ABSTRACT

In Thailand, the emissions of air pollutants from industrial areas are one of the main sources of air pollution. It is generally believed that indoor air pollution such as VOCs as negative causes for a health risk. In our research, we measured the concentration of two volatile organic compounds, formaldehyde and isopropyl alcohol, emissions from sheet-fed offset lithographic printing operations during January - July 2006 in Bangkok, Thailand. The portable ambient air analyzer were used to collect and analyze formaldehyde and isopropyl alcohol concentration. The 4 months average concentrations of formaldehyde and isopropyl alcohol were 5.1 ± 3.0 ppm and 267 ± 67 ppm, respectively. The results showed that formaldehyde concentration in sheet-fed offset printing process area was obviously found to be much above the guidelines values prescribed by the OSHA standard for human health (the OSHA standard for formaldehyde is 2 ppm as short-term exposure limit). Although, concentrations of isopropyl alcohol was not observed to be higher the standard of OSHA which is suggested for isopropyl alcohol as 400 ppm (980 mg/m3). We observed that the emission of formaldehyde was associated with the use of solvents in this printing house.

KEYWORDS

printing house, formaldehyde, isopropyl alcohol, sheet-fed offset

INTRODUCTION

Many types of air pollutants are found in ambient and indoor areas. Several studies have demonstrated that indoor air pollutants can be associated with many characteristics of symptoms of human health (Nilsson et al., 2002). Poor indoor air quality has been linked to sick building syndrome (SBC) (Sakai et al., 2004). Therefore, many studies have been conducted on indoor air pollution because most people spend a lot of time indoor living (Wadden et al., 1995). Many published studies confirmed that indoor levels exceed outdoors due to dominant sources indoors (Bartlett et al., 1999). In the case of volatile organic compounds (VOCs), major air pollutants in the indoor environment such as benzene, toluene, ethylbenzene, m,p-xylene, o-xylene isopropyl and formaldehyde are widely used in industry and exert serious adverse effects on human health (ACGIH, 2001). Dry process photocopiers have been implicated as contributors to VOCs emission. For example, Wolkoff et al. (1993) identified 61 different VOCs in photocopier toner powder and from the processed paper of six photocopier machines, three laser printers, and two matrix printers.

BTEX are frequently produced from industrial sources, including printing and paint manufacturing units (Hsieh et al., 2005). In the study of Na et al. (2004) indicated the main emission sources in Seoul which produced VOCs are motor vehicle, gasoline evaporation, natural gas and liquefied petroleum gas (LPG) and paint solvent. They reported that toluene (63%) is the most abundant component in paint.
solvents, followed by m-/p-xylene (19%), 0-xylene (8%) and benzene (1%). Many indoor air pollutants, such as VOCs, may cause lung cancer, exposure to VOCs such as benzene in the form of the toluene emitted from Chinese-style cooking is correlated with the risk of lung cancer among Chinese women who do not smoke (Guo et al., 2004). The investigations of VOCs also have been appeared in study on photo copier emission (Allen et al., 1978; Selway et al., 1980; Hansen and Andersen, 1986). A relation between indoor air pollutants such as printing house suspected to contribute to building-associated diseases. Formaldehyde and isopropyl alcohol are VOCs which also have been wildly studied in many indoor areas (Sakai et al., 2004). Thus, the aim of this study was focused on to measure formaldehyde and isopropyl alcohol from sheet-fed offset lithographic printing operations in printing house in Bangkok, Thailand to find out the health risk situation in this area.

MATERIAL AND METHODS

Sampling period and study area
In this research, we conducted the field study in a large printing house in Bangkok, Thailand. Formaldehyde and isopropyl alcohol concentration emission were collected from workplace area which sheet offset; 4 colors and 5 colors; printing presses are set up. Samples were collected in normal working period 8 hrs from 9:00 AM to 4:00 PM from January to July 2006. In our research, formaldehyde and isopropyl alcohol collected and analyzed by portable ambient air analyzers (Miran 205B series SaphirRe) for around 40 mins/time at 1 m above the ground in the same real-time time and area sample. The portable ambient air analyzers contains a single-beam infrared spectrophotometer. A micro controller automatically controls the analysis, processes the measurement signal, and calculates the absorbance values. The particulate filter was used during gas analysis to remove dust and other particulates and the zero gas filter removed most infrared-absorbing components from the air and was used to set the analyzer zero before analysis. Analysis results of VOCs were displayed in ppm.

RESULTS ANALYSIS AND DISCUSSION RESULTS

The average concentrations of formaldehyde and isopropyl alcohol from sheet-fed offset presses in workplace area in printing house were presented in Table 1. The amount of formaldehyde and isopropyl alcohol were measured 4 times since January to July 2006. The average concentrations of formaldehyde was highest in January at 8.28 ppm and ranged from 8.28 ppm, 7.93 ppm, 2.72 ppm to 1.94 ppm from January, March, May to July. While, the average isopropyl alcohol concentration was highest in January at 325 ppm ranged from 325 ppm, 312 ppm, 277 ppm to 155 ppm, respectively. The average for all 4 months of these VOCs were 512 ppm and 267 ppm in formaldehyde and isopropyl alcohol respectively.

