SUMMARY

S. Leskinen and V. Karvonen: An approach to natural-like mechanical ventilation of existing buildings. A new ventilation concept is presented based on multi-disciplinary analysis of economical, arcihitechtural, environmental and techinical problems of renovation. The ac-system consists of two units including heat recovery, filter, fan etc. The ac-unit installed in window opening operates periodically like human lungs, e.g. both exhaust and supply. They are operating to opposite directions, which are periodically reversed. When desired, the unit is stopped and used as an airing panel. In laboratory tests the specificated values were achieved. The heat recovery proved so efficient, that no air heating is needed even in lowest temperatures. Some noise and freezing problems were reported. In field test the occupants noticed no problems except slightly high sound level, which is later decreased. The system appears to solve many problems of renovation. Problem analysis and innovative approach, rather than developing traditional solutions, is suggested to be the right way to solve the complicated ventilation problems in renovation.

KURZFASSUNG

Zusammenfassung S. Leskinen und V. Karvonen: Verfahren zur naturgemässen mechanischen Ventilation fertiger Gebäude. Neues Ventilationskonzept basierend auf interdisziplinärer Analyze ökomischer, architektonischer, unweltbedingter und techn cher Problems der Renovierung. AC-system aus 2 einheiteh mit Wärmerückgewinnung, Filter, Ventilator usw. In der Fensteröffnung installierte AC-Einheit arbeitet periodisch wie die mänschliche Lunge, Luftab- und Zufuhr. Betrieb in Entgegen gesetzter Richtung, periodische Umkehrung. Die Einheit kann abgestellt und als Lüftungsklappe verwendet werden. Spezifizierte Werte nach Laborversuchen. Wärmerückgewinnung so effektiv, dass auch Beniedrigsten Temperaturen kaine Heizung nötig. Lärm- und Geffierprobleme. Bei feldversuchen keine probleme ausser etwas hohem Geräuschpegel, der später sank. Das System bietet eine Lösung für viele Renovierungsprobleme. Problemanalyse und neue Annäherugsweisse anstelle des Ausbau traditioneller Lösungen für komplizierte Ventilationsproblems bei der Renovierung.

RESUME

S. Leskinen et V. Karvonen: Approche toute naturelle de la Ventilation mecanique pour les bâtiments existants on presente, pour differents disciplines analytique, un nouveau système de ventilation fodés les problémes de rénovation de bâtiments en matiére de technigue d'ékonimie, d'architecture et d'environnement. Le systéme á air conditionné comprend deux unités de récuperateuer de chaleur, un filtre, un ventilateur etc. Le systéme á air conditionne est installé dans une fenêtre mobile gui opére periodiquement comme deuz poumonf bumains dont l'un aspire l'air tandisse que l'autre le rejéte. Ils fonctionnent dans deux directions opposées les, lesguelles sont periodiquement renverser. Quand on le désier le systéme peute étre stoppé et utilisé comme une bouche d'air. Les essais en laboratoire sur la valeur du materi ont été concluants. Le récuperateur de chaleus. Fut csi efficacé du'aucun atport d'air chaud n'a été necessaire méme á basse température. Quelgues bruits et problé de froid furend néannoins décelés. Les essais en environnement réel out montré gue les gens presents ne décelaient rien d'anormal exepté un léger bruit de fond gui á été plus tard reduite. Le systéme parait i resoure parait resoudre. De nompreux problémes dans la renovation de bâtiments. L'approche des problémes de ventilation pour l'analyse et l'innovationna plutôt gue par les solutions traditionnelles de developpement parait être la meilleure dé marche á suivre dans le domaine de la rénovation de bâtiments.

VENTILATION IN EXISTING BUILDINGS

PART II: AN APPROACH TO NATURAL-LIKE MECHANICAL VENTILATION OF EXISTING BUILDINGS

S. Leskinen and V. Karvonen
Society of Heating Engineens in Finland

Introduction

As discussed in part I, remarkable changes in the environment and operation conditions of air conditioning systems have taken place during the last few decades. When an old building is renovated a need of a totally new, good air conditioning system generally exists. People take it for granted that the improvements in the environment of a renovated building also includes a better indoor climate.

