IMPACT OF VOLATILE ORGANIC COMPOUNDS ON INDOOR AIR QUALITY

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Abstract : Over the past few decades, the presences of volatile organic compounds (VOCs) in indoor air has drawn the attention of scholars who have examined the subject with the aim of understanding their cause, effects, thereby highlighting some of the strategies that need to be applied to reduce exposure. Volatile organic compounds (VOCs) are gases which are emitted from solids and liquids which are made up of carbon excluding carbonic acids carbon dioxide, carbon monoxide, metallic, and carbides which take part in the atmospheric photochemical reaction. VOCs have been a growing public health concern as they result in various health complications including sensory irritation symptoms, asthma, allergic reactions, and respiratory diseases. This individual report discusses some of the fundamental factors surrounding VOCs such as their primary cause, their effects on human and approaches that can be employed in a bid to ensure that indoor air quality is improved.

Keywords: *Volatile organic compounds, Indoor air quality, pollution, Architects, built environment, health, construction materials.*

1. INTRODUCTION

The human race has made notable advances over the last three centuries that have resulted in an improvement in the quality of life. In the closing years of the 17th century, the world ushered in the industrial age which marked a shift from an agrarian economy to an industrial economy where goods were manufactured in large factories that had been invented due to advances in technological developments and scientific methods. Increased reliance on carbon fuels characterized the industrial age, and the increased use of carbon fuels has hugely affected the environment, especially in the form of air pollution. Air pollution points to the presence or introduction of poisonous substances into the air which have a significant impact on plant and animal life as well as the built environment. Regarding the built environment, pollution has resulted in the devaluation of buildings as air pollutants mix with rainwater producing acidic rain which corrodes building surfaces. There has been a continuous debate on the importance of the quality of air in built structures. Over the past few decades, the presences of volatile organic compounds (VOCs) in indoor air has drawn the attention of scholars who have examined the subject with the aim of understanding their cause, effects, thereby highlighting some of the strategies that need to be applied to reduce exposure.

2. VOLATILE ORGANIC COMPOUNDS

According to the United States, Environmental Protection Agency (EPA) volatile organic compounds (VOCs) are gases which are emitted from solids and liquids which are made up of carbon excluding carbonic acids carbon dioxide, carbon monoxide, metallic, and carbides which take part in the atmospheric photochemical reaction (George, et, al., 2016). VOCs have drawn the attention of various scholars mainly due to their short-term and long-term health effects on human beings and past research highlights that VOCs are consistently higher in indoors than outdoors, and they are discharged by numerous household products totalling in the thousands.

Some of the documented sources of VOCs include products used in the construction of new house have, such as paints, furnishings, solvents, furniture and new carpeting. Considering that VOCs are present in many construction materials, architectures and construction experts have been jointly addressing the problem recommending practical approaches that can be used to solve this individual issue facilitating that built structures have high air quality free from pollutants that might stem

from construction designs. It is imperative to discuss the cause and effects of VOCs before examining the relationship between architectural drawings and improved indoor air quality, and some of the procedures that need to be applied to lessen the complications caused by VOCs.

3. CAUSES OF VOLATILE ORGANIC COMPOUNDS

VOCs are caused by numerous products such as wood preservatives, cleansers and dispensers, hobby supplies, dry-cleaned clothes, pesticides, moth repellents and air fresheners just to name a few. There are very many sources of VOCs that they World Health Organization has submitted a classification system in which VOCs are classified as per the ease of their emission.

Indoor pollutants are either categorized as very volatile organic compounds (VVOCs), Volatile organic compounds (VOCs), and Semi-volatile organic compounds (SVOCs) (Bruce, et, al., 2015). Very Volatile Organic Compounds are incredibly unstable that they cannot be measured, and they are found wholly as gasses in the air rather than on surfaces or in materials. Kamal, Razzak, and Hossain (2016) state that the lower the boiling point of a compound the higher the volatility, and the likelihood that the compound will be discharged into the air. Volatile organic composites, on the other hand, are quickly emitted into the air, but they are not as unstable as VVOCs as they have a higher boiling point.

The other subgroup of volatile organic compounds is the semi-volatile organic compounds (SVOCs), and compounds classified in this subgroup tend to have a higher molecular mass and a higher boiling temperature making it difficult for them to evaporate into the atmosphere quickly (Kamal, Razzak, & Hossain, 2016). All these groups of volatile organic compounds are a concern in the built environment due to their potential for adverse health outcomes for human beings. Based on this discussion, it can be ascertained that the presence of VOCs in the atmosphere is caused by compounds that have lower boiling points meaning that they can be quickly released into the atmosphere reducing the quality of air that people breathe.

4. EFFECTS OF VOCS

Volatile Organic compounds lead to an array of sensory irritation symptoms which include the inflammation of the eyes, irritation of the skin, and nose, and these symptoms are typically reported by inhabitants as linked to the period that they have occupied an individual house. There has been an uptick in the number of sensory irritation symptoms published in the past, but the available research cannot assert that VOCs are the leading cause of sensory irritation. Most of the volatile organic compounds are not present in higher concentrations in the air of buildings to result in sensory irritation symptom. Nonetheless, mixtures of individual volatile organic compounds can react with one another resulting in the formation of highly irritant VOCs which can result in sensory irritation symptoms.

