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EXPERIENCES FROM WALL EXHAUST SYSTEMS IN BLOCKS OF FLATS

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Synopsis

A self administrated questionnaire was mailed to over 300 dwellings in blocks of flats using the wall exhaust. In almost all the dwellings there was a controllable ventilation unit. The units were either a mechanical exhaust ventilation system type with outdoor air inlets or mechanical supply and exhaust ventilation system with heat recovery and outdoor air intake on the wall. In the questionnaire, the daily use of ventilation unit, noise levels as well as odors and their sources in the dwellings were asked. The prevalence of odors in the dwellings using wall exhaust was in the same level as in dwellings with traditional way to conduct exhaust air from dwellings to roof reported in earlier studies. Habitants in the dwellings with mechanical supply and exhaust ventilation system reported less draught, slightly less odor problems and judged the air quality more fresh even in the bedrooms in the mornings than habitants in dwellings with mechanical exhaust ventilation system only. Habitants in dwellings with mechanical supply and exhaust ventilation system were much more satisfied with the ventilation system and, then regarded their dwellings more comfortable than habitants in dwellings with mechanical exhaust ventilation only.

1.0 Introduction

The usual way of extracting the waste air in a multistorey residential building is to conduct the air above the roof. In older buildings exhaust ducts are made from concrete or brick. They are very untight and often in poor condition. A new exhaust air duct system to the roof should be built which is very expensive in an old building. There are also some specially constructed new buildings as terraced multistorey buildings with several penthouses. In such buildings it is difficult to find place for exhaust air fans without causing noise or odor in neighbourhoods. Furthermore, in a normal multistorey residential building a wall exhaust solution would facilitate the use of an apartment-specific mechanical ventilation system in multistorey buildings as the duct-work to the roof could be left out.

Wall exhaust is not allowed according to the Finnish building code (1). Local building authorities can permit it in single cases. At present there are more than 15 multistorey residential buildings with more than 500 dwellings with wall exhaust solution.

Design guidelines for wall exhaust has been developed in Finland (2). There are no minimum distances between air intake and exhaust openings if the exhaust air velocity is 8 m/s or higher. Otherwise the minimum distance should be at least 40 times the square root of the free area of exhaust air opening. For example, an exhaust duct with a diameter of 0.125 m requires a minimum distance of 4.5 m from the nearest outdoor air intake.

2.0 Research

2.1 Buildings

The purpose of this study was to examine whether exhaust air from each apartment could be discharged outdoors via exhaust vents mounted on the outer wall in such a way that no odors or other harmful effects are caused.

In this study, at first all dwellings in blocks of flats with wall exhaust system were charted. In summer 1996 there were 12 buildings with 360 flats, out of which 335 flats had wall exhaust and the rest an ordinary roof exhaust system. Half of the dwellings had a mechanical exhaust system and the other half mechanical supply and exhaust system. Almost all the ventilation systems could be controlled by the occupants.

Half of the dwellings were built in the 1960's or 1970's and have been renovated during the years 1995-1996. The rest of the dwellings were new, built between 1993 and 1995. The time of occupancy of the dwellings varied from two months to three years. One third of the dwellings were condominium apartments and the rest were rental apartments.

The typical exhaust discharge velocity with maximum air flow was 3-4 m/s. One third of the dwellings had a maximum exhaust discharge velocity more than 8 m/s. The placement of the wall exhaust had three different main solutions.

1) There were about 100 dwellings where the exhaust air was ducted when needed from the roof of the stairwell to the outer wall of the stairwell. This solution introduces the most largest distance between the exhaust air opening and the fresh air opening.

2) The most common solution was to conduct the exhaust air straight from the kitchen to the nearest outer wall. This solution was used in dwellings which mechanical exhaust ventilation only. If there are only two or three dwellings per floor, it is possible to place the exhaust air opening and the fresh air inlets with sufficient distance between each others. The more dwellings in the same floors the more difficult it is to place exhaust air openings and fresh air inlets without being placed too close to each others. This problem occurs especially with small dwellings. In Figure 1 is an example of such building but with mechanical supply and exhaust ventilation system.