Too many people are disappointed in their expectations. The modern air conditioning is developed for new buildings. When we are making attempts to mix it with the totally different architecture and engineering of an old building we get entangled in complicated problematics including elements of economy, architecture, structural engineering, fire protection etc. Normally even the use of the building and heating system are changed, new demands for energy economy are presented etc. Too often our sophisticated technology is wrecked by high costs and, even worse, unsatisfactory operation.

In this paper an unconventional way to approach the problems is suggested as a result of this approach is presented a new ventilation system - natural-like mechanical ventilation as well as very promising results of laboratory and field tests of the system.

It is not insisted, that the new ventilation system is the best or even always the practical solution to every problem of renovation. It is suggested that problem analysis and innovative approach rather than developing traditional solutions is the right way to solve the complicated problems of renovation. Therefore more attention is paid on the method to analyse and solve the problem and less on presenting the system and the results achieved.

Ventilation problems in renovation

The size of the problem:

In Finland is completed new buildings 5% of the total building stock yearly, and the volume is slowly decreasing, whereas the renovation volume is increasing with moderate speed. Its volume in building-m³ is roughly half of new building volume. The most optimistic forecasts claim that within 10...15 years renovation volume will grow as great as that of new buildings.

Architectonic problems:

In some cases the motives to renovate a building are architectonic: either a historically respected environment or an individual building of high-class architecture.

Although the percentage of buildings of special value is comparatively small - obviously less than 10% of the whole renovation volume - the architects use to treat all buildings to be renovated as if they would have special arcitectonic value. So all modern technics is very emotionally rejected and the renovation is understood to include only the precise restoration of every single detail.

The reason of this slightly irrational behaviour is obviously psychological: the architects who are making renovation plans are interested in all old matters, and in conserving them. More creative persons are, of course, planning new buildings. The effect of this psychological factor must not be underestimated. When, for instance, the heating system is modernized, porcelain stoves are not touched although by dismounting them an one person office room could be large enough for two, in other words the costs are doubled. So these parts of heating system which once in the past were criticized as ugly monsters of modern technology are metamorphosed valuable work of art.

To be honest, practical problems often overcome psychological. There are several examples of damages caused especially by ducts and air conditioning units to the architecture of old beautiful buildings. After some bad experiences there are some architects who refuse to design modern air conditioning and underestimate its importance to the welfare of man.

Space problems:

Normally in a renovated building there is not any space for air conditioning units and ducts. The useful area of the building cannot be reduced, and so the equipment is quite often installed in a cramped and unpractical space, where the installation costs are excessive and where the system has not possibility to function or to be serviced properly.

Economic problems

In addition to installation costs even designing a sophisticated = complicated air conditioning system for renovation is difficult and expensive. Unfortunately this is only the top of iceberg. The secondary costs (tearing, construction, piping, electricity, fire protection etc) are sometimes many times over the costs of air conditioning itself. Worst of all, the estimation of these costs is difficult. In same cases the budget is exceeded 400%.

Fire protection:

The fire safety of an old building is usually not acceptable. Especially the air ducts still worsen the situation. In same cases they have resulted in costly constructional changes.

Other problems:

Because of the trouble caused to the users of the building, the time used to renovation is minimized, or the renovation is cut into small parts. In many cases only a part of a building is renovated. In all these cases it is difficult to utilize modern air conditioning with large ductwork, centralized regulation etc.

The specification of a new system

To overcome the difficulties listed before the properties of a new system were specified in autumn 1981. The following utopian demands were listed. The new system must:

1. Be easily installed in existing spaces of an old building.
2. Not cause remarkable secondary costs.
3. Not ruin the architecture of an old, beautiful building.
4. Not weaken the fire safety.
5. Make it possible to renovate a building only partly or step by step.
6. Have not higher investment costs than conventional air conditioning.

The specification above is discussing only the special problems of renovation. We listed furthermore some features which we thought to be worth of developing generally for any air conditioning systems. So the new system also must:

1. Be understood, operated and serviced by any normal people.
2. Have low running and energy costs.
3. Meet the strictest hygienic demands.
4. Reserve every person a possibility to influence his own environment.
5. Retain the possibility of airing or natural ventilation.

