Report on Lecture by Professor Dr Bjarne W. Olesen on Indoor Environment - Health - Comfort and Productivity and the European Energy Performance of Building Directive (EPBD)

By : Engr. Leong Siew Meng, M.I.E.M., P.Eng.

Indoor health environment and energy performance of buildings have become an increasing concern worldwide. IEM and MASHRAE members had the opportunity of finding out about the developments and requirements in indoor environment and energy performance of buildings in Europe from an ASHRAE distinguished lecturer and the Director of the International Centre for Indoor Environment and Energy, Technical University of Denmark, Professor Dr Bjarne W. Olesen.

The lecture on Indoor Environment and the European Energy Performance of Buildings Directive was presented in a half-day seminar, which was conducted in Bangunan Ingenieur on 21 March 2006. This seminar was jointly organised by the IEM Building Services Technical Division and ASHRAE Malaysia Chapter, and was attended by 37 participants. Professor Olesen's lecture was particularly appreciated as he had to make a special stop-over during his brief lecture tour of the Far East. The sections below are a summary of Professor Olesen's presentation of the two topics.

1ST TOPIC: INDOOR ENVIRONMENT - HEALTH - COMFORT AND PRODUCTIVITY

INTRODUCTION

Outdoor air quality in the cities of industrialised countries has improved greatly in recent decades. During this same period, indoor air quality has declined because of energy conservation, decreased ventilation and the introduction of many new materials and sources of indoor pollution. These developments and the fact that people in industrialised countries spend 90% of their lives indoors (on average) makes the quality of indoor air an important environmental issue with far-reaching

Professor Dr Bjarne W. Olesen of the Technical University of Denmark conducting an IAQ lecture in IEM

implications for human health. Professor Olesen's paper presented several interesting results regarding the influence of the indoor environment on the health, comfort and performance of the occupants, and also new knowledge on indoor pollutant sources.

HEALTH

In developing regions, limited number of studies has been conducted on IAQ and health. The studies have dealt mainly on indoor air pollution due to un-vented burning of biomass, and health effects such as acute respiratory infections, chronic obstructive pulmonary disease and lung cancer. WHO has estimated that burning of solid fuel for cooking and heating in developing countries might be responsible for nearly 4% of the global burden of disease, i.e. approaching 2 million premature deaths per year.

Studies on exposures in indoor environments and health effects in developed countries have mainly been conducted in Europe and North America. The evidence is strong regarding the relationship between IAQ and lung cancer, allergies, and other health and comfort effects including Building Related Illness (BRI), Sick Building Syndrome (SBS) and Multiple Chemical Sensitivity (MCS).

Allergic and asthmatic diseases have doubled in industrialised countries during the past two decades. In many industrialised countries, half the school children suffer from these allergic diseases, which are the main reason for absenteeism in schools.

Indoor air quality has declined partly because of comprehensive energy conservation campaigns and partly because high energy prices have motivated people to tighten their dwellings and reduce the rate of ventilation. Therefore, air change in many homes is at a historically low level. Other factors contributing to poor IAQ are the many new materials, especially polymers, and the numerous electronic devices that have been introduced indoor in recent decades, especially in children's rooms.

Studies show that low ventilation increases the risk of allergic symptoms significantly and that the presence of phthalates emitted from polyvinyl chloride, including plasticisers in children's rooms, increases the risk of asthma dramatically.

DAMPNESS

In a study of several residential buildings with natural ventilation, the humidity production was measured to 2.7 kg per person per day. To limit the increase in the humidity in the indoor air from people (persons, cooking, etc) to 4 g water per kg air in relation to outside air, a ventilation rate of 7 l/s per person is required. In typical residential buildings, this is equivalent to 0.35 l/s m². This corresponds to 0.5 air change per hour.

A distinction should be made between the moisture in the building structure and humidity in indoor air. Moisture in the building construction can degrade building materials; create favourable conditions for microbial growth and chemical reactions that are often identified as sources of allergens, irritant substances and bad odour. Relative humidity in indoor air may cause condensation on cold interior surfaces or in the construction that also increases the risk of microbial growth and chemical processes. It is also well known that increased water content of indoor air will raise the risk of house dust mite (HDM) infestation. The infestation of HDM may be considered low (up to 1000 ng/g dust) if indoor absolute humidity remains below 7g/kg air corresponding to relative humidity of 45% at 20-22ºC.

VENTILATION

Based on a recent European review, the scientific evidence indicates that outdoor air supply rates below 25 l/s per person in commercial and institutional buildings are associated with an increased risk of SBS, increased short-term sick leave and reduced productivity. Studies on the relationship between health effects and ventilation rates in homes are rare. However, literature on "dampness" suggests that inadequate ventilation in homes constitute a major risk factor for health effects (cough, wheeze, asthma and airways infections). A damp home is also associated with low ventilation rate (typically below 0.5 air change), which is not only associated with increased house dust mites infestation but also probably with increased concentration of many indoor-generated air pollutants.

