In the last issue we covered various issues related to Indoor Air Quality (IAQ). In this issue we focus on the Health Aspect of poor IAQ. Though, in the last issue we had mentioned that we would be covering issues related to design consideration, we felt that an understanding of the problems should precede the solution and thus the focus on "Health"

Indoor Air Pollution:
New challenges for the Health Professional & Building Designers

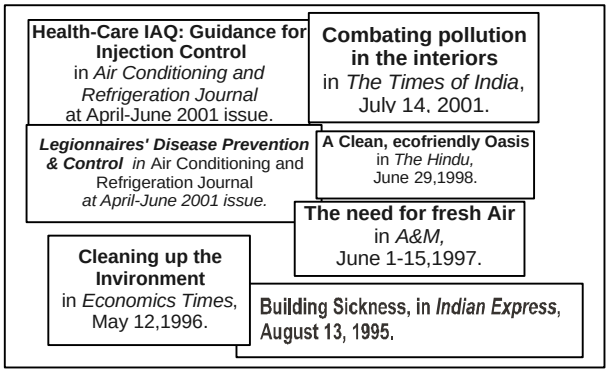
The awareness that indoor air pollution can be more harmful than outdoor pollution is fast gaining acceptance amongst health professionals, architects and building designers.

Over the last few years, our knowledge of environmental health and air quality issues has increased dramatically. Today, the medical profession has begun to accept that as a result of increasing exposure to a wide range of chemicals at work, home, and even in hospitals, there appears to be a growing population of chemically hypersensitive individuals.

Thus, while the outdoor environment continues to be of concern, the indoor environment is receiving increased attention as more information has become available on the presence and effect of indoor contaminants.

Researchers and health professionals have begun to focus on indoor air pollution with the increase in reports and evidences of symptoms or specific diseases that occur mainly in air conditioned and mechanically ventilated buildings. Studies have proved that level of contaminants in the indoor air can be often several times higher than outdoor air. This combined with the fact that people tend to spend 85-90% of their time indoors, proves the point that a person's major source of exposure to airborne contaminants can be indoors.

Some Headlines appearing in publications



The consequences of poor 'Indoor Air Quality' which a health professional must concern himself with -

a. the effect of poor IAQ on the health of the individual at his workplace or house. Physicians need to be aware of these health hazards when taking a new patient's history to make a proper diagnosis.
b. the effects of poor 'Indoor Air Quality' in the health care facility such as hospitals and nursing homes and consequential damage to the already ailing patient.

Effects of Poor IAQ on Health of Individuals: The Sick Building Syndrome (SBS)

"Sick Building Syndrome" is a term that describes the presence of acute non-specific symptoms in the majority of the people, caused by working in buildings with an adverse indoor environment. It is a cluster of complex irritative symptoms that include irritation of the eyes, blocked nose and throat, headaches, dizziness, lethargy, fatigue, irritation, wheezing, sinus congestion, dry skin, skin rash, sensory discomfort from odours, and nausea.

Health effects from indoor air pollutants fall into two categories those that are experienced immediately after exposure and those that do not show up until years later.

The lung is the most common site of injury by air borne pollutants. Acute effects, however may also include non-respiratory signs and symptoms, which may depend upon toxicological characteristics of the substances and host of related factors.

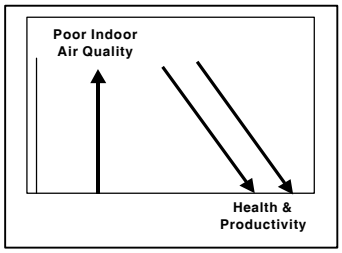
Immediate effects, in addition to the signs and symptoms already listed, may also include eye and/or nasopharyngeal irritation, rhinitis or nasal congestion, inability to concentrate and general malaise - complaints suggestive of a host of common ailments, some ubiquitous and easily communicable. The key factors are commonalty of symptoms among building occupants when the individuals are in the building.

