Quality of Indoor Air and Functionality of Ventilation in Finnish Schools and Day-Care Centres

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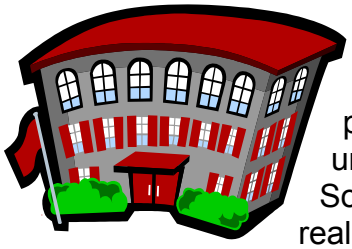
This paper summarises the main results from two research projects, focused on schools and day-care centres in Finland. The objective of these projects was to give a solid basis for development of ventilation concepts and products for better indoor climate and energy-efficient ventilation.

BACKGROUND

In Finland growing attention is being paid on indoor climate as one of main factors on health, well-being and economy. Even though it is possible only to give rough estimates of direct and indirect costs due to poor indoor climate, the figures presented after a Finnish study a few years ago were convincing. It was estimated that the annual costs from poor indoor climate were about FIM 18 billion € 3 billion or some € 600 per capita). As a consequence, the "Healthy Building" technology programme was launched.



Several studies from different countries in early 1990's have repeatedly ended up in reports about numerous problems (inadequate ventilation, draught, stuffy air, unpleasant odours...) in schools and day-care centres. Some studies have included investigations to find out the real reasons for problems and complaints about thermal conditions and/or indoor air quality (IAQ). But little attention has, until recently, been paid on the practical issues: HOW TO DESIGN, BUILD AND MAINTAIN HEALTHY INDOOR CLIMATE?

SCHOOLS

The first of the two studies reported in this paper included investigations in 15 school buildings in which the ventilation system was renovated. The purpose of this study was to investigate solutions for renovation processes. Both questionnaires to teachers and measurements (air temperatures, carbon dioxide contents as IAQ indicator) were made before and after the renovation.

In most cases a major renovation was done, typically natural ventilation or mechanical exhaust ventilation was replaced by balanced mechanical supply and exhaust. In a few cases the existing system was either partially upgraded or just cleaned and readjusted. Air flows in all the classrooms were dimensioned by the recommended minimum value (currently 3 l/s, m^2 or 6 l/s, person).

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The quality of the indoor air measured in the school buildings was essentially improved as the renovation work proceeded. As the contents of carbon dioxide in the school buildings ranged between 1 200 – 2 400 ppm before the

renovation work, they were below 1 250 in the maximum in all the school buildings with only one exception after that. After the renovation the maximum carbon dioxide contents in the school buildings furnished with natural ventilation were decreased 850 ppm in the average.

The teachers of the schools were delivered questionnaires on their health and on the indoor climate conditions in job environments. In the estimates given by teachers the quality of the air was experienced to have improved from school grade 6.5 to 7.9 (scale 4…10) due to the renovation work.

Measurements in all cases verified an improvement in IAQ. However, the analyses of the renovation processes revealed that the improvement could have been still higher if in all stages the regulations and good practice had been followed carefully.

Specified components have been often changed (to cheaper ones) by the contractor without consultations with the designer and client. This can happen especially if the performance values are not clearly defined, which is often the case.

Due to tight schedule concerning the contract, tests were typically delayed or done only partly.

Based on the results, a client's checklist was developed, just to pay attention to these crucial points in the building or renovation process.

Because similar indoor climate problems had been also reported for day-care centres as for schools, a similar approach was used also in the second study.

DAY-CARE CENTRES

The aim of the second study was to develop solutions to the problems and deficiencies encountered in the ventilation systems of day-care centres, which are manifested as poor indoor air quality or excessive energy consumption in the building at the maintenance stage of ventilation.

At the first stage of the project, mostly day care centres (15) constructed in the 1990's with mechanical supply and exhaust air ventilation were chosen for study. Four day care centres built in the 1960's – 1980's were also included. During the afternoon rest hour, carbon dioxide content, temperature and relative humidity were monitored and other measurements of ventilation capacity were made in altogether 32 resting rooms. At the same time, the directors and maintenance personnel of the day-care centres were interviewed and a questionnaire was presented to the staff.

The results of the study are similar to those in the School Project, revealing also in day-care centres the need to pay more attention in the decision-making, design, construction and operation&maintenance.

A typical problem is also that the number of children exceeds the one originally planned. In very few cases the personnel knew exactly the intended maximum number of occupants. So, the decision-makers and local authorities, and also the personnel in the day-care centre, should know the maximum number of occupants per room - which is one of the main design criteria for ventilation.

The ventilation rate should be maintained sufficient throughout the year. Based on the results the quality of indoor air is poor in children's rooms if the supply and exhaust air flows are only half of the recommended minimum value (currently 2 l/s, m^2 or 5 l/s, person). The ventilation system should hence be designed with more scope for variation, i.e. the supply and exhaust air flows per room should be higher than the minimum if ventilation capacity is cut down by 50 % in cold weather.

When a new building is adopted into use, it should be ensured that ventilation functions adequately in all situations that can be anticipated to occur. At the maintenance stage, the functionality of the ventilation system should be checked regularly by measuring the quality and temperature of indoor air and the air flows in each room. The ventilation system should also be cleaned regularly.

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