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TOWARDS **BETTER INDOOR** **ENVIRONMENT QUALITY** IN OFFICES



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A major portion of our lives are spent indoors with little or no ventilation, leading to growing concerns about the quality of our working environments and the risk to health

TEXT & PHOTOS COURTESY: Prof. Roshni Udyavar Yehuda, Dr. Ashok Joshi, Ar. Ashwini Deodeshmukh

Aspects

Indoor Environmental Quality



Source: Godrej Interio Project Green Wave; Rachana Sansad's Institute of Environmental Architecture

1. Aspects of Indoor Environmental Quality

There are concerns about the Indoor Environment Quality (IEQ) in offices as a growing body of scientific evidence has indicated that the air within buildings can be more seriously polluted than the outdoor air

Increasingly, office interior environments are becoming standardised with work stations, cabins, gangways, false ceiling and lighting systems, and most significantly, without natural ventilation. Most offices are part of a glass curtain wall exterior building, where air is circulated by means of air handling units (AHU) which provide the required air changes as provided by standards in the National Building Code (NBC).

There are concerns about the Indoor Environment Quality (IEQ) in offices as a growing body of scientific evidence has indicated that the air within buildings can be more seriously polluted than the outdoor air. Other research also indicates that as people spend most of their time indoors and the concentration of contaminants may build up in an enclosed space, the risks to health may be greater due to exposure to air pollution indoors than outdoors.

Indoor Environment Quality

Acoustics, Light, Thermal comfort and Indoor air quality (IAQ), determine the Indoor Environment Quality of offices. IAQ is a term that refers to the air quality within and around buildings and structures, especially as it relates to the health and comfort of building occupants. The main causes which

lead to poor IAQ in offices include combustion products such as carbon monoxide, nitrogen dioxide, sulphur dioxide, carbon dioxide, tobacco smoke components; respirable particulates such as those emanating from asbestos, fibre glass, inorganic and organic dusts, frayed materials, pollen grains; respiratory products such as water vapour, carbon dioxide; biological pollutants and bio-aerosols such as moulds and fungi, bacteria, viruses, nonviable microbial particulates; radionuclide such as radon; and VOCs.

Volatile Organic Compounds (VOCs) are a large and diverse family of chemicals that contain carbon and hydrogen. Volatile organic compounds (VOCs) are emitted as gases from certain solids or liquids. VOCs include a variety of chemicals, some of which may have short and long-term adverse health effects. Typical sources include painted surfaces, formaldehyde based adhesives used in furniture materials such as laminates, plywood and MDF; furnishings, carpets and fabrics, office equipment such as photo copiers and printers, office/residential cleaning supplies, pesticides and ceiling products.

Furniture and VOCs

A freshly unwrapped piece of furniture often carries a distinct scent. This is due to the slow release of VOCs from the products used to create and finish furniture. In a typical open office, the layout comprises of workstations made of metal frames along with marine plywood, glass wool infill and finished with laminate or veneer. Many of these materials emit VOCs as soon as they are unpacked. Emissions peak within a couple of weeks of production and then slowly dissipates.

Furniture is a particularly common culprit because so many materials, from coatings and glues to particle-board and upholstery, can contain VOCs. Some of these pollutants can be toxic or irritating to people with respiratory diseases or chemical sensitivities. Since people

spend a lot of time in close proximity to this furniture, in closed/ sealed office spaces, the long-term effects of these VOCs can be significantly detrimental. Formaldehyde, for example, is a known carcinogen often found in the adhesives that bind particle board together, as well as some coatings. Others, like butyl acetate (a common solvent in lacquers) and methylene chloride (paint thinner) can induce dizziness or headaches.

A Research Study on VOC in offices

With an objective to study the relative contribution of various interior surfaces in offices towards VOC emissions – with particular interest to VOCs from furniture – a joint research project was undertaken by the Rachana Sansad's Institute of Environmental Architecture and Godrej Interio in May 2013. The objectives of the project were to study interior materials that contribute significantly to VOCs in offices with estimation of VOC emissions ($\mu\text{g}/\text{m}^3/\text{hr}$) on actual basis for each material. The study also attempted to quantify Total VOCs (TVOCs), formaldehyde and total aldehydes, and identify individual VOCs as feasible. And most importantly, it aimed to analyse the relative contribution of furniture to VOC emission in typical office spaces.

A survey of 4 to 6 conditioned open office spaces having about 100 workstations were conducted to identify major VOC emitting materials in such offices. The collected data was summarized for the mean area (%) of the most significant VOC emitting materials in offices and the top five materials were chosen for the experiment. An experimental station of mirror finished aluminium sheets was designed to test VOC emissions of the materials identified from the summarised data. Total VOC emissions were measured from each material. Finally, the relative contribution of VOCs from furniture in offices was analysed.

