TRANSPARENT BUILDING ELEMENT EFFECTS ON HEAT ENERGY CONSUMPTION

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TRANSPARENT BUILDING ELEMENT EFFECTS ON HEAT ENERGY CONSUMPTION

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Abstract

Based on the law for energy transmission, comparative analysis of energy parameters for most common building elements has been performed in order to increase energy characteristics of buildings with change of transparent element surfaces (windows, balcony doors…). Heat energy saving, besides better thermal insulation, can be achieved also by proper choice of transparent elements, as well as by their optimal surface.

Keywords: Heat energy, transparent elements, buildings, energy efficiency

1. Introduction

With an increase of human population and with technology improvement, there is also increasing energy demand. Nowadays, energy is the main driving force for further development of civilization. Thus, its rational use has become one of the major challenges, also because classical energy sources present huge environmental risk. Since cca 40% of energy is spent on residential and business buildings, one can easily conclude about the importance of energy saving in these objects. The notion of building energy efficiency mostly includes two aspects, the first one are objects themselves, and the second one their use. Thus, by energy efficient building we actually mean low energy losses.

In Europe building heating and cooling spends cca 41% of total energy, whereas in Serbia it is as high as 47%! Figure 1 indicates that buildings are large energy consumers.

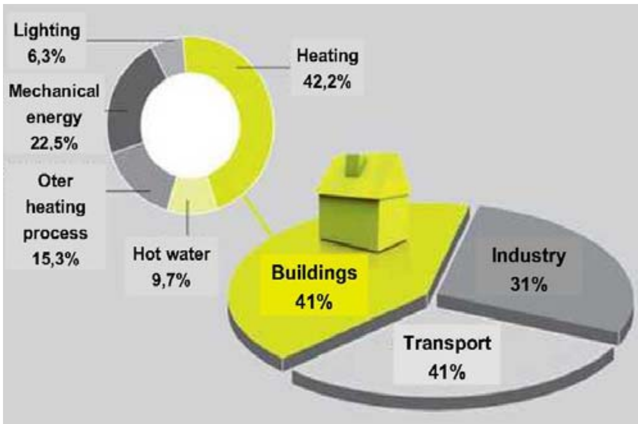

Figure 1. Graphical representation of spent energy distribution, [10]

2. Transparent element heat conduction

According to the building energy efficiency regulations, [1], coefficient of transparent element heat conduction is:

$$u = \frac{A_g \cdot u_g + A_f \cdot u_f + \psi_g \cdot l_g}{A_g + A_f} \tag{1}$$

where :

A_g – glass surface
A_f – frame surface
u_g – glass heat transfer coefficient
u_f – frame heat transfer coefficient
ψ_g – correction factor for glass–frame connection
l_g – length of glass-frame connection

If there are two or more glasses their total surface is used. Coefficients u_g and u_f are defined in [1] or by producer recommendations. For multiple windows length l_g represent total length of all glass-frame connections.

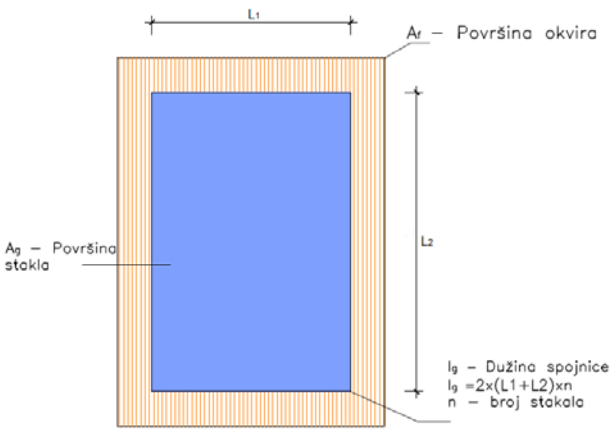

Figure 2. Parameters for calculation of heat transfer coefficient

3. Heat transfer coefficient calculation

Heat transfer coefficient calculation has been performed for window having different dimensions, frame and glass numbers. More concretely, glass dimensions are varied for PVC frame 5 cm. Double and triple glassed are considered, 6-12-6 mm and 6-12-6-12-6 mm, respectively. Dimensions were: width b=40–100 cm, height h=60-120 cm, with an increment 5 cm. PVC frames with two, three, five and six chambers have been analysed. Results are shown in Tabs. 1-3 and in Figs 3-5.

Table 1. Frame (5 cm) and glass surfaces

Transparent element	Glass Dimensions (cm)	Glass Surface (m^2)	Frame surface (m^2)
1	40 x 60	0.240	0.011
2	45 x 65	0.293	0.012
3	50 x 70	0.350	0.013
4	55 x 75	0.413	0.014
5	60 x 80	0.480	0.015
6	65 x 85	0.553	0.016
7	70 x 90	0.630	0.017
8	75 x 95	0.713	0.018
9	80 x 100	0.800	0.019
10	85 x 105	0.893	0.20
11	90 x 110	0.990	0.21
12	95 x 115	1.093	0.22
13	100 x 120	1.200	0.23

4. Comparative analysis of results

Based on the results obtained, the comparative analysis has been made for heat transfer coefficient change with changing of parameters affecting its value. The analysis is illustrated in the following diagrammes. In this analysis the effect of chamber and glass number on the heat transfer coefficient is followed. As the representative simple „9“ with glass dimensions 80 x 100 cm and frame width 5 cm will be used.

