

NEWS LETTER

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INDOOR AIR QUALITY: AN UNSLOVED PUZZLE

Introduction

World Health Organization says that indoor air pollution (IAP) is by far the biggest environmental problem of the world. Every year, 4.3 million people die due to the exposure to household air pollution caused by indoor open fire. It is 45-times of the global annual deaths from natural catastrophes and more than twice the number of people dying because of AIDS (WHO, 2015). It is the second-biggest cause of death after dietary risks, such as over- and under-nutrition in India (Global Burden of Diseases Study, 2010).

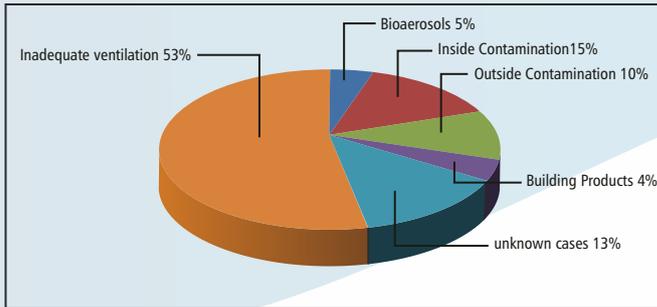
The most common IAP's are particulates (PM_{10} and $PM_{2.5}$), gases (carbon monoxide, nitrogen oxides, sulphur oxides, VOCs) and biological agents (bacteria, fungi, molds and mites), radon and asbestos. The predominant sources of these pollutants in urban buildings are indoor smoke, cooking and cleaning activities, poor ventilation, and emissions from building materials and penetration from ambient air (figure 1). However, in rural indoor environments, biomass burning is the main source of IAPs.

These IAPs use our lungs as gateways to enter the body to affect the brain, circulation, central nervous system, endocrine system, blood and immunity, therefore, a strong correlation exists between indoor air quality (IAQ) and lung health of the people. A prolonged exposure to IAP can initiate ischemic heart disease, stroke, chronic obstructive pulmonary disease (COPD), lower respiratory tract infection (LRTI) and lung cancer. Women and young children are the predominant ones affected by IAP.

IAP: Unreported and Unattended Problem

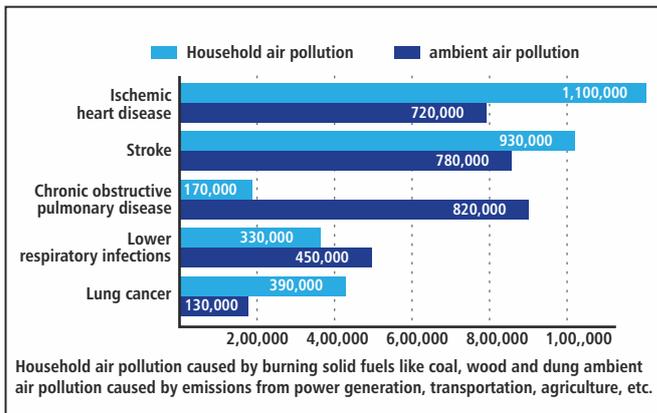
IAP is the most unreported and unattended problem in the world and reasons for this are various myths, lack of awareness, lack of Indoor Air Quality Data and Standards. Till 1980s, air pollution believed to exist only outdoors or in industrial environments until the IAP episodes happened in headquarters of EPA building at Washington, D.C., where more than 100 people fell sick within 15 minutes of entering the office (due to accumulation of CO and poor ventilation). As an outcome of such episodes happened at many places in the world, researches on IAP (including its causes, effects, monitoring, modeling and control methodologies) has been taken up on fast pace at developed world and the regulations/standards have been formulated worldwide for IAQ. Those are WHO guidelines, American Society of Heating, Refrigerating and Air-conditioning Engineers Inc. (ASHRAE) standards, Occupational Safety and Health Administration Permissible Exposure Limit (OSHA) standards, The National Ambient Air Quality Standards (NAAQS)/ US Environmental Protection Agency (USEPA) standards. China has introduced these standards as early as in 1976. Korea has introduced Air Quality Standards even for A/C Buses. However, in India we don't care much about the IAQ. We show concerns only for the Outdoors. Much of our life today is indoors. The data reported on deaths caused by air pollution in 2013 clearly indicated that indoor air pollution is much more dangerous (Figure 2).

