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ENERGY EFFICIENCY OF VENTILATION SYSTEM IN APARTMENT BUILDINGS

EFEKTYWNOŚĆ ENERGETYCZNA SYSTEMU WENTYLACJI W BUDYNKU MIESZKALNYM

Abstract

The article shows impact of the location of apartments on the heat requirement of each type of apartment as well as the possibility of different savings of heat by using ventilation equipments including recuperative devices.

Keywords: *ventilation*, *heat*, *apartment*, *building*, *energy saving*

Streszczenie

Artykuł przedstawia wpływ lokalizacji mieszkania na wymagania cieplne poszczególnych lokali jak również możliwości oszczędzania energii przy użyciu systemu wentylacji z rekuperacją.

Słowa kluczowe: *wentylacja*, *ciepło*, *lokal mieszkalny*, *budynek*, *oszczędność energii*

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1. Introduction

In this paper, the energy performance of the ventilation system in an apartment building is documented. Twenty-one flats are in the building. Only some apartments have the same equipment. Energy consumption in the individual apartments is different, because their location within the apartment building varies.

2. Ventilation of the apartment building

The research was carried out in an apartment building with four floors above ground level. The building has a total of 21 apartments. On the first floor 6 apartments of type A-1, B-1 and C-1 are located. On the second floor 6 apartments of type A-2, B-2 and C-2 are located. On the third floor also, 6 apartments of type A-3, B-3 and C-3 are located. On the first floor, second floor and the third floor are identically located apartments. But the heat transfer through building envelope is different, because the apartment´s location is different within the building. On the fourth floor there are 3 apartments of type D-4 and E-4.

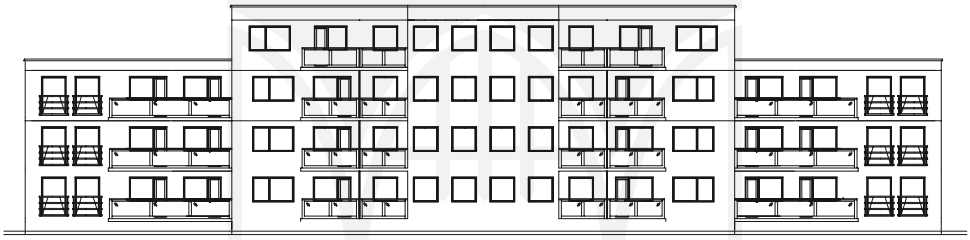

Fig. 1. View of the apartment building [3]

Table 1

The basic parameters (calculation according to STN EN 73 0540, STN EN 13 790 [4, 5])

Type of apartment	Apartment area [m^2]	Volume of apartment [m^3]	Specific thermal loss of transition (apart. 1/2/3) [W/K]	Specific thermal loss of ventilation (n = 0.5) (apart. 1/2/3) [W/K]	Specific thermal loss of ventilation (n = infiltration) (apart. 1/2/3) [W/K]
A	85	235	58/58/84	31/31/31	7/7/7
B	75	209	33/33/33	28/28/28	3/3/3
C	58	160	31/31/31	21/21/21	4/4/4
D	98	300	95/95	40/40	7/7
E	112	340	77	45	7

The external wall in the upper floors are made out of brick with thickness of 380 mm. Thermo-insulating plaster thickness is 35 mm [3].

The roof deck of the building is formed by a flat roof. The slope is on the inside of the roof. Thermal insulation is made from extruded polystyrene – thermal insulation boards of 150 and 200 mm. Windows are proposed as plastic with insulating double glazing. Heat transfer coefficient of window is U = 1,0 W/(m^2·K) [2]. The annual energy demand for heating and ventilation was calculated according to methodology of STN EN 73 0540 and STN EN 13790 [4, 5].

