Indoor Air Pollution

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Abstract

This paper deals with the indoor air pollution and its scope is to saw that, air pollutant concentrations behind the closed doors of homes and other buildings are often higher than corresponding concentrations outdoors. As most of the studies, researches and information are addressed to outdoor air pollution and in accord most of the people are not aware that indoor air pollution may have significant effects on their health.

During the beginning of 1970s scientists has started to study indoor air pollution and according to their results they had been convinced that indoor air pollution can cause serious health problem.

Indoor air pollution deals with chemical, biological and physical contamination of indoor air and in many cases it is among the top five environmental risks to public health.

Key words*: indoor air pollution, health, environmental risks, air pollution*

Introduction

In developing countries, the main source of indoor air pollution is biomass smoke which contains suspended particulate matter (5PM), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), carbon monoxide (Ca), formaldehyde and polycyclic aromatic hydrocarbons (PAHs) and the types of diseases that indoor air pollution may cause are respiratory diseases, cancer and even death.

For the identification of pollution sources researches have been performed on areas where individuals are spending most of their time and these areas usually are: offices, restaurants, coffee shops, offices, shopping centers etc. (Lee et al., 1999; Wargocki et al., 2004).

There are a number of different sources that may cause indoor air pollution and the origin of these sources may be either from inside or from outside of the buildings. Indoor pollution falls in thre main categories: a)chemical, b) microbiological and c) noise and the indoor pollutio depends on: outdoor pollution and pollution due to construction material (asbestos, concrete ciment used as insulation materials, synthetic materials, wood conservatives, clues, colors, cleaning materials, etc).

Generally, the sources of air pollutant that can affect building air quality are: radon gas, tobacco smoke, biological pollutants and household products. Indoor air contaminants can originate within the building or be drawn in from outdoors. Researches and studies based on indoor air pollution pointed out that building location plays an important role on indoor air quality because if outdoor contaminant sources or emissions from nearby resources are not controlled then inner air pollution levels may exceed the outdoor levels of pollution (Jones et al., 2000; Edwards et al., 2001).

Material and methods

Indoor air quality is not a topic that can be easily understood or defined. There three factors that are involved in the indoor air quality which are constantly change their interaction and when they are not controlled affect the building occupants. These factors are: a) pollution source, b)Ventilation and HVAC systems and c)pollutant pathways.

- Source: deals with contamination or discomfort indoors, outdoors, or within the mechanical systems of the building.
- Vendilation:deals with the bringing of fresh air into a building and exhausting stale indoor air out of the building and HVAC: deals with the control of: fresh air intake, exhaust old, stale air, and indoor temperature and humidity
- Pollutant Pathways: deal as a link between pollutant source and the building's occupants.

Volatile Organic Components (VOCs) according to EPA is any "any volatile compound of carbon" is classified as a VOC for regulatory purposes, unless it appears on a list of compounds that have been specifically exempted and they can easily become vapors or gases. Also, along with carbon, they contain elements such as hydrogen, oxygen, fluorine, chlorine, bromine, sulfur or nitrogen and they are released from burning fuel, such as gasoline, wood, coal, or natural gas or they are released from solvents, paints, glues, and other products that are used and stored at home and at work. Many volatile organic compounds are also hazardous air pollutants. Volatile organic compounds, when combined with nitrogen oxides, react to form ground-level ozone, or smog. Examples of volatile organic compounds are gasoline, benzene, formaldehyde and solvents. Many volatile organic compounds are commonly used in paint thinners, lacquer thinners, moth repellents, air fresheners, hobby supplies, wood preservatives, aerosol sprays, degreasers, automotive products, and dry cleaning fluids.
The mean VOCs indoor which appear in room temperature and pressure bigger than 0.13 kPa are following:

- Alkans
- Alkens
- Aromatic Hydrocarbons
- Ketons- Aldeids
- Organic esters
- Halogents Hydrocarbons
- Fenols/ Chlorofenols
- Nitro- compounds
- Pentan, exan, octan, etc
- Ethylene, propene
- Benzene, toluol, xylol
- Formaldeid, acetone
- Amins, amids, nitrote compounds
- Menthol, limonen, terpen, etc

The VOCs concentrations depend on temperature, humidity and selection tension to specific materials. Also, wooden constructions and materials which are covered by conservatives (PCP and Lindane have been forbitten since '80s). Measurements on PCP in the room air, identify concentrations of **0.6 µg/ m^3** while on the cotton surface, after 48

hours, it was **32.000 µg/ m^3!** Similarly lindane in the room air was **1.6 µg/ m^3** while the concentration in the cotton was **8000 µg/ m^3!**
Consideration of indoor exposures to air pollutants is critical to accurate assessments of the health risks associated with these chemicals because people spend a large fraction of their time indoors where concentrations of many airborne pollutants often tend to exceed ambient levels. Surveys relative to time spent by individuals indoors location converge that on average people spent 87% of their time indoors (Jenkins et al., 1992; Klepeis et al., 2001).
Studies performed on airborne concentrations inside buildings found that many toxic VOCs are of higher concentration that ouside the buildings (Pellizzari et al., 1986; Wallace, 1987; Daisey et al., 1994).
The prevension of the rapid VOCs dispersal of airborne contaminants is based on two reasons:

- the numerous indoor sources of VOCs like cleaners, air fresheners, and insect repellents and
- the low rates of outdoor ventilation that is usually used in houses and offices

Other cases where VOCs appear are in

- Combustion processes, in particular smoking, are indoor sources of complex mixtures of VOCs.
- Attached garages are a potential source of gasoline vapors due to evaporative and exhaust emissions.
- Materials and products used in new construction, remodeling, and redecorating are other major contributors to indoor VOC concentrations in residences and offices.

