Ventilation and low-income housing: a sensitive problem

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ABSTRACT

It is well known that appropriate ventilation represents one of the prerequisites for achieving good indoor comfort, and we try to ensure a continuous and sufficient intake of fresh air into a building. But, ventilation losses are also one of the most important components of a building thermal balance, and we try to reduce them as much as possible. In theory, these two seemingly contradictive facts can be technically adequately solved in various ways. In practice though, the extent of the problem, the possibilities to deal with it, and the final results depend on many relevant technical, but also user-dependent factors. In the paper typical examples of ventilation-related problems is presented, with stress on the ones observed in apartments owned by municipal housing funds and social housing organisations. Our on-site investigations performed in the past few years showed that difficulties with quite similar consequences can occur regardless of the building age, type, or thermal characteristics. As expected, improved building air-tightness can significantly contribute to the extent of the problems, particularly when incorrect ventilation manners and patterns are already present.

KEYWORDS

ventilation, mould, indoor comfort, microclimate, housing

INTRODUCTION

Especially in low-income and social housing stock several elements of sick building syndrome are connected to improper ventilation, often combined with unsuitable heating levels. This usually arises from fear of high operational costs, and low or no understanding of basic building functions.

Even in cases of state-of-the art planning and construction, the calculated high-performance energy characteristics can be overshadowed by poor real-time results originating in bad operational practice. It is of course relatively easy to operate with numbers and energy units on paper, and to draw red and blue arrows on plans, showing (anticipated) airflows through rooms, apartments, and buildings. The important question is how to ensure that these ideas find practical realisation.

It is also necessary that tenants want and know how to perform their active part, and recognize ventilation as a basic means of achieving good indoor comfort, and healthy and hygienic indoor conditions.

To illustrate this, four examples are described and results of audits performed by ZRMK are presented here. In most of the cases it was the behavioural aspect (or, occupancy patterns), which represented the crucial part of the causes for various troubles, including general low indoor air quality, excessive indoor air humidity, mould growth, and low internal surface temperatures.

CASE 1: A COMPLETELY RENOVATED BUILDING

The Municipal Housing Fund of Ljubljana has developed a strategy for renovation and construction of buildings solely in a low-energy manner. Outcomes of renovation of a multi-apartment building from 1970s in Ljubljana occupied by low-income tenants are presented here. The building envelope had been thermally insulated at the time of construction, but only with a couple of centimetres of insulation, and with substantial thermal bridges left unsolved.

Renovation included added thermal insulation, replacement of old windows with energy efficient ones, replacement of existent radiators with new ones of a smaller capacity due to reduced heat demand, and installation of individual mechanical ventilation units with heat recovery to compensate better air tightness of the building combined with expected unchanged natural ventilation patterns. Due to constructional restraints it was not possible to establish a central ventilation system. It was expected that energy consumption would show a significant decrease compared to the existent state, and that problems with mould growth and surface condensation would be avoided.

Monitoring of energy parameters during the first heating season after renovation did not show expected results in energy figures. IR thermography showed no considerable faults in construction, and the winter itself was not significantly different from long-term averages.

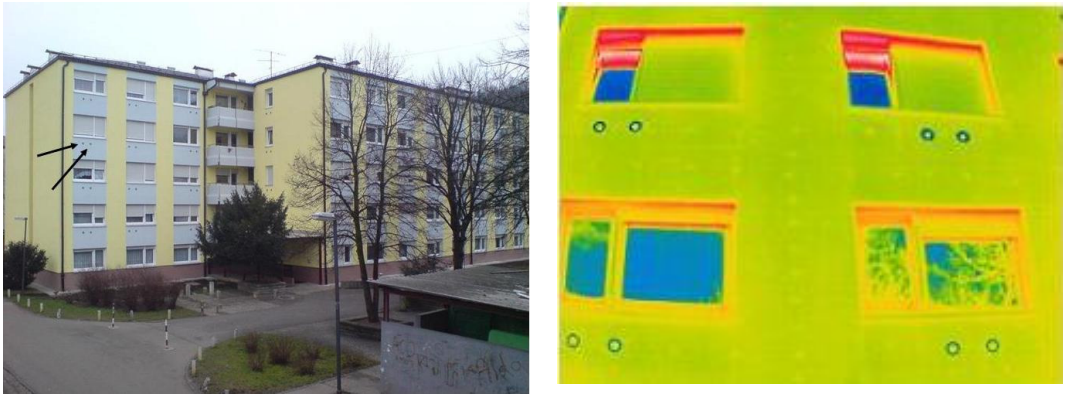

Figure 1: Left, photo after renovation, air inlets and outlets of individual mechanical ventilation units with heat recovery visible. Right, IR close-up photo, windows open, mechanical ventilation not in operation.