COMFORT

The new draft European standard (prEN15251) listed three categories for recommended ventilation rates. Different parameters like %-Dissatisfied, decipol or CO2-Concentration as an indicator of the bio effluents from people and the required ventilation rate. The CO2 concentration above outdoor level corresponding to the three air quality categories is 460 ppm (category A), 660 ppm (category B) and 1190 ppm.

People and their activities (smoking, activity level), building and furnishing (floor covering, paint, furniture, cleaning, electronic equipment, etc) and ventilation systems (filters, humidifiers, ducts, etc) contribute towards poor indoor air quality.

Even the outside air may be a source to indoor air quality problems. It is difficult to compare the different types of sources. One measurement was introduced by using the Olf-Decipol units.

The CO_2 emission is an indicator for the bio effluents from people. The CO emission is used as an indicator for smoking. Electronic equipment like PCs can be a significant source. Both people and buildings are taken into account in newer standards for the required ventilation rates in buildings. There are big differences between the European and ASHRAE recommendations. One major reason is that ASHRAE requirements are minimum code requirements, where the basis for design is adapted people, whereas the European recommendations are based on un-adapted people.

ENVIRONMENT AND PERFORMANCE

Extensive research has provided an understanding of the relationship between factors such as ventilation, air-conditioning, indoor pollutants and adverse effects on health and comfort. The complexity of a real environment makes it very difficult to evaluate a single parameter on human performance as many of the factors are present at the same time. In addition, worker motivation affects the relationship between performance and environmental conditions (e.g. highly motivated workers are less likely to have reduced performance in an unfavourable environment).

One way of evaluating the performance is the use of self-reported performance. This was used to study the self-evaluation of the influence of environment, job satisfaction and job stress on performance. The study was conducted among 170 people in six offices.

It is clear that the indoor environment was evaluated to have the biggest influence on performance. There is limited information showing a direct relationship between SBS symptoms and worker productivity. There is substantial evidence that poorly perceived indoor air quality is likely to have a negative effect on work performance. Independent investigations conducted in Denmark using different ventilation rates and in Sweden using various types of pollution sources established an overall relationship between ventilation rate per person and performance. Quantitative relationships were developed based on the research results and showed that for every 10% increment in percentage of dissatisfied in the range of 15-68%, 1% decrease in performance can be expected.

The results of recent studies show that improving IAQ in real buildings has in fact larger effect on the actual performance of office work (up to 9%) than would be predicted from the field laboratory experiments.

CONCLUSION

The required ventilation rate in buildings must take into account both comfort and health. People and building contents are the sources of polluting the indoor air (apart from the outdoor air). Studies have shown that even if the ventilation rates meet existing standards, there may still be a significant number of people not finding the environment acceptable and in some cases result in health problems.

An increased ventilation rate will increase the performance of the occupants. Limiting the pollution sources, improving air

quality by air cleaning or increased ventilation rates may increase performance of the occupants by 5 to 10%.

To reduce energy consumption by decreasing the quality of the indoor environment is a bad investment. An optimal indoor environment is the most important requirement for a healthy, comfortable and productive working environment.

2ND TOPIC: THE EUROPEAN ENERGY PERFORMANCE OF BUILDINGS DIRECTIVE (EPBD)

From the beginning of 2006, all new European buildings (residential, commercial, industrial, etc) must have an energy declaration based on the calculated energy performance of the buildings including heating, ventilating, cooling and lighting systems. This energy declaration must refer to the primary energy or CO2 emissions. This directive also states that the energy performance calculation must take into account the indoor climate, but gives no guideline.

This directive requires all member countries by January 2006 to implement building codes on a national level. Each building must have an energy certificate and regular inspections of heating, cooling and ventilation systems must be performed. The objective of this directive is to promote the improvement of the energy performance of all buildings within the community, taking into account outdoor climatic and local conditions, as well as indoor climate requirements and cost-effectiveness. The directive refers to the energy use and does not take into account a life cycle energy demand (energy used to produce the products used for building).

The European Organisation for Standardisation (CEN) is now preparing a series of standards to cover the requirements for indoor environment, energy performance calculations for building and systems, ways of expressing energy performance, inspection of heating-cooling-ventilation systems and conversion to primary energy. The lecture also gave the status of the on-going implementation of the directive and discussed issues related to the indoor and outdoor environment.

In conclusion, Professor Olesen said that the new directive for energy performance of buildings requires considerations of the indoor environment. It is therefore not possible to fulfill requirements for the energy performance by decreasing the indoor environmental quality. ∎