The health effects of volatile organic compounds can vary greatly according to the compound, which can range from being highly toxic to having no known health effects. The health effects of volatile organic compounds will depend on nature of the volatile organic compound, the level of exposure, and length of exposure. Long-term exposure to volatile organic compounds can cause damage to the liver, kidneys and central nervous system. Short-term exposure to volatile organic compounds can cause eye and respiratory tract irritation, headaches, dizziness, visual disorders, fatigue, loss of coordination, allergic skin reactions, nausea, and memory impairment.

Results and discussion

During summertime the houses have very bad quality of houses indoor air because the exchange rate of air is very limited (0.1-0.5). In Bavaria among 180 houses more than 6 years old observed to have, high concentrations aromatic hydrocarbons. The natural VOCs are terpen hydrocarbons emitted by pine trees or from cleaning products (especial the limonen). The hydrocarbon concentrations due to anthropogenic production effected from the distance between forestry areas and urban areas with big traffic. In summer time the concentrations of a-pinen are bigger thanthe concentrations of toluol in foresty areas In fact:

- The aromatic compounds are producing by the car emissions.
- The main emissions are benzon toluol, ethylobenzon, xylol and 1.2.4-trylobenzon.
- The maximum value of benzen, which has been recorded, is 445mg/ m^3 from the car tank inside the garage.

The benzene is the main carcinogenic compound and it is present only to unleaded gasoline and some color dissolvers. Its maximum permitted concentration is 5 μg/ m^3 (according EU- directives)

Conclusions

The concentrations are made in specific materials from which are produced items (furniture,etc) and these materials emitted indoor. The VOCs indoor are always higher than outdoor. The Biological Particles indoor are: mites,mikits, bacteria and legionella and these particles provoke allergy to the people like as: noise running, asthma, fever, muscle pain, lung disease, skin diseases, etc. Also, the Biological Particles are responsible for the Sick Building Syndrome (SBS) as well as for the Organic Dust Toxic Syndrome (ODTS). From SBS suffer mainly the people involve with agrochemicals.

The aliphatic hydrocarbons are emitted mainly by internal sources and from diesel engines. First time discovered in 1920 that the house dust mites provoked skin diseases. Mites are eating and survive with the skin layer of the men. The ideal conditions are T= 25^{o}C and humidity 70-80 %. Their highest concentrations indoor are on matrices, pillows, towels and carpets: 10-100 mites/ gr of house dust.

Allergies due to mikits are presented within either in few minutes or after 4-8 hours. Among patients with breathing problem 2-30 % was due to allergies. The volatile compounds of mikits appear with specific odure of fungus. This is a complex mixture of alcoals, esters, aldeids and various aromatic hydrocarbons.

About 100.000 species of mikits have been found indoor! The majority of them developed indoor in the T= 10-15^{o}C, and with minimum aquatic capacity a_w to be between 0.75-0.98. The water, which is the main source of the humidity, helps the development of mikits in bricks, concrete etc (summer and autumn are the most favor seasons to mikits).

The most important sources of bacterias are huminitizers. The first identification of bacteria concentration in house, made in 1887 in Scotland where found 120.00 bacteria/ m^3. Obviously it was a wrong measurement since today we know that the maximum indoor value of them is 512 bacteria/ m^3. (without climatization) and 244 bacteria/m^3(with climatization). In outdoor their maximum is 625 bacteria/ m^3.

In 1976, during a meeting of 200 people in Philadelphia (USA), 34 people died due to legionella. Today, we know that there are 40 species of it with most important to be the "Legionella pneumophila». The cultivation period is 2-13 days and can be confronted with special antibiotics. They are not going from human to human but only through the water drops. It has been announced legionella through warm water in air- contidioning etc. Above 60^{o}C in the water legionella cannot survive. Radon is another indoor pollution and it has been identifies as a carcinogenic gas.

From the garbage disposal areas there are emissions of methane, CO_2 and H_2S. The main problem is the methane because can cause self-burn when its concentration is 5-15 % in the air.

The cigarette smoke has some thousand chemical compounds! When the cigarette smoke's CO is 2 ppm indoor, we observe health problems to the inhabitants.

Formaldield is emitted indoor from the furniture, plastics and materials with resins of uria- formaldeild. Formaldield is caused problems on the eyes and breathing.

Since CO_2 is produces continuously from the human beings because of the breathing the WHO put the limit value for indoor CO_2 concentration to be 6.3 g/m^3 (3500 ppm).

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