However, thermography did reveal some of the important possible problem sources. We saw that even on a winter night many of the windows were open due to misunderstanding of the purpose and functioning of the mechanical ventilation system with heat recovery (see Figure 1). Additionally, many of individual ventilation systems were simply switched off. Tenants explained that windows were open because it was “too hot” in the apartments. But, in the same time we heard complaints about new radiators being “too small” concerning the floor surface of rooms, so all the thermostat valves on radiators were turned to the maximum

position. The ventilation system was regarded as something more or less just consuming electricity, so it was switched off.
Concerning this unchanged tenants' behaviour it was not possible to expect better results. Still, it seems that the choice of installing mechanical ventilation units to each room prevented excessive indoor air humidity, but since they were operating on a random basis, often together with open windows, there was only little effect to reduction of heat consumption. The housing fund staff realised that providing tenants with one-off information about new systems was not enough, and that these activities (information, education) would have to be continuous.

CASE 2: A PARTIALLY RENOVATED BUILDING

A case of a multi-apartment building in the town of Postojna shows a variety of situations in the same house. The building is owned by the Municipality, and it was thermally insulated a few years ago. In some of the apartments we found severe cases of mould growth and even deterioration of timber window frames by moisture, while in the others the tenants knew nothing about such issues.

Our investigation included IR thermography to check the continuity of thermal insulation of the facades, and monitoring of indoor microclimate using data loggers. There was no particular pattern of problems' occurrence to be found related to positions of individual apartments or to the number of tenants. Many of the tenants confirmed that they regularly switch off the heating completely when leaving to work, and switch it on again after coming back home late in the afternoon. Most of them at the same time tend to leave windows slightly open at the top during this period, which causes constant cooling of structures around window area to inappropriately low temperature levels.

Figure 2: Condensate on glazing internal surface, and mould on internal blinds.

As a rule, mould growth was present in rooms where furniture occupied most of the room surface, including wardrobes on or very close to external walls. These rooms are thus very difficult to ventilate properly and thoroughly, especially areas behind cabinets and wardrobes. Lack of proper ventilation was demonstrated also through droplets of condensate on lower window frames and on glazing, and through mould visible even on internal blinds (see Figure 2).

As a completely opposite situation, in other apartments there were no problems present at all. Interviews with these tenants reflected that they ventilate their apartments several times a day and in case of intermittent heating lower the thermostat settings only by a few degrees. See Figure 2 illustrating substantially different microclimate in two apartments of the building.

One of the tenants reported that previous occupants moved out because supposedly the apartment was totally unhealthy. She stated that when moving in all the corners and many external wall surfaces were overgrown by mould, so first she had to clean everything away and paint the apartment. Until now, after several years spent in the previously “critical” apartment, there has been no visible trace of mould growth anywhere.

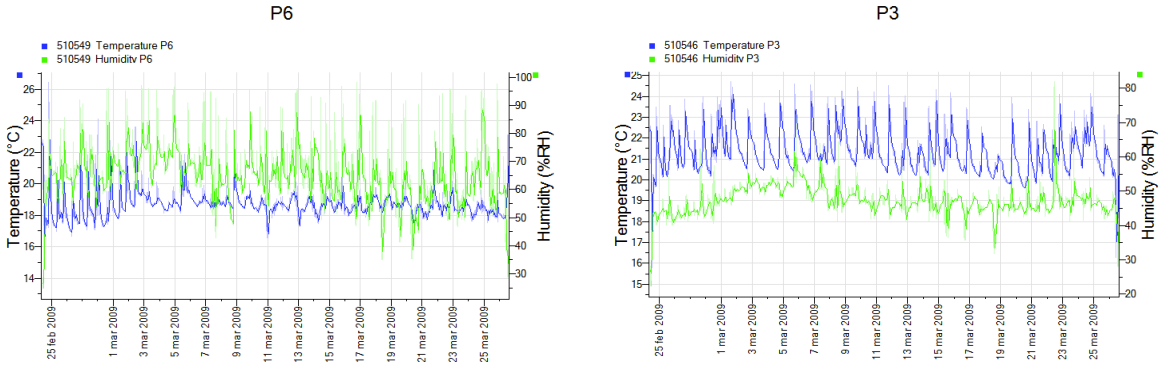

Figure 2: Range, fluctuations, and levels of indoor air temperature and relative humidity in two of the apartments.