3) In two buildings most of the exhaust air openings of dwellings were placed straight over the fresh air inlet. Also part of the dwellings had exhaust air opening less than half a meter from the outdoor inlet of next door dwelling.

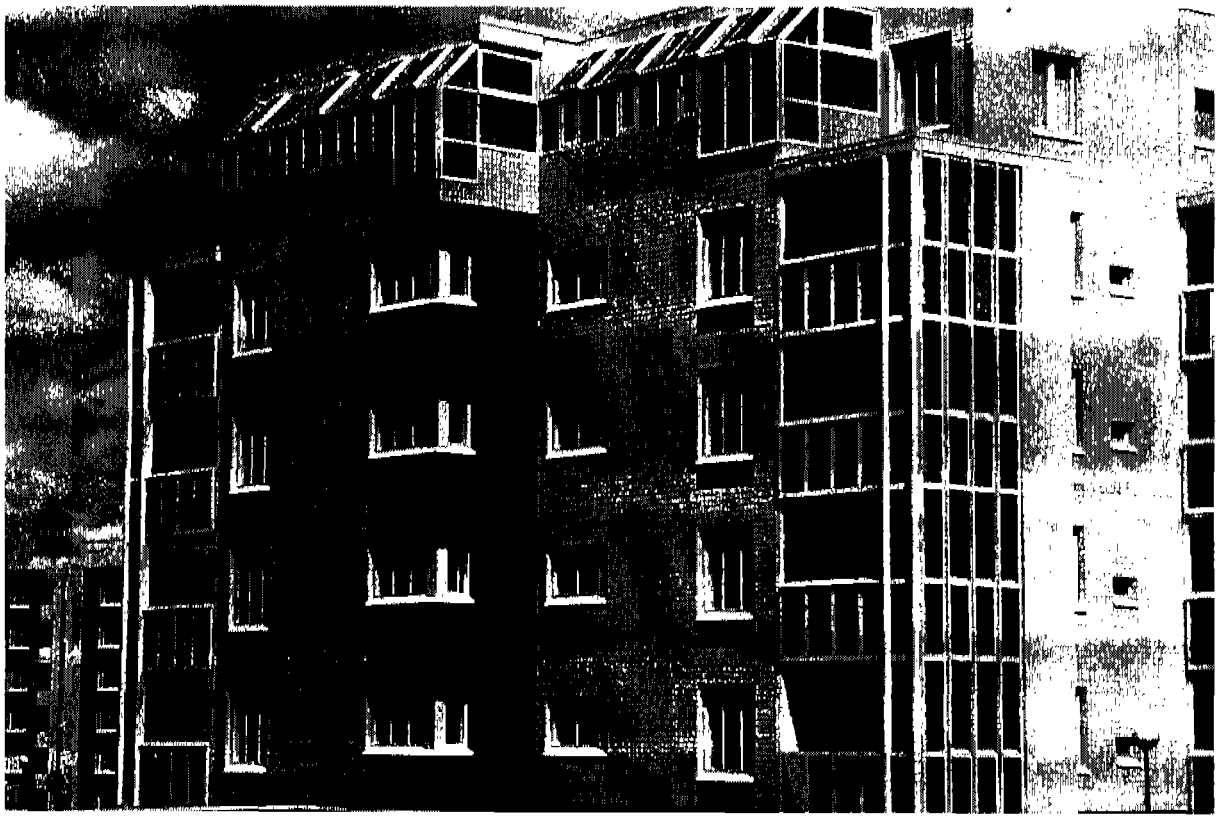

Figure 1. A block of flats with mechanical supply and exhaust ventilation unit in each flat and a wall exhaust solution. Outdoor air intakes and exhaust air openings are located in the same facade. Wall exhaust openings have longer shadows than outdoor air intakes.

2.2 Method

During this research, about 20 HVAC-engineers, janitors, building managers etc. involved with buildings having wall exhaust system were interwied. During these discussions no problems associated with wall exhaust occurred.

A self administrated questionnaire was mailed to all 352 dwellings. In the questionnaire, the daily use of ventilation unit, noise levels as well as odors and their sources in the dwellings were asked. The number of questionnaires returned was 200, which represents about 56 % response rate.