Past research also highlights that prolonged exposure to VOCs increases in cases of asthma, allergic reactions, and respiratory diseases. Additionally, current research highlights that extensive exposure to VOCs results in the development and progression of cancer. A case in point, a study conducted by Bentayeb, et, al., underscored that increased exposure to benzene and formaldehyde led to the development of cancer in the animals used to complete the survey (Bentayeb, et, al., 2015). Benzene and formaldehyde are considered by many authorities to be likely carcinogens, but research is lacking on how precisely these compounds result in the progression of cancer. There is heightened incredulity on the health risks of VOCs, but existing literature highlights that increased exposure to VOCs and SVOCs can result in the health complications. As a result, architects are bequeathed with the role and responsibility of coming up with stratagems that can limit or reduce indoor sources of VOCs and SVOCs.

5. THE ROLE OF ARCHITECTS AND DESIGNERS IN IMPROVING INDOOR AIR QUALITY

Architects and designers can apply an array of strategies that can be aimed at decreasing the use of constructions materials that have high VOCs in a bid to improve indoor air quality. One of the approaches that can be employed to better indoor air quality is by particularizing the use of sealants and paints that have next to zero VOCs content as this can help to prevent the discharge of volatile materials into the atmosphere improving the quality of indoor air (Leung, 2015). If architects and designers start the selective use of paints that have next to zero VOCs companies will be compelled to produce paints that are not only good for the environment, but also for the general human health.

Architects should also use construction materials that are readily available as this reduces the carbon footprint left during the construction processes. When construction materials are shipped from various regions of the world, there is a lot of transportation with the use of multiple transportation channels, such as the use of ships, and trucks which complicate the issue of air pollution making it challenging to attain healthy indoor high-quality air. If air is widely polluted in the external environment, it becomes remarkably difficult for architects to design buildings with high indoor air quality. By lowering the demand for import products architects indirectly reduce the demand for oil and gas which are the primary factors attributed to increased air pollution and climate change around the world.

Persily (2015) highlights that indoor air quality can be increased by using specific plants which play a massive role in purifying the air in and around constructions. Some of the primary sources of indoor air pollution as highlighted in this individual essay include benzene, formaldehyde, chloroform, and xylene. These chemicals are widely used in the manufacture of essential materials used in indoors, such as carpeting, adhesives, ceiling tiles, caulking compounds, stains, particle boards, photocopiers, electrographic printers, solvents, plastics, and paper towels. It is glaring that most of the products used indoors have been made with the use of VOCs.

However, these elements can be eliminated from the air by growing distinct plants, such as the Arrowhead vines which removes chemical vapours from the atmosphere. Additionally, architects can use the Boston fern which is known for its ability to remove air pollutants. The other plant that can be used to enhance indoor air quality is the English ivy which mainly helps in the extraction of formaldehyde from the air (Pluschke, P., & Schleibinger, 2017). Architects and designers should consider incorporating some of the listed plants while planning the construction of new structures as plants not only improve the quality of indoor air but they also enhance and enrich the environment making indoor space look beautiful if they are meticulously used.

In some instances, the sources of VOCs can be efficiently reduced through product substitution and behavioural changes. Nonetheless, in some cases mitigation measures are complicated, and they might require trade-offs. Outdoor air ventilation is a different approach that can be used to lessen the concentration of VOCs emitted from indoor sources. Outdoor air can be directed to buildings through the installation of mechanical ventilation systems containing fans, or by expanding the openings of windows, doors. The use of outdoor air guarantees the constant flow of air into the indoor environment which reduces the concentration of VOCs emitted from indoor sources in the event improving indoor air quality.

Nonetheless, it should be heeded that increased ventilation can easily be applied than source control, and this is an essential element that should be considered in the design of a building as increased ventilation simultaneously reduces the concentration of many VOCs. While ventilation minimizes the frequency of VOCs in indoor air, it also increases the amount of energy used by a building and in many instances, it results in slight reductions of VOCs that can also be achieved through source control. Ventilation might reduce VOCs produced as a result of increased emission, but they are not effective in reducing the concentration of SVOCs that are mainly found on indoor surfaces. Architects need to understand that with improved indoor air quality people can lead healthy and productive lives free from diseases in the event perusing their life goals and objectives. However, research needs to be advanced on the impact of VOCs so that fitting programs and legislation can be adopted to thwart complications that stem from poor air quality. Indoor air quality is a pressing public health concern that needs to be addressed at the local level, states, and federal level.

6. .CONCLUSION

There has been a continuing discussion on the importance of quality of air in built structures, and volatile organic compounds have drawn the attention of scholars who have explored the topic with the objective of understanding their cause, and effects, thereby devising some of the approaches that need to be applied to reduce exposure. VOCs are gases which are emitted from solids and liquids which are made up of carbon excluding carbonic acids carbon dioxide, carbon monoxide, metallic, and carbides which take part in the atmospheric photochemical reaction. VOCs are a huge public health concern as they result in various health complications such as sensory irritations, asthma, respiratory difficulties, and cancer.

Architects and designers have an essential role to play in facilitating that indoor air quality remains free from contamination from VOCs compounds and this can be attained by specifying the use of sealants and paints that have next to zero VOCs. Additionally, architects can ensure that the constructed buildings have adequate ventilation as ventilation reduce the concentration of VOCs increasing indoor air quality. It is essential for architects and designers to understand that everyone is responsible for air pollution and including the materials used building industry. Therefore, they should strive to design buildings that result in the reduction of the carbon footprint in the event improving the quality of life.

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