ENERGY CONSUMPTION IN SMALL DOCTOR'S OFFICES IN POLAND

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Summary

In Poland most part of energy in buildings is used for heating and ventilation. The energy consumption is a big economy problem, especially in the medical centers, doctor's offices or hospitals, where the indoor climate is specific. It is possible to reduce heat losses by improving the building walls or roofs insulation and increasing the efficiency of the heating or ventilation system by changing the regulation or equipment type, but we must remember about maintaining a minimum air change rate. There is the Directive of the Minister of Health concerning on sanitary and technical requirements and devices in medical care centers that defines the minimum amount of ventilation air in Poland. In the paper the energy consumption in a few medical practices was shown. The values for recommended ventilation conditions were calculated and compared with the real energy consumption. The conclusions about the potential of energy savings without reducing the amount of ventilation air below acceptable values were presented.

Keywords: energy consumption, public buildings, heat losses

1 The energy consumption for heating

The total heat loss is the main parameter that influences the energy consumption for heating in buildings and its cost, and it is calculated from formula (1):

$$\Phi_i = \Phi_{T,i} + \Phi_{V,i} \tag{1}$$

where Φi is total heat loss in W, $\Phi_{T,i}$ is heat loss for transmission in W, $\Phi_{V,i}$ is heat loss for ventilation in W.

The heat loss for transmission depends on the materials used for building construction, external barriers insulation and areas. In the existing buildings the only way that could save energy coming from this kind of heat losses is thermal modernization including walls and roofs insulation and windows replacement. The main factor that could increase or decrease heat losses for ventilation is the ventilation air flow dependent on an air change rate. In Poland, the Directive of the Minister of Health [1] specifies the conditions that should be fulfilled by doctor's offices and this regulation makes clear that every room in a health care institution should be fitted with a ventilation system which ensure at least 1.5–2 air changes per hour. On the other hand the Polish standard PN-83/B-03430 [2]

determines the minimum value at 20 m^3 per person for hour. Heat losses generate the design energy value for heating Q_i, but the real energy consumption Q_k is connected with the production, distribution, accumulation and regulation of the heating system efficiency and according to [3],[4] these four factors are used during calculation:

$$Q_k = \frac{Q_i}{\eta_g \cdot \eta \cdot_d \eta_s \cdot \eta_e} \tag{2}$$

where: η_g is an average seasonal efficiency of manufacturing a heat transfer medium (final energy) of energy supplied to the limit of the carrying amount of the building, η_s is an average seasonal efficiency of the heat accumulation in the capacitive elements of the system, η_d is a seasonal average efficiency of the transport of the heat carrier, η_e is an average seasonal efficiency of regulation and the use of heat.

2 The energy consumption analysis

The data from five health centers located in Białystok were analyzed. They were the integral part of big buildings where more offices, public organization etc. had their own rooms. Short characteristic of tested doctors' offices were shown in table 1.

Tab. 1 *The doctors' offices characteristic*

Parameter	Object 1	Object (2)	Object (3)	Object 4)	Object (5)
Volume	45.0	116.0	74.0	89.0	146,0
Number of rooms	1	4	3	2	3
Number of staff	2	4	3	2	3
Location	Part of a building				
Energy source	Heat centre				
air change rate from tests	1,0 -3,4	1,1 -1,2	1,3-2,7	1,2-3,1	2,4-3,6
U value for external walls	0,88	0,22	0,28	0,68	0,68
U value for windows	1,5	1,7	1,5	3,0	3,0
Regulation of heating system	Thermostatic valves				
Ventilation type	Natural, gravity				

For all buildings the amount of the annual energy consumption and heat losses (divided to heat loses for transmission and ventilation) was calculated. The values were estimated for the actual conditions (the maximal air change rate recorded during one year-period tests – was marked as "a", the minimal air change rate recorded during one year- period tests – was marked as "b"). Then the similar values for the recommended conditions (the ventilation air stream and air change rate recommended by the standards [1], [2]) were estimated and marked as "c". In buildings where some improvements in building envelope or heating system were possible the analyzes included also the situation with the recommended air change rate after thermal modernization (marked as variant "d"). The U values for walls after modernization were 0,22 W/m^2K, for windows 1,5 W/m^2K. There were no roofs in tested offices because there were other rooms above them. The results were shown on fig. 1 and fig. 2.