Figure 1: Sources of Indoor Air Pollution



Source : National Institute of occupational Safety and Health

Figure 2: Air Pollution Deaths By Type (2013)



Source: WHO report, 2015

IAQ status: India V/s The world

WHO has ranked India as world's worst country in terms of the air pollution, with 13 out of 20 most polluted cities of the world are in India alone. Minding you that indoor air tends to be more polluted and could be more dangerous than ambient air as studies of Indian Council of Medical Research (ICMR), International Agency for Research on Cancer and WHO confirms. Further, EPA and WHO has ranked indoor air pollution amongst the top five environmental health risks to the public and is one of the top 10 death, disease risk factors in India.

The existing body of published literature for India has mostly focused on IAP due to the burning of biomass fuels in unvented cook stoves in rural, semi urban areas or in urban slums and on their socio-economic status (Dr. Kalpana Balakrishnan's Group). However, a far less attention has been paid to the IAP issues in urban areas which is an equally important problem due to multiple sources of air pollution. Only a handful of research studies has been investigated in urban indoor settings in India on IAQ. Even the so far conducted research is either limited to

individual studies or based on short-term measurements that suffer from a small sample size, which are not sufficient enough to formulate the standards of IAQ for a country like India, where so much of variations exists in indoor as well as outdoor climatic conditions and the sources for urban environments. In contrast to it, developed countries are extensively carrying out studies on **epidemiology** (e.g. case- control studies on cardiovascular diseases, lung diseases etc.); **exposure assessment** at different levels of population; and **interventional research** analysis to improve the fuel types, ventilation types, peoples behavior and activities indoors etc.

Glimpse of IAQ Research in India

- ▶ Over the last three decades, several studies have reported results from epidemiological investigations and air quality measurements in rural households using solid fuel such as wood, cow dung and crop residues in different parts of the country (E.g. in Gujarat, Maharashtra and Madhya Pradesh by Smith et al.,; Aggarwal et al., ; in Delhi and U.P. by TERI, Saksena et al., in Karnataka, Tamil Nadu and Andhra Pradesh by Ramakrishna, and Balakrishnan et al.) . The issue of solid fuel use and smoke exposure is very well recognized in Indian rural settings. However, research priorities needs to concentrate on health sector.
- ▶ A number of short-term IAQ and health exposure research studies in urban settings, including, school children from different cities (Delhi Schools- by IIT Delhi, CPCB and CNCI, Kolkata, CSIR- IGIB and CSIR-NEERI; Mumbai schools- by CSIR-NEERI Mumbai, Chennai schools- by IIT Madras and for Kolkata schools- CPCB and CNCI, Kolkata) of India has been performed in last decade. The findings of the studies clearly indicate the reduction in lung function of the school children from urban centers like Delhi due to air pollution exposure is up to 43.5%, compared to rural children, where reduction due to air pollution exposure is 25.7%. The health impacts even further varies with the location of the school buildings in urban centers, i.e. in industrial, commercial and residential areas. The impacts are much more severe on children of the schools located in industrial and commercial areas as compare to residential areas (Mathew et al., 2014). In all the cases, the reduction in lung function is more prevalent in girl children. In addition to it, the above studies also concluded that IAQ is strongly influence by ambient air quality, meteorological parameters, such as

temperature, relative humidity, wind speed and direction specially in naturally ventilated buildings. Human influence and their activities are also one of the most significant factors to influence IAQ (Goyal and Khare, 2009).

- A recent survey conducted by Artemis Hospitals at Gurgaon as part of Clean Air India Movement (CLAIM) says that about 76 per cent of the offices and houses had PM_{2.5} levels far above the normal (>60 µg/m³). Due to unhealthy IAQ, about 31 per cent of the respondents had some kind of airway disease and 46 per cent people were found to have symptoms suggesting a respiratory disease (Hindu, 2016). The report also stated that people who spend 90 per cent of their time indoors has been linked to "Sick Building Syndrome" where people exhibit a range of ill-health effects related to breathing indoor.

(The term 'sick building syndrome' has been used to describe the situation when a large number of people who live or work in the same building report various symptoms, such as lethargy, headaches, dizziness, eye irritation and allergies, as well as more serious complaints including respiratory and cardiovascular diseases and cancer).

- A pollutant released indoors is 1,000 times more likely to affect human lungs than a pollutant released outdoors (says the recent report of CLAIM).

Where do we Stand Now?