The questionnaires were recorded and analyzed with the SAS-computer package /3/. The prevalence of odors in different kind of wall exhaust solutions were tested with chi-square test. The same test was used for comparison of the prevalence of indoor air related problems with different ventilation system.

3.0 Results

3.1 Sufficiency of ventilation

According to 65 per cent of the occupants the ventilation of bedrooms and living room was sufficient during the heating season. The ventilation in them was also more often too high, especially in bedrooms, than too low. The ventilation of kitchen, bathroom and WC was more often too low than too high. No one judged the ventilation of sauna too high.

Occupants in dwellings with mechanical supply and exhaust ventilation system felt the ventilation of living and bedrooms more often sufficient than in dwellings with mechanical exhaust ventilation only. In those dwellings one third of the occupants felt ventilation of living and bedrooms too high during the heating season.

3.2 The use of ventilation units

The daily use of the ventilation units was relatively low, figure 2. The ventilation unit was never used in full speed in one eight of the dwellings. The median daily use of the full speed was 1.5 hours. The mean daily use of the full speed was 2 h and 15 minutes during heating season and 3 h and 15 minutes during summer.

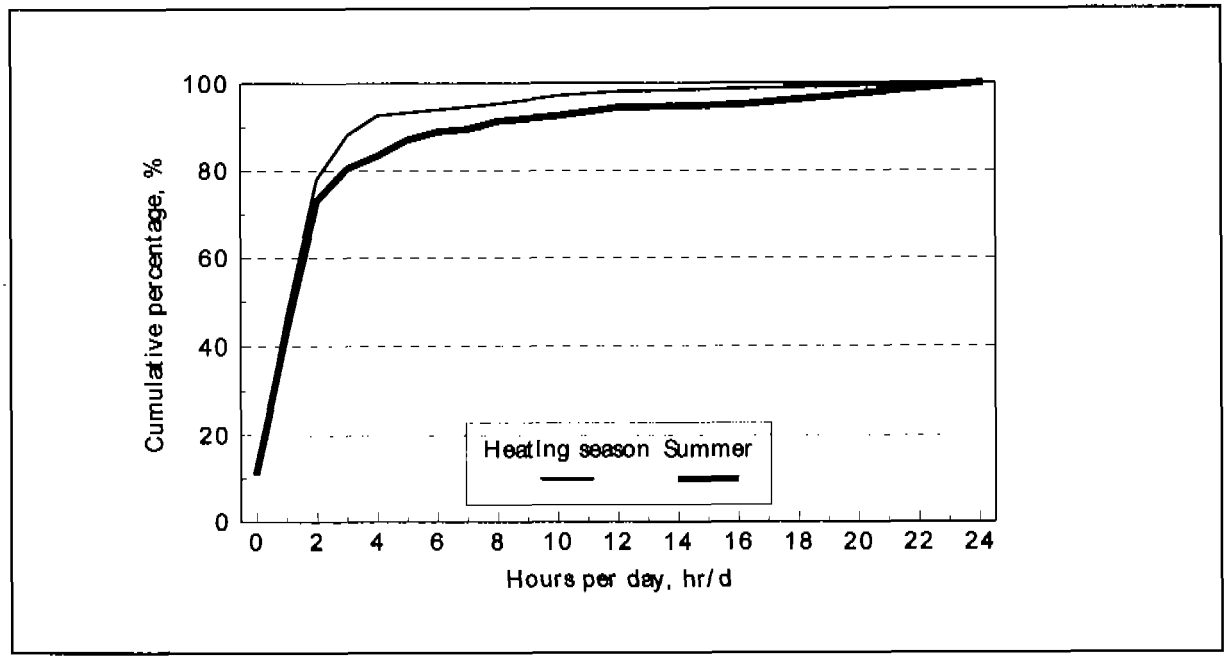

Figure 2. The distribution of the daily use of ventilation units in dwellings during heating season and summer.

About 80 per cent of the occupants did use the ventilation unit in minimum speed during the nights. Nearly 80 per cent used the ventilation unit in full speed during cooking. More than one third of the occupants used the ventilation unit in full speed during showers. The same number used the minimum speed. Even in the dwellings equipped with sauna one fifth of the occupants used the minimum speed during sauna baths.

