

Session I

**STRUCTURES AND MATERIALS**

# Indoor Air quality and human activities in buildings

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## Abstract

*People spend most of their time indoors either at home or at work. If the indoor environment is polluted, the occupants may experience number of possible health conditions such as sneezing, fatigue, headache, dizziness, nausea, irritability, and respiratory diseases as asthma. Also, long term exposure into the pollutants can cause more serious health effects. Therefore it is very important to maintain a high degree of hygienic level in all our buildings by achieving a proper design and maintaining an adequate ventilation system in the indoor environment. There are different types of ventilation that can be used in the indoor environment such as free running systems by opening windows and doors, fans and air conditioners. But due to the poor operational practices in the modern buildings such as restricting free ventilation by closing doors and windows in most of the time and no proper maintenance in the air conditioning system may pollute the indoor environment. Therefore numerous forms of indoor air pollution are possible in the modern buildings. In this paper, recent research is revised on effect of air freshener and tobacco smoke on indoor environment with modern operational practices.*

**Keywords:** *Indoor air pollution, Air fresheners, Tobacco smoke*

## 1. Introduction<sup>1</sup>

Most of us spend around 90% of our time in the indoor environment. Therefore, it is essential to maintain higher level of health and safety inside all types of buildings. In the last several years, the scientific evidence has indicated that the air within domestic and other buildings can be more

seriously polluted than the outdoor air in most of the industrialized cities. Thus, there can be several risks involved for the occupants of various types of buildings.

When we consider the modern buildings with prevailing operational practices and maintenance, there is a great possibility for the contamination of the indoor environment.

Most of the indoors get polluted due to poor operational practices of both free running and air conditional buildings. Although the windows are provided in buildings according to the building regulations, the occupants do not open them daily due to various reasons such as poor micro climate around the building with dusty outdoor environments and vehicle fumes

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etc...Also the air conditional spaces are not well maintained by providing adequate amount of fresh air. Therefore air conditioners should also be serviced on proper maintenance schedule. NIOSH[1] looked at 500 of the first IAQ investigations that they had done and found that inadequate ventilation, contamination from inside the building, and contamination from outside the building were the top three sources of IAQ problems. [2]

In order to understand the indoor air pollution it is very essential to identify causative agents and the sources of them. Sulfur Dioxide (SO<sub>2</sub>), Nitrogen Dioxide (NO<sub>2</sub>), Carbon Monoxide (CO), Volatile Organic Compounds (VOC), Carbon Dioxide (CO<sub>2</sub>), Particulate Matter (PM) and undesirable temperature can be identified as common types of causative agents. These pollutants are caused due to combustion products, building materials, equipment used in buildings, vehicle emissions, chemicals used in maintenance, environmental tobacco smoke and polluted outdoor air. A comprehensive study is going on considering above factors on indoor air quality and their effect on sick building syndrome. This paper highlights two such factors such as effect of air freshener and tobacco smoke on indoor air quality.

### 1.1 Pollutant sources studied

A study has been carried out to investigate the effect of building operational practices and two causes for polluted indoors such as air freshener and tobacco smoke.

#### 1.1.1 Air freshener

Air Fresheners are consumer products that typically emit fragrance and used in houses, offices, stores, restrooms and commonly in public bathrooms with the promise of creating a clean, healthy, and sweet-smelling indoor atmosphere. Furthermore there are broad range of air fresheners such as traditional sprays, continuous release (Outlet and battery operated), solid gel dispensers, hanging car air fresheners and potpourri.

In this investigation it was found that Air Freshener that we commonly use is a simply mask odor with chemicals and it is failed to remove contaminants in the indoor environment. They sometimes add toxic chemicals to the atmosphere that may lead to cause severe health problems to the occupants. Mainly the levels of volatile organic compounds (VOC) will increase due to some types of air freshener. Furthermore many of these air fresheners contain Phthalates, hazardous chemicals known to cause hormonal abnormalities, birth defects, and reproductive problems and it will help to enhance and maintain the smell of the air freshener. NRDC's[3] independent testing of 14 common air fresheners, none of which listed Phthalates as an ingredient, uncovered these chemicals in 86 percent (12 of 14) of the product tested, including those advertised as "all natural" or "unscented". According to the state of California notes that five types of Phthalates found in air freshener product are Di-ethyl Phthalate (DEP), Di-n-butyl Phthalate (DBP), Di-isobutyl Phthalate (DIBP), Di-methyl Phthalate (DMP), Di- isohexyl Phthalate (DIHP). [4]

In addition, many cleaning agents and air fresheners contain chemicals that can react with the other air contaminants to yield potentially

harmful secondary products. For example, terpenes can react rapidly with ozone in indoor air generating many secondary pollutants, including toxic air contaminants such as Formaldehyde. Furthermore, ozone-terpene reactions produce the hydroxyl radical, which reacts rapidly with organics, leading to the formation of other potentially toxic air pollutants. [5][6] But this bad effect of toxicants can be diluted with the opened windows in a free running building and properly serviced air conditioner.