Table 1 Four months average VOCs concentrations during January to July 2007.

<table>
<thead>
<tr>
<th>Month</th>
<th>Formaldehyde (ppm)</th>
<th>Isopropyl alcohol (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>8.28 ± 1.5</td>
<td>325 ± 52.57</td>
</tr>
<tr>
<td>March</td>
<td>7.93 ± 1.6</td>
<td>312 ± 59.30</td>
</tr>
<tr>
<td>May</td>
<td>2.72 ± 3.12</td>
<td>277 ± 88.19</td>
</tr>
<tr>
<td>July</td>
<td>1.94 ± 1.9</td>
<td>155 ± 12.3</td>
</tr>
<tr>
<td>4 month average</td>
<td>5.12 ± 3.0</td>
<td>267 ± 67</td>
</tr>
</tbody>
</table>

*OSHA = Occupational Safety & Health Administration
When comparing these average concentration with OSHA stand (Occupational Safety & Health Administration) of formaldehyde and isopropyl alcohol that suggest for human health (Figure 1 and 2), the results showed that formaldehyde concentrations in January, March, May and average 4 months were obviously found to be much above the guidelines values prescribed by the OSHA standard (the OSHA standard for formaldehyde is 2 ppm as short-term exposure limit). Although, concentrations of isopropyl alcohol in all 4 months were not observed to be higher the standard of OSHA which is suggested for isopropyl alcohol as 400 ppm (980 mg/m³).

Figure 1. Formaldehyde concentrations in four months compare with OSHA standard value.

Figure 2. Isopropyl alcohol concentrations in four months compare with OSHA standard value.
Results of our study confirmed the finding of VOCs from printing process. Moreover, the results showed that the emission of formaldehyde and isopropyl alcohol were associated with the quantity of used solvents in this printing house. We observed that in January and March the amount of solvent was used in operation of printing process, this results parallel with the high concentrations of both VOCs. In our study, the average concentrations of isopropyl alcohol for each month or all 4 months are well below the standard for employee in workplace environment (Table1 and Fig. 2) but formaldehyde concentration exceeded standard obviously. This results indicated that formaldehyde concentration in this area as a potential risk factor for human health in this printing house. Many research also confirm that individual VOCs can be toxic for human health and considered to be carcinogenic, mutagenic, or teratogenic (Zuraimi et al., 2005; Wang, 2007). Hence, our results showed that the concentrations of formaldehyde can to be toxic to a wide range worker in this workplace area. Many research confirm the presence of VOCs in indoor area and printing facilities. For example, Wadden et al. (Wadden et al., 1995) investigated emissions in an offset print shop and measured 13 different VOCs in the indoor air, including toluene. The average toluene concentration in this study (1.7 ppm) was near the toluene level in the offset print shop investigation reported by Wadden et al.(1995) ranged from 0.9 ppm to 7.6 ppm. Guo et al. (2004) also studied risk assessment of exposure to VOCs in different indoor environments, they found 7 different VOCs in printing room. In Japan, formaldehyde concentration in indoor areas were also studied. Sakai et al. (2004) measure Formaldehyde and others VOCs in 37 urban in Nagoya, japan and 27 urban in Uppsala, Sweden. Results showed that Formaldehyde concentration in Nagoya was significantly higher in modern concret houses than in wooden houses and higher in newer houses. VOCs concentration in indoor areas were also studied. VOCs emission from printing house in Thailand were also measured in 2005 (Thanacharoenchananphas et al., 2007). BTEX (benzene, toluene, ethylbenzene, xylene) were sampled from work place area (sheet offset printing), the results showed the average concentrations of BTEX were 101.7ppm, 1.7 ppm, 3.0 ppm and 1.9 ppm, respectively. They found that benzene concentration exceeded the level that recommended by ACGIH. Data in USA showed that the lithographic printing industry in the United States is a powerful economic force of approximately 53,000 firms, 85 percent of which are small business enterprises and the majority of lithographic facilities employ less than 20 individuals. These industries are responsible for emitting up to 6.17 X 108 metric ton per year of VOCs into the atmosphere (Bartlett et al., 1999).

CONCLUSIONS

This study provides interesting data concerning the indoor air pollution in Thailand. The results demonstrated that sheet-fed offset printing operation could produce individual VOCs, formaldehyde and isopropyl alcohol were found in workplace area in printing house in normal working period from 9.00 AM to 4.00 PM. We also found that, the average formaldehyde concentration from printing house in period 4 months were higher the standard that are the recommended by OSHA for employee in workplace environment. This results indicate that formaldehyde was the risk indoor air pollutant for workers in this printing house.

ACKNOWLEDGEMENTS

We would like to thank Physics and Engineering Division, Department of Science Service, Thailand for assisting in measurement of ozone and VOCs concentration and use of laboratory facilities through this study. This research was funded by Faculty of Agriculture Natural Resources and Environment, Naresuan University.
REFERENCES


