Emissions of Volatile Organic Compounds from Flex Printing Facility

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Abstract
The present study was undertaken to investigate, the level of volatile organic compounds (VOCs) in working zone of flex printing facility in Novi Sad, Serbia. The levels of VOCs were determined at four sampling positions: at the machine; at a distance of 3 m from the machine; at the outlet of machine, at the entrance of the digester and at the exit of the digester. The quantitative determination of VOCs compounds was performed using portable Voc Pro Photovac. VOCs concentrations varied within the 8h-sampling period and differed between sampling positions. The highest concentration was measured at the outlet of machine, entrance in digester, while the lowest at a distance of 3 m from the machine.
The obtained levels of VOCs exceed the levels advised by OSHA and NIOSH standards. Therefore, this paper provides propositions on improving the process of flexographic printing, and therefore, human health.
Keywords: flex printing, VOCs, occupational safety and health

1. Introduction

The indoor air of an industry can be contaminated, depending on the kind of activities occurring, the emissions of the sources and the type of equipment used (Saraga et., al, 2011). In printing environments there are various emission sources of chemical contaminants, such as volatile organic compounds (VOCs), ozone and particulate matter (Kiurski et. al., 2013). VOCs are common in various environments with biogenic or other hazardous effects. Recently, the need to monitor human exposure to VOCs has become increasingly urgent because of the concerns about the quality of human life and the awareness of the impact of VOCs on the environment and human health. VOCs include a large group of air pollutants such as benzene, toluene, xylene, acetone, isopropanol, methyl ethyl ketone, etc. Exposure to VOCs is associated with allergies and adverse respiratory effects, frequently expressed as asthma or chronic obstructive pulmonary disease (COPD) (Learner et al., 2012). Workers can be exposed to contaminants by inhalation, ingestion, and dermal contact. Inhalation exposure to air pollutants is the most significant pathway compared to other exposure pathways (Sempere, 2012). Hence, the health risks due to inhalation exposure have gained the attention of indoor air quality researchers (Guo et al., 2004). The main source of VOCs in the process of flexographic printing is solvents of colour (Savić, 2009). The function of the solvent is to keep the colour in liquid state until it is transferred to the printing surface. Thereafter, the preferred solvent property is to evaporate as soon as possible so that the paint on the surface dries.
The main objectives of this paper were to determine the level of VOCs in a flex printing facility located on the territory of Novi Sad, Serbia and to suggest ways to improve the indoor air quality and protect the health of the employees. Results presented in this paper contribute to awareness on air contamination.

2. Materials and Methods

Concentrations of VOCs were determined in indoor air at a flex printing industry, located on the territory of Novi Sad, Republic of Serbia. It is a typical building, 30 m^2 in size and employs two workers. Both workers were in charge of all operations in the printing facility. Scope of production depends on business volume and on the type of printing material. Flex printing facilities have a system for ventilation, which often does not work. The flex printing facility where sampling too place is represented in the Figure 1.

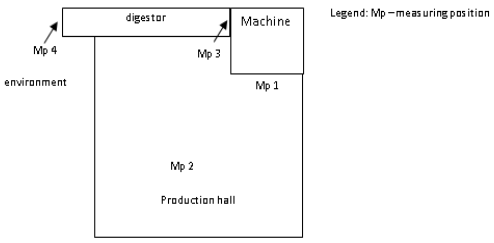

Figure 1. Measuring positions in flexography production: Mp1 - At the machine; Mp2 - at a distance of 3 m from the machine; Mp3 - At the outlet of machine, entrance in digester; Mp4 - At the exit of the digester

Indoor 8-h average air samples were collected at each sampling location. The quantitative determination of VOCs which have a boiling point below 185 °C was performed using Voc Pro Photovac (serial number: VPAJ006, Casella, England).

3. Results and Discussions

The obtained levels of VOCs as the average of each sample within 8h sampling period are presented in Figure 2. The highest concentration was measured at sampling location Mp3 at the outlet of machine, while the lowest at sampling location Mp2 at a distance of 3 m from the machine. This was expected because the machine on which the printing was performed should be closed, however, due to age, there were no lids and other protection against vapour. Also, the ventilation systems were in poor condition. Additionally, the use of the solvent into the machine came directly from the bucket that was open, and was potentially the main source of VOCs in the air of the flex printing facility. Furthermore, it lead to the retention of VOCs in the production hall.

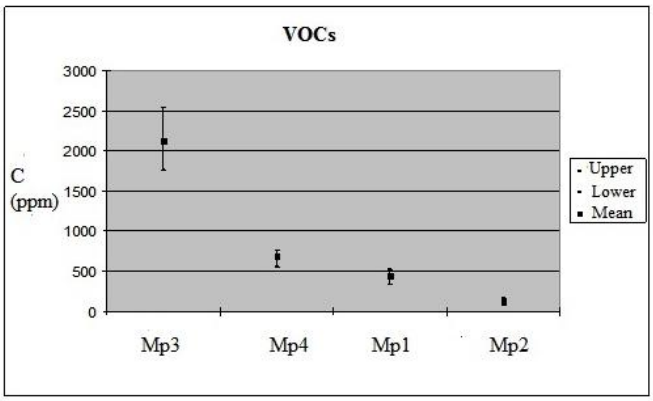

Figure 2. Level of VOCs concentrations measured in the flex printing facility

4. Conclusion

Values of total VOCs measured in the flex printing facility were very high. Therefore, it is apparent that when working on the machine, the worker should avoid the areas of application of paint and the place where the colour is open and evaporated, or if necessary, to stay there, wearing a protective mask with activated carbon. Concentrations in the work area of the machine and in the production hall were also high, but by setting better ventilation on the machine, modernizing the technology, closing the colour bucket, improving ventilation in the facility, placing buckets with paint in separate rooms and similar measures, VOC concentrations are reduced to an acceptable measure.

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