3.3 Odors

Odor problems were named in 69 dwellings (35 %). This is quite a typical level occurring in Finnish dwellings. The most common types of odor were environmental tobacco smoke (ETS), cooking smell from the kitchen and exhaust gases from cars (Figure 3).

After cases where odors were from indoor sources, e.q. sewer gases and building materials, were excluded there were still 54 (27 %) dwellings with problems with outside odor sources. Most of those odors were cooking odor from staircase.

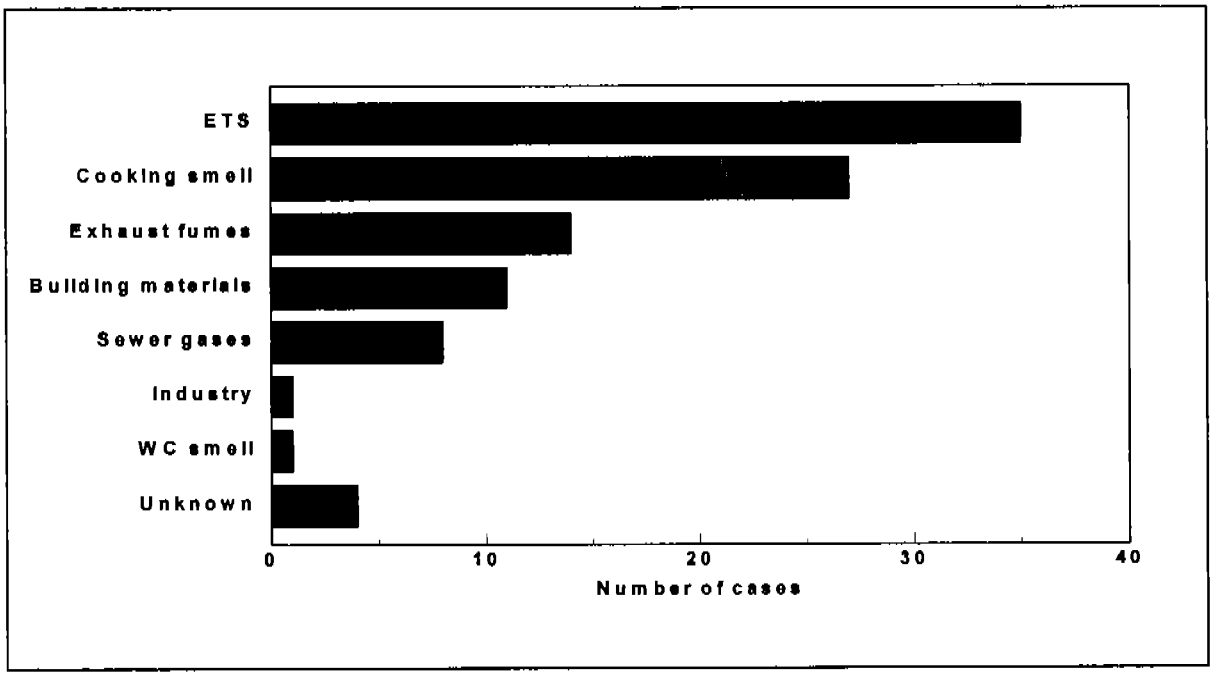

Figure 3. Odor types in dwellings.

Evident odors from outdoor occurred altogether in 32 dwellings (16 %). The most dominat sources were environmental tobacco smoke and car exhaust fumes. The main source of tobacco smoke was smoking on balconies in the vicinity of dwelling. There was only one case where the inhabitant proposed that the reason for cooking odor transfer was wall exhaust of the nearest neighbourhood.

It was not possible to find out any difference between different solutions concerning placement of the exhaust openings and air inlets and exhaust air design velocities.

The prevalence of odors was in the same level than in building with traditional way to conduct exhaust air from dwellings to roof /4/.

Dwellings with exhaust ventilation unit only had slightly higher prevalence of odors like cooking fumes and tobacco smoke from other dwellings or staircases than dwellings with supply and exhaust ventilation unit. The most likely reason for that is much higher under pressure between two dwellings, one dwelling with opened windows due to cooking or smoking and one dwelling with closed windows. Odors are transferred through cracks from polluted dwelling to another dwellings.