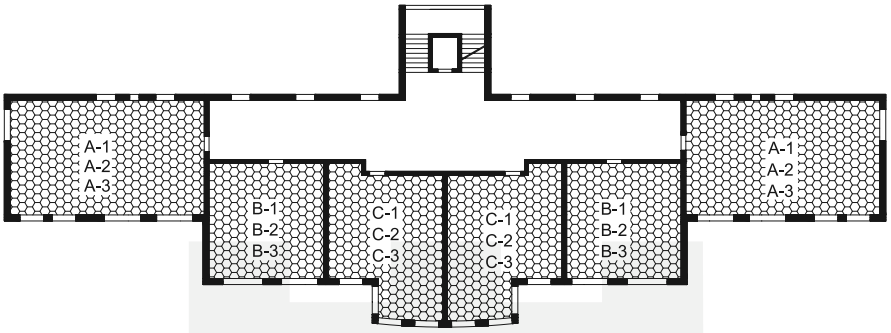

Fig. 2. Foor plan of the 1st, 2nd and 3rd floors above the ground

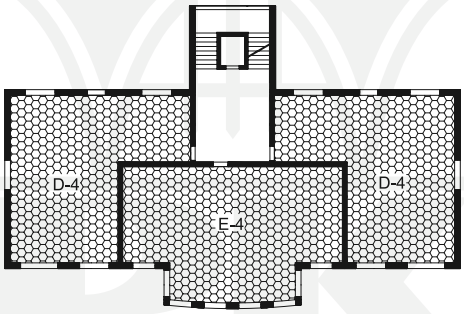

Fig. 3. Floor plan of the 4th floor above the ground

In this building a controlled air handling unit is designed to provide heat recovery by means of recovery equipment. In this study two alternatives of the ventilation system are analyzed.

The first alternative involved installing an individual air handling unit in each apartment. The task of these units will be to provide the required indoor climate for just one apartment. Each ventilation unit is in operation independently.

In the second alternative central air handling units are designed for more apartments, which are situated one above another. A central air handling unit will be installed on the roof of the apartment building. In each apartment a control element will be installed to provides the air supply required for a particular apartment. Each apartment can have a different desired microclimate and also different required flow rate, which is dependent on the size of the apartment, number of persons in the apartment and individual requirements of people in the apartment.

For each apartment equipment is designed, which provides equal pressure of ventilation. The device ensures a forced inlet of fresh air and concurrently lets out the polluted air.

Table 2

The efficiency of the heat recovery unit (example of the evaluation)

	Type of apartment	Type of the ventilation unit	Supply air [m^3/h]		The efficiency of the heat recovery unit [%]		
			Max.	Required	Min.	Max.	Mean
1. altern.	B	DUPLEX 180 EC4	180	104	89.4	95.4	90.6
	C	DUPLEX 180 EC4	180	80	90.7	96.2	91.4
	D	DUPLEX 180 EC4	180	150	88.4	94.3	89.6
	E	DUPLEX 180 EC4	180	170	88.1	93.9	89.3
2. altern.	3 × (B + C) + D + E	DUPLEX NS 1500	1500	872	74.3	79.6	74.7

In the ventilation system heat recovery is used. This will significantly reduce the heat consumption for heating of outside air. Air handling unit is used for transporting air. The unit consists of fans, filters, heat exchanger and heater. The fan has the ability to regulate the power according to required air exchange. Ventilation units are controlled according to required temperature, air humidity, concentrations of carbon dioxide etc.

3. Energetic assessment of the ventilation system

Energy requirement was calculated for each apartment. Heat consumption was calculated (Fig. 4):

- for transmission of heat across the construction of the building,
- for warming the ventilated air:
  - Energy requirement for warming the infiltrated air,
  - Heat loss of ventilation,
  - Obtained heat from heat recovery air.

While calculating energy requirements, it is also necessary to add the energy required to run the ventilation system. For simplicity, in this case, the energy required to drive the fan has not been considered.

Heat demands for individual apartments are shown in figure 4. The arrangement of individual apartments are deliberately illustrated so as to show the location of apartments within the apartment building.