The materials showed excellent graded response with significant trend in VOC

emissions from low to high. Carpet flooring and paint were found to emit more VOC emissions as compared to System Furniture (including laminate and fabric). Ceiling tiles emitted the lowest amount of VOCs while carpet tiles emitted the highest quantity.

An IAQ Scorecard

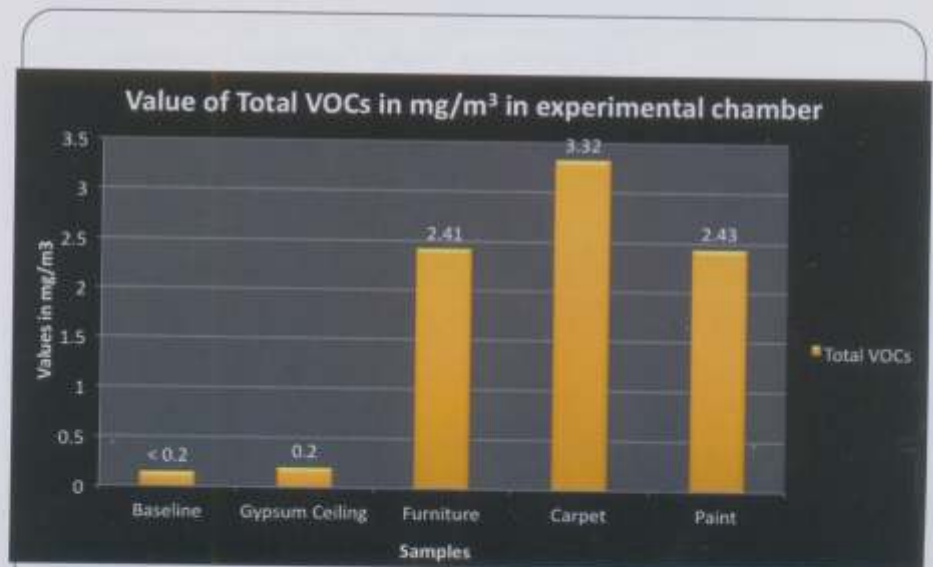
An IAQ scorecard was prepared through a joint project of Rachana Sansad's Institute of Environmental Architecture and Godrej Interio in 2012. This involved three components – VOCs, Suspended Particulate Matter (SPM) and Microbial content. Interior spaces were categorized into Walls/ Partitions/



2. Experimental chamber to measure VOC emissions

3. Results of the research indicated maximum VOC emissions from Carpet tiles

4. The IAQ Scorecard for ceiling components



Source: Godrej Interio Project Green Wave; Rachana Sansad's Institute of Environmental Architecture

3



Limits of Indoor Air Concentrations due to emissions from Systems Furniture and Seating at 168 hours

Chemical Contaminant	Emissions Limits Systems Furniture	Emissions Limit Seating
TVOC _{toluene}	≤ 0.5 mg/m ³	≤ 0.25 mg/m ³
Formaldehyde	≤ 50 ppb	≤ 25 ppbw
Total Aldehydes	≤ 100 ppb	≤ 50 ppb
4-Phenylcyclohexene	≤ 0.0065 mg/m ³	≤ 0.00325 mg/m ³

Panelling, Ceilings/Ceiling components and Flooring. A total of 77 components comprising these interior space categories were listed:

- Walls/ Partitions/ Panelling – aluminium frames, MDF, commercial plywood
- Ceilings/ Ceiling components – gypsum, calcium silicate, mineral wool
- Flooring – granite, kota, vitrified stone, marble

A component rating system was developed with a scale of 1 to 3 with weightage to each element as 2, 2.5 and 1.5 given for VOCs, Microbial content and SPM respectively. These were then given an aggregate ranking from 10 to 70 points – with <14 being least acceptable and 57 – 70 being most acceptable. Based on the Bill of

Quantities (BOQ), each item of interior furniture was then given a ranking and all the different combinations were assessed in terms of their projected indoor air quality performance.

Strategies for better indoor environment quality in offices:

Offices can adopt a multi-pronged approach to improving indoor environment quality. By opting for voluntary rating systems such as the Leadership in Energy and Environmental Design (LEED), for New Construction (NC) or Commercial Interiors (CI), they can ensure better indoor environment quality. The U.S. Green Building Council's (USGBC) "Green Building Rating System for Commercial Interiors" (LEED CI 2009) has the following criteria (refer Table 1) for receiving "EQ Credit 4.5 Low-Emitting Materials, Systems Furniture and Seating":

Offices should adopt to follow a policy of purchasing or developing interiors from BIFMA or Greenguard or any other standard rated furniture with acceptable indoor air quality standards. Finally, an approach to natural ventilation or flexible operable fenestrations or air change systems, will help enhance indoor environment quality and worker productivity. ●

(The article is produced from a series of research projects conducted jointly by RSIEA and Godrej Interio on indoor air quality)

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