System description

As the result of picking out dozens of peculiar applications the unit presented in fig. 1 was selected. The unit is installed in the aperture of an ordinary airing panel and provided with hinges so that it can be used for airing in summer and temporarily even in winter exactly like an airing panel.

During the cold season it is usually used for mechanical ventilation. The unit is working periodically in reversed directions both for exhaust and supply. The unit is equipped with a regenerative heat recovery element, but in addition to it, the whole unit is acting as a regerative heat recovery devide thanks to its reversed function.

Basicdy the unit is functioning like human lungs. However, the actual buildings cannot be dilated and contracted like thorax, and that is why the complete system presented in fig. 2 consists of two units functioning in opposite directions: one exhausting, the other supplying air simultaneously. The directions are periodically reversed.

Much attention was paid to draughtless air supply. The best results were achieved with a solution presented in fig 1. The air is supplied through numerous small high induction rate nozzles located on large area over the window.

As presented in fig. 1 and fig. 2, all details of the system are visible. All parts can be opened and cleaned with customary cleaning device.

Results in laboratory tests

The first laboratory tests were made by the manufacturer and completed with official tests of the Technical Research Center of Finnish state. The majority of the test results was satisfactory: the specified and calculated performance was achieved, the system was functioning properly etc. Therefore only such features which may result in problems in practice are discussed in this paper.

It was observed in the very first tests, that the heat recovery efficiency of the unit was extraordinary high. So an attempt was made to manage quite without heating coil. Thanks to effective air supply the attempt was succesfull. There is a slight air temperature fluctuation in the nozzle opening (fig. 3), but it is almost totally disappeared in the distanse of 0.5 m because of good induction properties of the nozzle. It was found out, that the unit can operate without heating coil properly even in the extreme conditions of Finland (dimensioning temperature -28 °C in the south, -32 °C in the north).

Unfortunately this extraordinary charasteristic is attended by a problem: freezing. In exceptional conditions (outdoor temperature -20 °C, indoor temperature + 22 °C and relative humidity 50%) the filter and discharge opening of the unit were frozen mostly because of internal leakages. In normal conditions (rel. humidity 30%) no freezing was reported. The construction was improved and in later tests it was observed to remove the moisture in the form of snow. However, the final security can be achieved only with extensive field tests, because the snow-building phenomenon is not completely theoretically controlled.

Field Tests

The first field tests were made during years 1982-84 in two small office rooms (70 m^2 each).

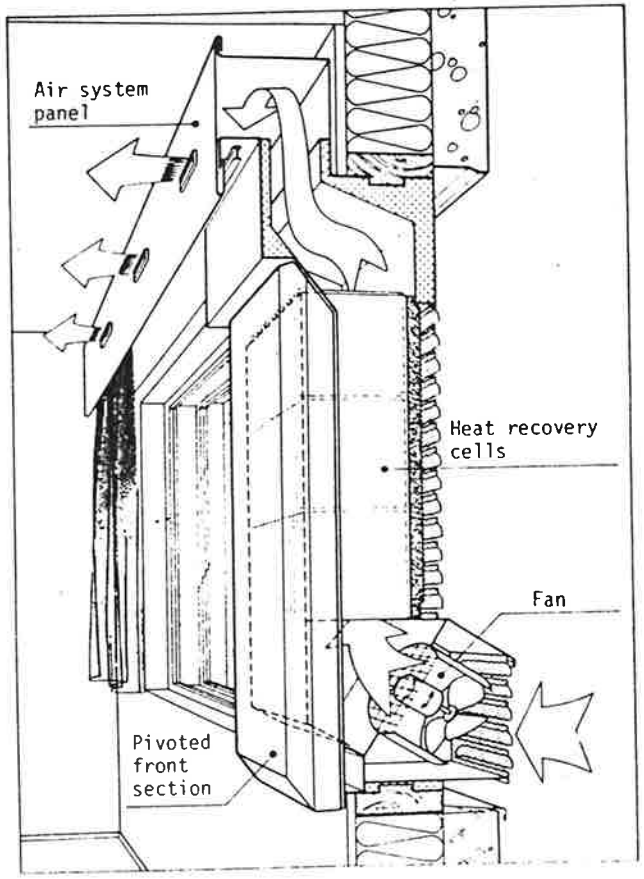

Fig 1. Air conditioning unit for natural-mechanical ventilation.