3.4 Noise

45 per cent of the occupants felt the noise level from ventilation unit disturbing with full speed and 10 per cent even with lower speed. Disturbance from ventilation noise was more common in dwellings with mechanical exhaust air unit only than in dwelling with mechanical exhaust and supply air unit. The main reason for that was the location of ventilation unit in dwellings. The exhaust air unit was placed over the cooker in the kitchen which often has straight contact with the living room. The supply and exhaust air units were placed in the bathrooms which were isolated from living and bedrooms.

There is a risk for too high noise level on the baloconies or in the yards when wall exhaust systems are used. This requires sufficient sound attenuator after exhaust fan. However, there were no complaints concerning too high noise levels outside caused by exhaust fans.

3.5 Draught

Almost 60 per cent of the dwellings were at least at times draughty. The main reasons for the draught sensation was too low room temperature and the windows.

More than 70 per cent of occupants in dwellings with exhaust ventilation system only reported of frequent or constant draught.

30 per cent of the occupants in dwellings with exhaust and supply ventilation system reported draught. 20 per cent of the occupants in dwellings with exhaust ventilation system and fresh air radiators reported draught. According to the occupants, The main reason for draught in these dwellings was too low room temperature, not ventilation system.

3.6 Air quality

Over 50 per cent of the occupants judged the air in their flats as fresh, 40 per cent as fresh or stale and less than 5 per cent as stale. The freshest air was reported in the dwellings with mechanical supply and exhaust air system (70 %) whereas the percentage among occupants living in dwellings with mechanical exhaust was 40 %. The air in the bedrooms was reported to be stale in the morning by 37 % of the occupants in the dwellings with supply and exhaust air ventilation and by 59 % of the occupants in the dwellings with exhaust air ventilation only.

There were no difference between dwellings with different ventilation system in airing habits.

3.7 Satisfaction and comfort of the occupants

65 per cent of the occupants were satisfied with the performance of ventilation system during the heating season and 75 per cent during the summer time. During the heating season, there was a great difference between occupants living in the dwellings with supply and exhaust ventilation and exhaust ventilation only. The percentages of satisfied with ventilation system was 83 and 48 %. During the summer time there was no difference between different systems.

60 per cent of the occupants said that their dwelling are comfortable during the heating season and 84 per cent during the summer time. During the heating season, only 43 per cent of the occupants in dwellings with mechanical exhaust only judged their dwellings as comfortable where as among the occupants in dwellings with mechanical supply and exhaust air ventilation system the percentage was 80 %. During summertime there was no difference between different systems.

4.0 Discussion

Results from these buildings with wall exhaust system did not show any things against it. It was not possible to find out any difference between different solutions concerning placement of the exhaust openings and air inlets and exhaust air design velocities.

Surprisingly, smoking on the balconies was the dominant odor problem in this study. Approximately 5 per cent of the inhabitants suffered greatly from the ETS from outdoor air. The location of fresh air intakes (supply and exhaust air unit) were in some buildings far too near the balcony of the neighbourhood.

The location of the parking lot was in some buildings far too near to the building itself. More attention should be paid to outdoor air inlet location in order to control more efficiently ETS and car exhaust.

In order to minimize odor problems in multistorey buildings, the tightness between dwellings must be improved, the pressure differences between dwellings should be decreased, more efficient local exhausts for cooking purposes should be developed and more tight doors between dwelling and staircases are needed.

Some of the occupants never use the full speed during cooking, showers and launder. The same problem has been found widely in Finnish flats with user controlled mechanical ventilation unit. More information must be given to occupants concerning the importance of ventilation.

Noise from ventilation units in full speed caused widely disturbance among occupants. Ventilation with lower noise levels are needed for night time cooling of dwellings. The placement of outdoor air intakes should be done more carefully; the fresh air inlets should not locate in the same facade with balconies.

This study included a few dwellings with fresh air radiators. These dwellings were judged as comfortable as dwellings with supply and exhaust air ventilation system. Of course much more research must be done to confirm this finding.

The feedback from the occupants showed quite clearly that in the Finnish climatic conditions ventilation systems where the outdoor air is preheated are much more preferred than older systems without preheated supply air.

Acknowledgements

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