## 2.2 Tobacco smoke

Smoking in enclosed spaces exposes occupants to indoor air pollution from the by-products of tobacco combustion in confined spaces where airborne contaminant removal is slow and uneven. The physical design of the cigar, leaf type and composition, and wrapper type may all affect the cigar emissions. For a given composition, the mass of a cigar consumed during smoking is a primary determinant of the quantity of its emissions. Tobacco active smoking and passive smoking have been implicated as risk factors for most of malignant disease such as lip and oral malignancies, lung cancer, oesophageal cancers and also infectious diseases like tuberculosis (TB), and pneumonia. In this experiment it has revealed that CO, CO<sub>2</sub> and VOC have exceeded the permissible indoor air quality limit due to the tobacco smoke.

## 2. Methodology

In this study, we have used Indoor Air Quality Monitor (IQM60 Environmental Monitor V5.0) to identify the air pollutants from the air fresheners and tobacco smokes. From this equipment, it is possible to identify CO, CO<sub>2</sub>,

NO<sub>2</sub>, VOC, temperature and relative humidity of the atmosphere. IQM meter had been placed in the enclosed working space with a height of 2.2m from the ground level in order to simulate the height of the, at rest person on the chair. The occupant density was kept at zero in order to isolate the effect of pollutants. This enclosed area is having one window-type air condition system with completely restricted natural air flow into the room. In order to enhance the accuracy of the test, instrument has been kept at particular place (usually at the center of the room) 1 hour before obtain the readings.

## 3. Results and Discussion

### 3.1 Air freshener

In order to contrast the indoor air quality with and without air freshener, instrument had been kept 30 min to measure the indoor air quality before sprayed the air freshener. In addition to that, air freshener sprayed several times after some time lag in order to see the variation of the air quality due to the air freshener. From this study, we have identified that mainly the levels of volatile organic compounds (VOC) will increase due to the tested types of air fresheners. Here are some graphs which explain the effect of air freshener on indoor air quality.

Therefore we decided to fix the boundaries by testing the constant volume of the air fresher content (60ml) in the particular space. Besides that we have studied the time requirement for the dispersion of the above quantity up to the permissible limit. Figure 2 gives the more details;

According to the figure 02, max VOC content is 3.65ppm which is 5 times

higher than the indoor permissible value and also time requirement for the dispersion is approximately 1hr 30 min.

### 3.2 Tobacco smoke

As mentioned above same methodology has been adopted for the tobacco smoke test. Descriptively, compare the indoor air quality with and without tobacco smoke by burning 3 cigars, one cigar at a time with the above working conditions. In this experiment it has revealed that CO, CO<sub>2</sub> and VOC have exceeded the permissible indoor air quality limit due to the tobacco smoke. Below graphs will demonstrate the effect of tobacco smoke on indoor air quality.

As figures 03, 04, 05 illustrated, CO content is 139.43ppm-15 times higher than the indoor CO level (9ppm-ASHRAE), CO<sub>2</sub> content is 1257ppm-that is higher than the permissible indoor CO<sub>2</sub> level (1000ppm-ASHRAE), VOC content is 19.29ppm-25 times higher than the indoor VOC level (0.75ppm-OSHA).

Furthermore we have contrast the above pollutants emission by burning and smoking one person a one cigar at the time. From those results we have observed that CO, CO<sub>2</sub> and VOC levels are above the indoor permissible values in both cases. But when someone smoking, CO and VOC levels are much far below than the results obtained from the burning cigar.

## 4. Conclusion

This study reveals that enclose space can restrict the dispersion of indoor pollutants such as air fresheners, tobacco smoke etc. Opening windows in free running space would dilute the most of the indoor pollutants. Also to promote opening of windows and

openings in free running ventilation, a better micro climate should be created with a desirable tree cover.

## 5. Acknowledgement

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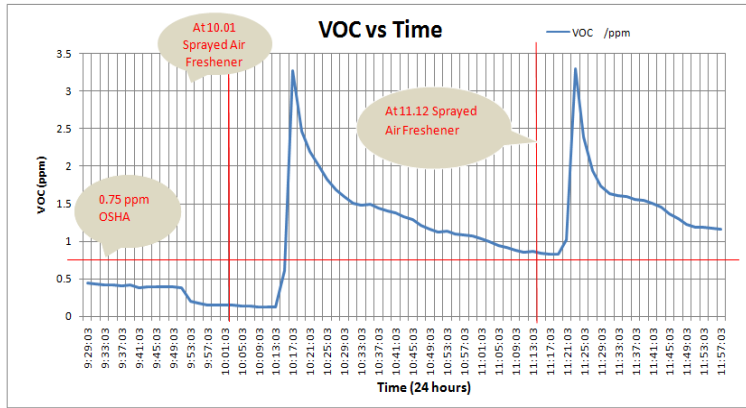