'Sick Building Syndrome' should be suspected when a substantial proportion of those spending extended time in a building (as in daily employment) report or experience acute on site discomfort. It is important however, to distinguish SBS from problems of Building Related Illness (BRI). The latter term is reserved for situations in which signs and symptoms of diagnosable illness are identified and can be attributed directly to specific airborne building contaminants. Legionnaire'

disease and sensitivity pneumonitis, for example are Building Related Illnesses(BRI).

Another diagnostic label of Multiple Chemical Sensitivity (MCS) also referred to as “chemical hypersensitivity” or 'environmental illness is being applied increasingly. Persons with MCS are said to suffer multi-system illness as a result of contact with or proximity to, a spectrum of substances including airborne agents.

The economic consequences of the sick building syndrome and building related illnesses relate to decreased productivity, absenteeism and the cost of providing the correct environment.



While there is no proof that maximum comfort leads to maximum productivity, there is ample evidence that an improved environment decreases worker complaints and absenteeism, thus indirectly enhancing productivity.

SBS in buildings may be due to a variety of causes like:

* Inadequate maintenance of the air conditioning (HVAC) system, which becomes a source of contamination.
* Increased occupancy and activities(load) than designed.
* Inadequate fresh air/ventilation.
* Poor circulation or badly placed vents to prevent outside air reaching the occupants.
* Improperly located outdoor vents bringing in contaminated air from automobile exhausts or restrooms.

Pollutants contributing to Poor IAQ

Sulphur, nitrogen dioxide, carbon monoxide produced by combustion and emission, high pollen counts, pesticides, chemical compounds, all contribute to outdoor pollution. Indoor air will contain all of the pollutants of the outdoor air as well as those generated indoors by the occupants and their activities.

The indoor air contaminants which can be hazardous to health include Environmental Tobacco Smoke (ETS), formaldehyde, radon, asbestos, VOCs emanating from solvents, paints, varnishes, carpets, pesticides causing long term and short term illnesses. Biologicals like bacteria, viruses, fungus exhaled by humans or due to presence of high humidity, directly affect the health of the occupants causing respiratory infections, Tuberculosis, measles, smallpox and staphylococci are transmitted by ventilation systems in hospitals. Bacterial aerosols are incubated in toilets, water machines and carpets and are distributed by cooling equipment. Indoor allergens include pollen, mold, fungi, hair, insect parts and chemical additives causing lung and skin diseases. Odour and dust cause significant discomfort, feelings of unpleasantness.

In a conditioned space, since free passage of air is limited, pollutants tend to accumulate resulting in higher concentration of some contaminants than outdoor ambient air. Most of the pollutants that we find indoors can be sourced to commonly found items around us.

Listed below are some common pollutants and their effects on health

Pollutant	Source	Health effect
Environmental Tabacco Smoke (ETS)	Cigarette + Smoke exhaled by smoker	Leading cause of lung cancer, headache eye irritation, wheezing cough. Asthma and bronchitis in children.
Bacteria, Fungus, Mold, Mildew	Wet or moist walls, ceilings carpets and furniture, poorly maintained ACs.	Allergic reactions, infections illnesses e.g. influenze, measles and chicken pox, eye nose throat irritation etc.
Carbon Monoxide (CO)	Environmental tabacco smoke.	Fatigue, chest pain in heart patients, impaired vision, headaches, dizziness, nausea and respiratory irritation.
Formaldehyde	Pressed wood products made by using adhesives, ETS, drapes other textiles and glues.	Eye, nose and throat irritation, wheezing, coughing, skin rash and severe allergic reactions
Volatile Organic Compounds(VOCs)	Paints, paints strippers and other solvents, wood preservatives, carpets, varnishes and cleaning and disinfecting agents.	Eye, nose and throat irritation, headaches, loss of co-ordianation, nausea, damage to liver, kidney and central nervous system.
Asbestos	Fire proofing material, floors and tiles.	The long term effects are chest and abdominal cancer and lung infections. Asbestos induced lung cancer.