This case showed that in the same building, in apartments with symmetrical or identical layout, completely different situations can occur. If there are boundary conditions present (adequate heating system, possibility of natural ventilation etc.), which allow tenants to maintain proper microclimatic conditions (air temperature and relative humidity), then tenants have to take on their share of responsibilities, and also liabilities for consequences related to patterns of use. In this case the importance of proper and regular ventilation of occupied spaces again proved to be one of the most vital elements for achieving good overall indoor comfort.

CASE 3: AN OLDER BUILDING WITH NEW WINDOWS

A case investigated in the town of Celje shows how indoor climate conditions can substantially change by installing new windows in an older uninsulated multi-apartment building, when this measure is not accompanied by a change in ventilation patterns. The municipality followed complaints by tenants of one of the buildings and decided to replace existent windows in bad condition with energy efficient ones, thus radically increasing also the airtightness of the envelope.

Not long after this renovation complaints started about surface condensation and mould growth in several apartments. We performed IR thermography mainly to check the quality of installation of windows, and monitoring microclimate with data loggers.

As the building remained uninsulated, we did not expect to find crucial causes for the problems on the envelope, but suspected problems with low level of ventilation and enhanced airtightness.

Tenants explained that indoor thermal comfort before the renovation was not too satisfying, with air draft problems occurring because of faulty windows. However, this problem actually had a positive impact as it compensated deficient natural ventilation already before renovation. New windows eliminated the aforementioned problems, but created new, even more unpleasant ones (see Figure 3).

Figure 3: Left, new energy efficient and airtight windows in an uninsulated wall. Right, consequences of constant ventilation with window in an inclined position.

Many tenants continued their previous patterns of (not) ventilating the apartments, thus supposedly saving money on heating costs. Some of the tenants claimed that they “constantly” ventilated the rooms, but this was done mainly by inclining the windows at the top, often because they could not be opened normally due to furniture layout or occupied internal window shelves. As a result surface condensation occurred, especially on window lintels, followed by mould growth. In many cases this occurred in rooms where radiators were turned off to save on heating costs, but the doors to adjacent heated spaces (especially kitchen) remained open or were not airtight at all, thus allowing warm and humid air to come in contact with cooled surfaces.

Mould was found also in some areas, which correspond to the definition of geometrical thermal bridges, but were not problematic before the renovation. Higher relative indoor air humidity after the replacement of windows brought conditions suitable enough for surface condensation and mould growth. This was especially true in apartments where bathroom and kitchen ventilators were out of function or simply not used. A well-meant measure such as replacement of windows in an uninsulated building can have unpleasant consequences if not accompanied by increased ventilation.

CASE 4: AN OLDER BUILDING IN ORIGINAL CONDITION

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Another case from the town of Celje is represented by a ground-floor apartment with higher ceilings in an older building. The building is still in its more or less original condition, with brick walls with no added thermal insulation, and with original windows

with wooden frames. Contrary to some of the observations above, in this case uncontrolled ventilation through gaps between window frames and wings did not help to improve indoor conditions to the extent that no problems with mould would occur.

Here, the tenants heated only few rooms of the apartment. As a low-income family they wanted to reduce operational costs as much as possible. This included switching off the radiator system (district heating), and using individual gas-fired heating appliances instead. In this way indoor air temperatures rarely reached comfortable levels, and gas as a fuel added its share to air humidity. Internal surfaces remained below the surface condensation point for longer periods during colder month of the year.

Figure 4: Mould growth on the bathroom ceiling, heating turned off, poor ventilation.

Uncontrolled ventilation additionally contributed to low indoor temperatures, thus worsening the situation. One of the typical examples observed here was the ceiling area above the window in the bathroom (see Figure 4), where the combination of air temperature and humidity was particularly inappropriate. Of course, suggesting active natural ventilation of the apartment would probably reduce the indoor air humidity, but with heating and other occupancy patterns remaining unchanged it would further reduce indoor temperatures to most inconvenient levels.

In cases like this, renovation measures such as replacing the windows and making the envelope more airtight would not be a solution. It is very difficult to find a reasonable compromise in cases when low-income tenants occupy an older building, and have to pay for the operational costs.

CONCLUSION

Ventilation remains one of the key issues in building renovation and construction. It represents one of the steps towards overall energy efficiency, and towards good indoor comfort. On one hand, natural and/or mechanical means of ventilation shall be planned and realized in a competent way, following of course also regulatory demands. On the other hand, these efforts can prove abortive if they are not followed by corresponding actions by building users. A real challenge is how to conceive and perform educational and informational activities in the social housing sector, when to rely on natural ventilation, and how to balance between centrally controlled systems and possibilities of individual regulation and adaptation.