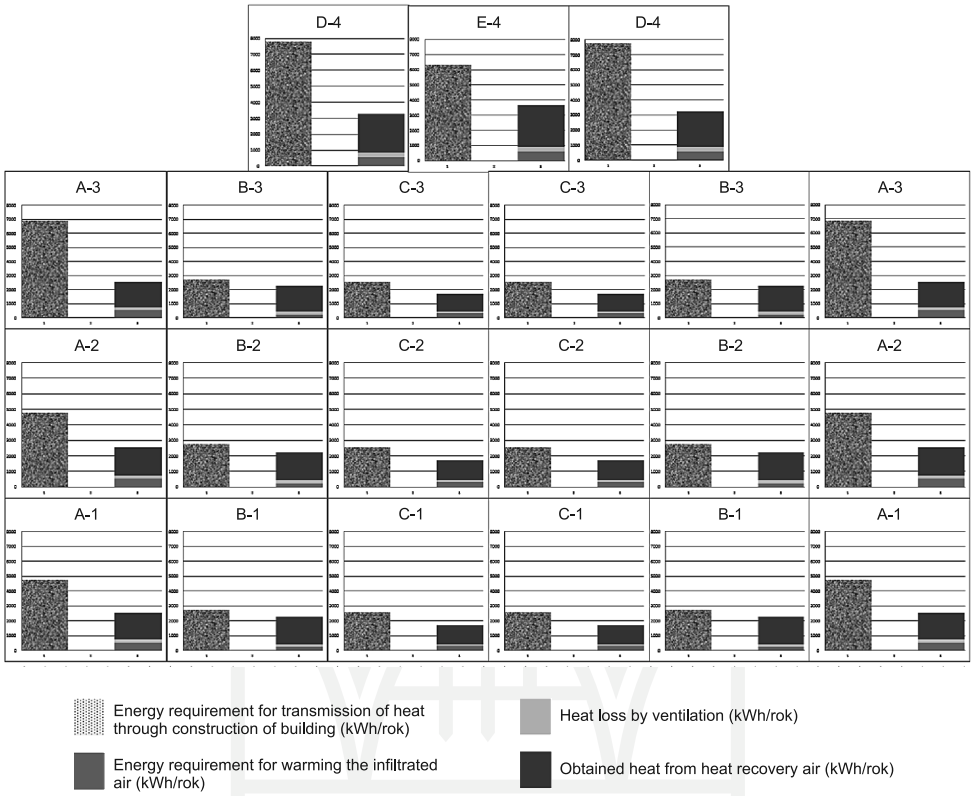

Fig. 4. The heat demand for individual apartments

4. Discussion

The aim of this paper was to analyze heat saving when using ventilation systems, whose component part is a device with heat recovery air. Advanced production technology of fans enables production of efficient electric motors with controlled rotation speed. So we can provide controlled ventilation of spaces with minimal energy consumption. Whereas the purpose of ventilation is to provide comfort while ensuring appropriate hygienic environment in the apartment, it is needed to design a device taking into account energy consumption and hygienic parameters. In addition to these parameters, it is important to take into account the environmental parameters [1].

Each mechanical ventilation system requires regular check-maintenance: change of filters, cleaning air ducts and etc. Also, this activity requires finances.

Apartment of type B (area 75 m^2) has energy savings of 37% and return on investment is 18 years. Apartment of type C (area 58 m^2) has energy savings of 30% and return on investment is 25 years. The central ventilation unit, which is for: three apartments of type B,

three apartments of type C, one apartments of type D and one apartment of type E, has energy savings of 26% and return on investment is 12 years.

Table 3

Obtained heat from waste air

Apartment type	A-1	A-2	A-3	B-1	B-2	B-3	C-1	C-2	C-3	D-1	E-1
Obtained heat from waste air (%)	22	22	18	37	37	37	30	30	30	22	28

5. Conclusions

From the analysis it can be concluded, that it is preferable to install individual ventilation units with heat recovery in apartments with more built-up volume. For apartments with less built-up volume it is advantageous to install a central ventilation unit with heat recovery designed for more apartments.

In this analysis an air handling unit with a constant air flow is used. For this case, the projected saving of energy will approximately of 18–37 % – see table 3. We assume that energy saving will be larger, when we use controlled ventilation system.

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