The importance of IAQ in Hospitals/Nursing Homes

Nowhere, is the importance of IAQ as critical as in Hospitals and health care facilities. Continual advances in medicine and technology necessitate the airconditioning of hospitals and medical facilities. Hospital airconditioning assumes a more important role than just the promotion of comfort. In many cases, proper airconditioning is a factor in patient therapy in some instances, it is the major treatment. However the relatively high cost of air conditioning, some times lead to an inadequate and improperly designed systems with not enough care to factor in specific requirements for ventilation, filtration and cross contamination.

If outdoor air intakes are properly located and areas adjacent to outdoor air intakes are properly maintained, outdoor air, in comparison to room air is virtually free

of bacteria and viruses. Infection control problems frequently involve a bacteria or viral source within a hospital. Ventilation air dilutes the viral and bacterial contamination within a hospital. If ventilation systems are properly designed, constructed and maintained to preserve the correct pressure relations between functional areas, they remove airborne infectious agents from the hospital environment.

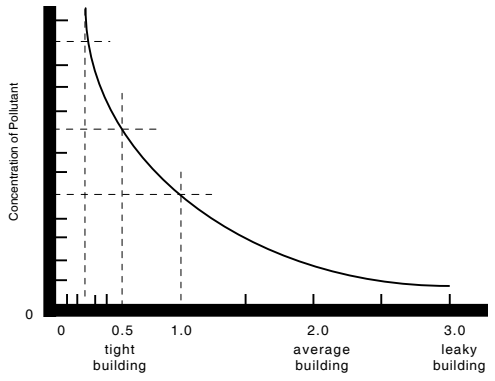
Areas of the hospital which require more careful control of the aseptic condition of the environment are the **surgical suites**, **postoperative recovery rooms, ICUs, burn wards, isolation units**. Ventilation with 100% fresh air is the only means to keeping the airborne organisms contamination low.

Other areas which require high rates of ventilation are **Radiology department, laboratories, infectious disease** and **virus laboratories, autopsy rooms** and **animal quarters**.

Management and improvement of Indoor Air Quality

Air quality can be improved by designing systems that provide air virtually free of dust, dirt, odours, chemical and radioactive pollutants, bacteria, virus and humidity buildup. **Increased fresh air ventilation is the answer "THE SOLUTION TO POLLUTION IS DILUTION"! The** focus of all designers have to fundamentally shift to this all important aspect of new building ventilation design strategies.

***The Dilution Principle**: concentration of pollution is inversely proportional to ventilation rate*



Air changes per hour

The only solution to mitigate the unacceptable levels of airborne pollutants inside conditioned spaces are: **addressing the source of pollution and addressing the level of contaminants in the air.** These may be referred to as '**source control'** and '**removal'** respectively.

Source control, though the preferred approach, may not be often practical. Source control measures are pollutant specific and may include use of low formaldehyde emitting materials, banning of cigarette smoking, prevention of radon entry through sealing of foundations, eliminating use of asbestos and storing of paints and chemicals outside the occupied space. Controlling relative humidity will prevent microbial contamination.

Removal of contaminants from a building or reducing its concentration can be accomplished by passive or active fresh air ventilation.

Passive ventilation refers to air exchanged through doors, windows or other openings by natural forces. In most air conditioned buildings, these openings have been reduced to the minimum to conserve energy.

Active ventilation systems provide continuous ventilation to which passive ventilation may add but not subtract when pollutants are evenly mixed throughout a space and the source rate is constant; the concentration of airborne pollutants will be inversely proportional to the ventilation rate, that is, doubling the ventilation will halve the concentration!

An existing ventilation system which is inadequate because of design flows, poor maintenance or expanded use of a building is often associated with poor indoor air quality. Mitigation can often require redesign or maintenance. In cases where the outdoor air ventilation provision of an HVAC system is not being used, the remedy is obvious - increase ventilation.