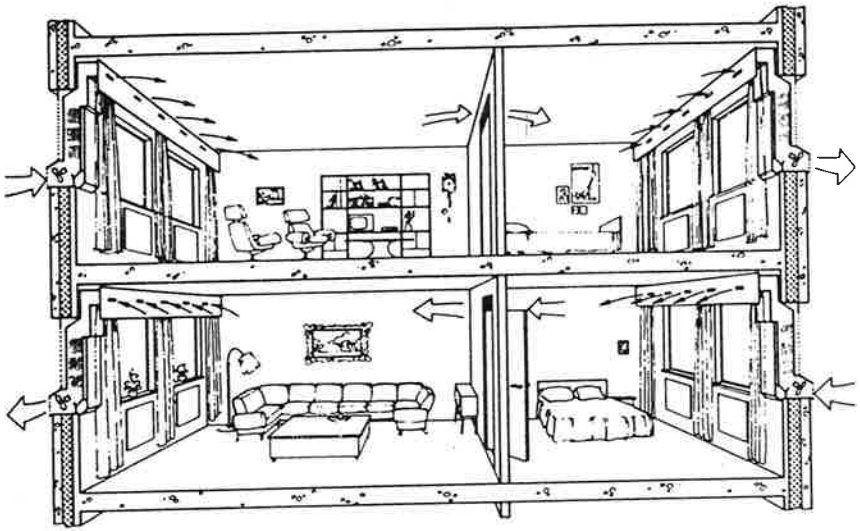

Fig 2. Natural- mechanical ventilation system.

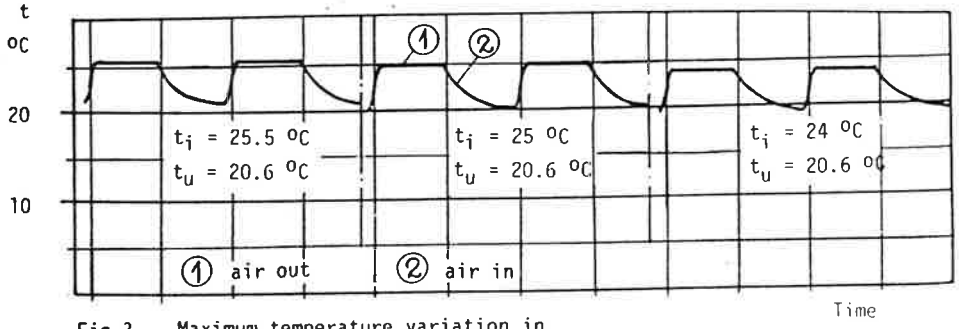

Fig 3. Maximum temperature variation in the nozzle.

These tests were concentrated on the function and technical properties of the units, and the results were very similar to the laboratory tests.The people working in the offices were quite satisfied. Some criticism was rised against sound level, although the measured maximun pressure level (37 dBA) does not usually cause any complaints. Evidently this can be connected with the periodicd nature of the sound.

The second stage of field tests was started in winter 1984. In this program different types of buildings are studiet: some small residences, a primary school, a hairdressing saloon, an office etc. In addition to normal functional tests the research program includes tracer gas studies of ventilation efficiency and the influence of wind and outdoor temperature, measurements of different impurities, and even a comparative research of the direct and secondary costs of different air conditioning systems. The final results of this prolonged research will be reported in 1986. However, some conclusions can be drawn already now:

- Sound level must be perhaps 5 dB lower compared with continuous sound.
- Ventilation efficiency appears to be exceptionally good mainly because of the reversed function.
- Pressure relations in a building and even air humidity to certain degree can be governed by changing the timing (supply/exhaust) of the unit.

Conclusions

Although the natural-like mechanical ventilation appears to meet all the specified requirements, it should be observed only as an example of unconventional way to approach the problematics of air conditioning. During a decade after the first energy crisis the dominating problem of air conditioning has been minimun ventilating rates, which has arosen several environmental problems. In the same time the air conditioning systems have been developing more and more centralized and complicated even so, that the people have loosen the control of their own environment. The authors of this paper suggest that an unprejudiced, less technocratic and innovative approach may generate new solutions, which are more approach human, more understandable but not less techinically advanced than existing solutions.

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