Figure 01 Variation of VOC with time for air freshener

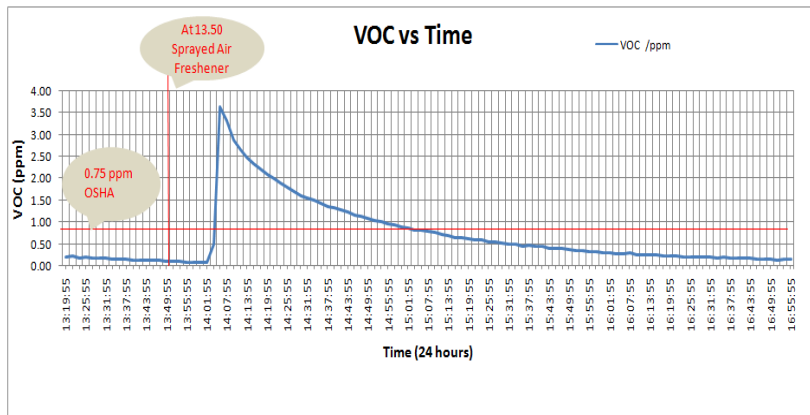


Figure 02 Variation of VOC with time for air freshener

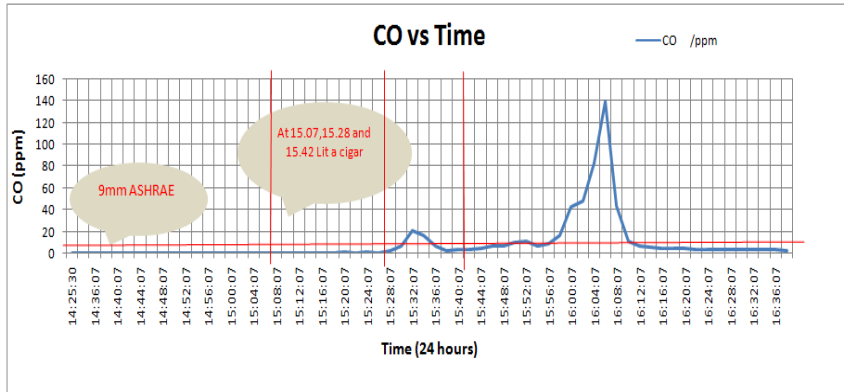


Figure 03 Variation of CO with time for tobacco smoke

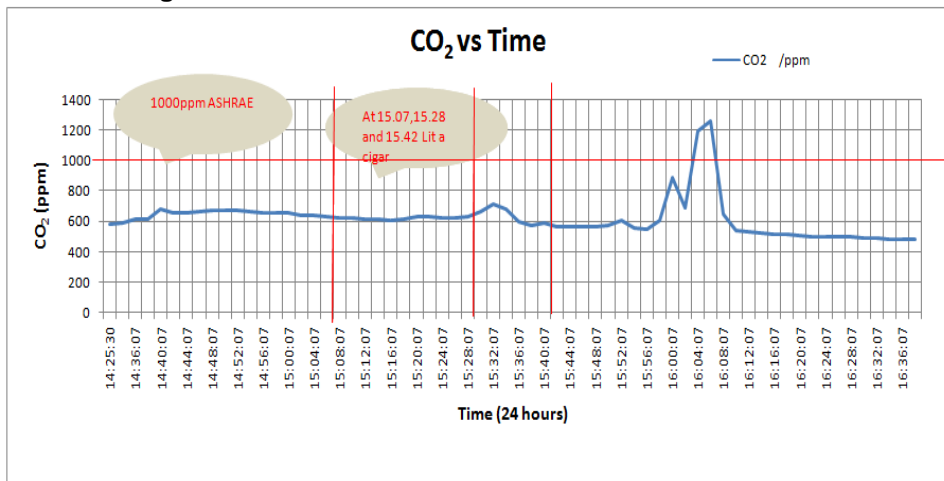


Figure 04 Variation of CO<sub>2</sub> with time for tobacco smoke

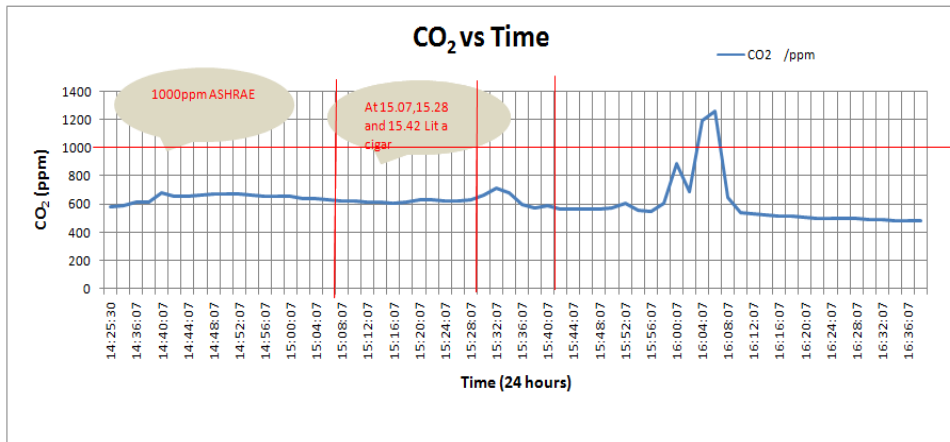


Figure 05 Variation of VOC with time for tobacco smoke