Reproduced below are the recommended ventilation rates for Offices, Commercial Spaces, Auditorium and Healthcare :

Application	Estimated maximum Occupancy P/1000 ft^2 or 100 m^2	Outdoor Air Requirements cfm/ person	L/s person	cfm/ ft^2	L/s m^2
Hospitals					
Patient rooms	10	25	13		
Medical procedure	20	15	8		
Operating rooms	20	30	15		
Recovery and ICU	20	15	8		
Autopsy rooms				0.50	2.50
Physical Therapy	20	15	8		
Retail Stores, Sales Floors, and Show Room Floors					
Basement	30			0.30	1.50
Upper floors	20			0.20	1.00
Storage rooms	15			0.15	0.75
Dressing rooms				0.20	1.00
Malls and arcades	20			0.20	1.00
Shipping and receiving	10			0.15	0.75
Smoking Lounge	70	60	30		
Auditorium	150	15	8		
Hotel, Motels, Resorts				Cfm//room	L/s room
Bedrooms				30	15
Lobbies	30	15	8		
Conference rooms	50	20	10		
Offices	7	20	10		

Source : ASHRAE Standard 62-1999

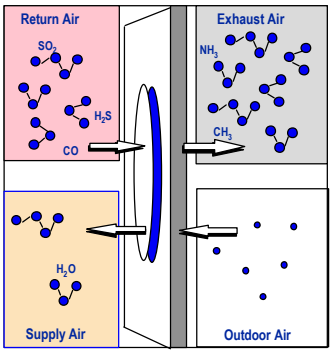
Higher fresh air ventilation needs translate into higher outdoor air changes per hour, which means more

airconditioning loads and higher capacity plants to be installed. This leads to higher first cost and higher operating costs.

Increasing ventilation rates translates into two ways - An improved indoor environment and significant higher utility bills for the owners. Hence effective management of energy systems becomes imperative.
The solution is the use of energy recovery devices of which the energy/heat wheel is the most appropriate.

How does the Energy/Enthalpy Wheel help to increase Ventilation as well as Save Energy?

The energy wheel preconditions fresh outside air before it is introduced to a building. The system can easily be tapped into an existing ventilation system. A portion of the air that would normally be recirculated through the system is exhausted through the wheel and fresh air is introduced into the building in its place. Operating in virtually any climate zone, a single desiccant wheel operated with just a small motor to rotate the wheel can deliver fresh air on a year round basis that is generally within 3-7 degrees and 10% RH of inside conditions, regardless of what outside conditions are (without any type of mechanical cooling or heating). The cost to provide high levels of fresh air ventilation becomes minimal compared to the normal heating cooling requirements of the building. The potential benefits are numerous.



* Current standards for outside air ventilation can be met or exceeded with minimal energy cost impact on the building.
* Incoming outside air is dehumidified by the desiccant wheel, allowing the rest of the ventilation system to run dry. As a result, indoor humidities are maintainable well below the conditions that would favour the growth of mould, mildew and other microbial contamination.
* The need for cooling capacity that normally would be required to dehumidify and cool outside air is eliminated. This is typically 30 to 50% of total system capacity. **In most cases, the cost of the energy wheels is almost less than the cooling capacity it is replacing.** The first cost of a building's cooling system can actually be reduced with a wheel system.

Criteria to be kept in mind while choosing the wheel for hospital application

* Wheel must be molecular sieve coated, so that there is almost no cross contamination.
* Wheel must be designed for over 80% energy recovery – both latent and sensible and must be ideal for tropical climates where latent load is high.

Conclusion :

It is the need of the day, for health professionals as well as building designers to understand the health effects arising from poor indoor air quality and to understand how and what factors affect the indoor air quality in offices, auditoria, hospitals and nursing homes and what could be done to improve the air quality!

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