Most of the developed countries (United States, European Union, Canada, Australia, etc.) have already formulated guidelines and standards for IAQ and ventilation, limiting people's exposure to cigarette smoke by banning smoking in workplaces and banning on use of certain substances like asbestos, formaldehyde etc. in building materials after understanding the impacts of poor IAQ on human health. However, there are no IAQ standard protocols and guidelines currently exist in India.

Since the Bhopal gas disaster in 1984, the main responsibility of Indian regulatory agencies (Central Pollution Control Board (CPCB) under Ministry of Environment, Forests and Climate Change (MOEFCC), Govt. of India) was to implement National Ambient Air Quality Monitoring (NAAQM) programme and laying down the NAAQ standards under Air (Prevention and Control of Pollution) Act, 1981. However, monitoring the indoor air pollution is not their mandate and there are no regulations/

compliance/standards and government policies for IAQ exist till date in India. **IAQ is still "no one's baby"** in India', resulting in insufficient infrastructure and unskilled manpower to design/formulate the IAQ monitoring/ modeling protocol in the country. Considering the increasing urbanization and growth of the cities in India and the increasing IAQ problems in urban areas, an effort has been made by the IAQ research team from IIT Delhi, CSIR-NEERI and University of Delhi to prepare the IAQ protocol for India, which has been submitted to Central Pollution Control Board (CPCB), Govt. of India in year 2012. However, the draft protocol is still lying with CPCB without any further action on it. Therefore, **IAQ is still an 'unsolved puzzle' in India.**

A Ray of Hope

Though, no initiatives have yet been taken at government level in India to solve the puzzle of IAQ, a few steps at non-government levels have been taken up, such as Green Rating for Integrated Habitat Assessment (GRIHA), a green building rating system in India; A council is formed named, Indian Green Building Council (IGBC), which emphasize the need to take into account various indoor environmental parameters, while constructing new buildings in India through a certification system. Even if, the air quality and ventilation are not yet fixed as a criteria to evaluate the buildings, Environmental Tobacco Smoke (ETS) and VOCs are considered, while rating the buildings, which can resolve at least some issues of IAQ if not completely.

Three Level Initiatives

To solve the puzzle of IAQ, a three level approach needs to be adopted and to set out the future road map for mitigating IAQ impacts. Those are as follows:

Firstly, at the Government level, there is a need of integration between the various governmental agencies (e.g. MoEF&CC, CPCB, Bureau of Indian Standards) to set up a robust plan that could lead to the formation of IAQ policies. It is however first needed to identify the knowledge gaps and the potential areas for interventions.

These knowledge gaps could be filled by supporting the long term research studies focusing on establishing the monitoring protocols, long term monitoring of IAP in varying indoor environments, health and exposure assessment, and proposing recommendations of possible guidelines that can be translated into the standards after the consultation with

stakeholders (e.g. environment scientists, building engineers and managers, epidemiologist (public health expert), architects, HVAC engineers).

Also it is needed to launch the mass awareness and education campaigns on IAQ in both rural and urban areas of India, probably under the national compliance monitoring programme. A better emphasis of the Government is needed to promote the use of cleaner fuel and low-cost environmental friendly technologies (e.g. solar energy lanterns to replace indigenously built kerosene lamps, biogas and improved cook stoves) for both the rural and urban poor population. The possible way forward is to offer attractive subsidies so that these remain available for users at an affordable price.

Secondly, at the industrial level, there is a need to identify the best practices and benchmarks for IAQ in buildings and sensitize the members, clients and industries on IAQ to create demand. For instance, the manufacturing industry can play a vital role to develop better building materials (e.g. low VOC-emitting materials), and the energy efficient

household appliances that are suitable for Indian conditions. Likewise, the preferred use of greener building material by the construction industry in new residential homes and commercial buildings could help in reducing the levels of IAP. Novel approaches for building new homes such as Radon-Resistant New Construction (RRNC) can help reducing the risks of lung cancer from exposure to radon in indoor air. Furthermore, the industries can provide the feedback to the government on the IAQ guidelines and their suitability according to the demand and requirements.

Last but not at the least, at the research/academia level, there is a need for a thorough assessment to identify the gaps in present research space of IAQ, including energy and fuel usage, types of fuels, pollutant emissions, and health and exposure risk assessment. Research community can also assist Government agencies with the mass public awareness campaigns to familiarize the general public with the IAQ related concerns and possible measures.

The Solutions to save our indoor environments will be discussed in next issue.

The upcoming event on IAQ



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4, DDA Shopping Complex, Hargobind Enclave, Vikas Marg Extn., Delhi-110092

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