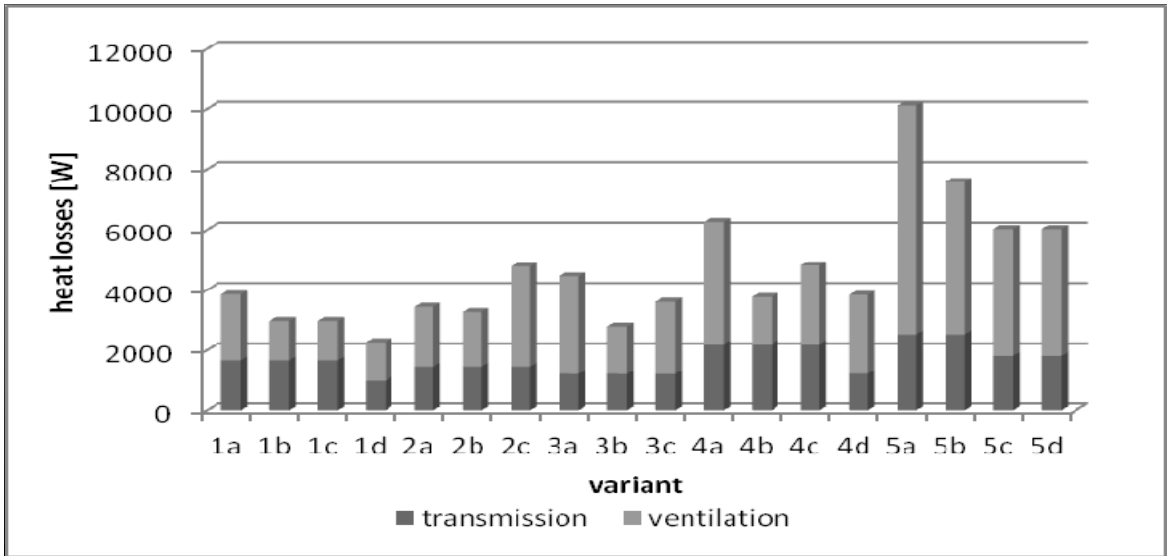

Fig. 1 *The heat losses*

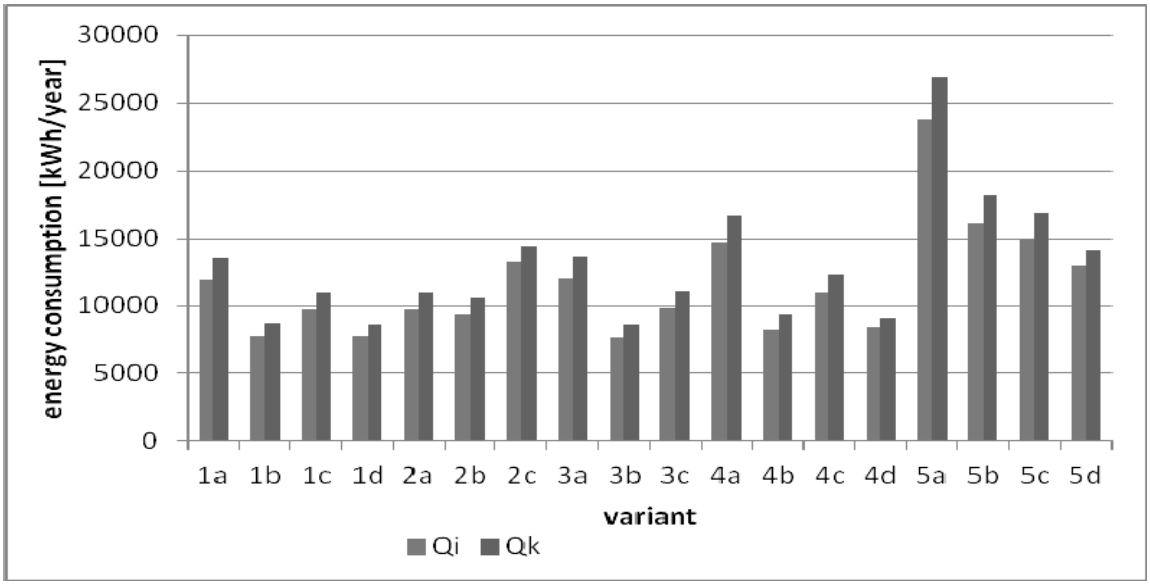

Fig. 2 *The energy consumption (Q_i without heating system efficiency and Q_k – with heating system efficiency)*

3 Conclusions

This study consequently focused on the energy consumption in small doctor's offices depending on the air change rate. First of all, the results analyze showed the differences in potential possibilities of energy consumption rationalization. In office 1 after the thermal modernization (walls insulation and windows replacement) energy consumption would be only 2 % lower than now if the air change rate is on the recommended level, while 37 % energy savings could be obtain in the office without air flow changes. In other objects these values are from 2 to 47 %. In case of doctor's offices 2 and 3 the building improvement was not possible and not necessary. In object 2 an air average rate was to low and it should be higher, so it would case higher cost for heating – the energy consumption would increase

about 25 %. It was also concluded that in office 3 no differences would be recorded because an average air change rate was nearly the same as recommended by the standards [1], [2].

Lead to a conclusion, the health centres are specific places, where not only energy efficiency is important but indoor air quality too. Sometimes during thermal modernization we do not remember about it and a good cost reduction is obtained but the air stream is too low. In other situation the prediction about costs' reduction is to optimistic because people do not remember about the need to maintain minimal air change rate. It should be noted that the recommended ventilation flow should be considered during the calculation because in the case of strict economic situation it is required to estimate the proper energy costs and simple pay-back time for each modernization.

Acknowledgement

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References

[1] Directive of the Minister of Health of 21.08.2006 concerning sanitary and technical requirements which have to be met by rooms and devices in medical care centres, Journal of Laws of 2006 no. 180 pos. 1325.

[2] PN-83/B-03430 – *Ventilation in collective dwelling places and public buildings – requirements*. (Revision Az3) – February 2000.

[3] Directive of the Minister of Infrastructure of 6.11.2008 on the methodology for calculating the energy performance of the building and premises residential part of the building or constituting an independent whole technical unit – the preparation and design of energy performance certificates. Journal of Laws of 2008 no 201, pos. 1240

[4] PN-EN 13770: 2006 Thermal performance of buildings – *Calculation of energy use for space heating*.