.17PM<sub>10</sub>, and sound by 14dBA.

Relative humidity is the percentage of water vapor in the air at a given temperature in comparison to the amount of water vapor it is capable of holding at that temperature. Relative humidity has high influenced to the human health as too high or too low relative humidity can increase or reduces the body's ability to lose heat through perspiration and evaporation. Thus, causing the discomfort and generally less hygienic atmosphere. The recommended average relative humidity for the indoors is 30 to 65%, when the outside temperature is 20°F or more (ASHRAE Standard 55, Indoor Air Quality Handbook, 2013, Pg.7). In this study, the relative humidity was 64.5% at the temperature of 23.5°C before using X-Dent Box which showed that it was quite high of humid which can trigger the health problem. However, it showed reduction of 13.9°C to 50.6°C when the X-Dent Box was used which revealed the ability of the X-Dent Box to reduce the relative humidity thus improve the air in the dental laboratory.

Carbon dioxide has been recognized by ASHRAE (The American Society for Heating, Refrigeration and Air-conditioning Engineers) as the surrogate ventilation index or the only measurable variable and it is a good indicator of occupancy and ventilation in an air-conditioned room like the USIM dental laboratory. Even though CO<sub>2</sub> by itself is not considered an indoor air contaminant and humans are the major source of CO<sub>2</sub>, if CO<sub>2</sub> levels in a room are higher than 1000 ppm, it is an indication that not enough outdoor air is coming in to dilute the CO<sub>2</sub> level. Carbon dioxide (CO<sub>2</sub>) showed the greatest reduction (19.66%) of its level which indicates that the occupancy, ventilation rate and the circulation of the pollutants within the dental laboratory space is better if the X-Dent Box is used due to the effectiveness of the X-Dent Box to trapped majority of the dust formed during trimming process directly into the vacuum.

On the other hand, the dust particulate matter (PM<sub>10</sub>) which measured the mixture of dust that produced during trimming process of the dental prostheses within per metre square of the dental laboratory space. PM<sub>10</sub> measure the mixture of small particles size of dust mixture which are 10 – 2.5µm particles in size. The dust can bypass the body's natural defences in the nose and throat and enter lungs. Then it will be deposited in the extra thoracic or upper trachea-branchial region which can cause upper respiratory tract infection and at long term effect to lung carcinoma. This study has shown that there is a massive reduction of 63.4% of the dust particulate matter concentration by using the X-Dent Box. It presented that the dust mixture that floating in the environmental area of the dental laboratory of Dental faculty USIM was drastically reduced when the X-Dent Box is used as most of the dust has been successfully suction straight away by the vacuum system connected under the X-Dent Box. Is also shows that effectiveness of X-Dent Box to prevent the dust from escape into the air but trapped in the box. Thus, by long time of X-Dent Box usage will eventually reduce the side effect of having high concentration of dust particulate matter.

The Total Volatile Organic Compound (TVOC) comprises of many chemicals of solids and liquids type. It causes short term and long-term effect especially to the respiratory tract as it can be inhales while the compounds float into the environment (*United State Environmental Protection Agency, EPA, 2017*). Dental technicians who work almost all the time in the dental laboratory will have high risk of having the effect of high concentration of TVOC indoor. The effects are such as eye, nose and throat irritation; headaches, loss of coordination and nausea (also known as Sick Building Syndrome, SBS); and as long term can cause damage to liver, kidney and central nervous system and risk of cancer. In this study, it showed that by using the X-Dent Box, the TVOC has reduced the concentration by 15.5% thus help to reduce the effect of high TVOC short and long term.

The IQA monitors also measured the effect of sound or noise exposure in the dental laboratory during the trimming process and other dental laboratory procedures were done. Study has shown that there is impact of hearing impairment or hearing loss due to frequencies emitted from hand pieces and equipment with high pitch sound in dental clinic and dental laboratory (Bahannan et al, 1993; Altinöz et al, 2001). The noise levels measured in the dental area (clinics and dental laboratory) varied between 64 and 97 dB(A) which laboratory engines was the highest level and it is considered to be close to the limit of risk of hearing loss (Kadanakuppe et al, 2011). The risk of having hearing impairment will increase by increase duration of working life. This study reported a high reduction of the sound when the X-Dent Box was used from 83dB to 69 dB which has 16.9% of reduction. By this reduction it can be actually reduced the risk of having nearing impairment at early stage of working life.

Sick Building Syndrome signs and symptoms related to the dental laboratory environment ( <i>Standard questionnaire survey, ICOP IAQ 2010</i> )		
1	Asthma	16%
2	Headache	50%
3	Tiredness	58%
4	Coughing	50%
5	Skin rash	50%
6	Eye irritation	75%

Table 1: Sick Building Syndrome signs and symptoms related to the dental laboratory environment (*Standard questionnaire survey, ICOP IAQ 2010*)

<b>Indoor Air Quality (IAQ) (ASHRAE STANDARD 62, Direct sense IAQ GrayWolf &amp; DustTrack TSI, USA). The minimum standard IAQ reading is 0.15mg/m<sup>3</sup></b>				
<b>Contaminants (unit)</b>		<b>Standard</b>	<b>Before using X-Dent Box</b>	<b>After using X-Dent Box</b>
1	Temperature (°C)	23-26	23.5	23.4
2	Relative Humidity (%)	40-70	64.5	50.6
3	Carbon Monoxide (ppm)	10	0.4	0.3
4	Total Volatile Organic Compounds (TVOC, ppm)	3	0.258	0.218
5	Carbon Dioxide (ppm)	C1000	641	515
6	Ozone (ppm)	0.05	0.0	0.0
7	Dust particulate matter (PM <sub>10</sub> )	10mg/m <sup>3</sup>	0.262	0.096
Sound level measurement (Sound level meter, SLM)				
1	Sound (dBA)	90	83	69

Table 2: Indoor Air Quality (IAQ) and Sound Level before and after using X-Dent Box

#### 4. Conclusion

This study has shown that under any working conditions of trimming process of dental prosthesis the use of X-Dent Box as the protection equipment has been proven to help reducing the Indoor Air Quality as it is successfully trapped the trimming dust to be directly suctioned into the connected vacuum. As a result, it successfully reduces the IAQ index and thus produce a cleaner air and environment at the dental laboratory and for future consequent will reduce the risk of the dental technician to have upper respiratory tract diseases. Further research about the effect of IAQ index in related to the use of X-Dent Box to the dental technician's health and other dental personnel is required.

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