Figures 6 and 7 show heat transfer coefficient for double and triple glass, respectively, and different number of chamber.

5. Conclusion

Based on diagrams and results presented here, one can conclude that the increase of number of chambers does not affect significantly heat transfer coefficient for double glass. Figures 3 and 4 indicate that 0.6-3.5% of the reduction of heat transfer coefficient.

On the other hand side, if triple glass (6-12-6-12-6 mm) is used instead of double one (6-12-6 mm), Figure 5 indicates much more significant effect on heat transfer coefficient, up to 22-23%.

If diagrams shown in Figs. 6 and 7 are analysed, one can conclude that surface effect is different, but generally speaking its increase, regardless of number of chambers, lead to the single value. For triple glass this effect is more pronounced (8-11%) than for double glass (1-3%).

Tabela 2. Heat transfer coefficient for PVC two-chamber window with doublé glass 6-12-6 mm

Transparent element	Glass surface	Frame surface	Connection length	Glass heat transfer coefficient	Frame heat transfer coefficient	Connection heat transfer coefficient	Window heat transfer coefficient
	m²	m²	m	(W/m²K)	(W/m²K)	(W/m²K)	(W/m²K)
1	0.240	0.11	4	2.9	2.2	0.04	3.1371
2	0.293	0.12	4.4	2.9	2.2	0.04	3.1230
3	0.350	0.13	4.8	2.9	2.2	0.04	3.1104
4	0.413	0.14	5.2	2.9	2.2	0.04	3.0991
5	0.480	0.15	5.6	2.9	2.2	0.04	3.0889
6	0.553	0.16	6	2.9	2.2	0.04	3.0796
7	0.630	0.17	6.4	2.9	2.2	0.04	3.0713
8	0.713	0.18	6.8	2.9	2.2	0.04	3.0636
9	0.800	0.19	7.2	2.9	2.2	0.04	3.0566
10	0.893	0.20	7.6	2.9	2.2	0.04	3.0501
11	0.990	0.21	8	2.9	2.2	0.04	3.0442
12	1.093	0.22	8.4	2.9	2.2	0.04	3.0387
13	1.200	0.23	8.8	2.9	2.2	0.04	3.0336

Tabela 3. Heat transfer coefficient for PVC two-chamber window with triple glass 6-12-6-12-6 mm

Transparent element	Glass surface	Frame surface	Connection length	Glass heat transfer coefficient	Frame heat transfer coefficient	Connection heat transfer coefficient	Window heat transfer coefficient
	m²	m²	m	(W/m²K)	(W/m²K)	(W/m²K)	(W/m²K)
1	0.240	0.11	4	2.9	2.2	0.04	3.1371
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12	1.093	0.22	8.4	2.9	2.2	0.04	3.0387
13	1.200	0.23	8.8	2.9	2.2	0.04	3.0336

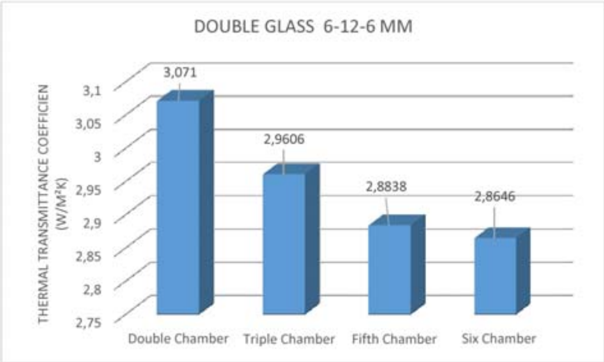

Figure 3. Heat transfer coefficient (W/m^{2}K) for transparent element "9", Tab. 1 for different number of chambers – double glass 6-12-6

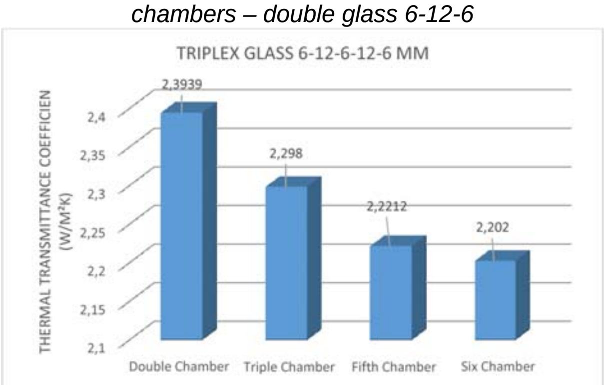

Figure 4. Heat transfer coefficient (W/m^{2}K) for transparent element "9", Tab. 1 for different number of chambers – triple glass 6-12-6-12-6 mm

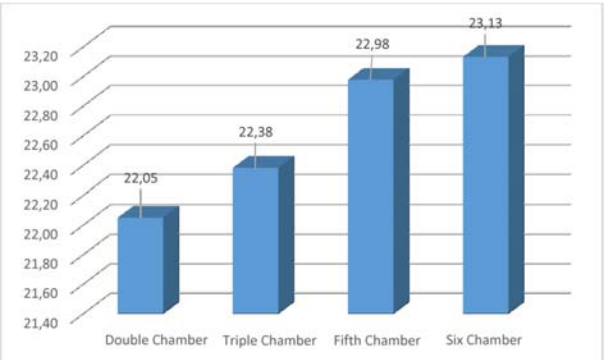

Figure 5. Heat transfer coefficient (W/m^{2}K) for transparent element "9" for different number of chambers and double and triple glasses, based on Fig. 1 and 2

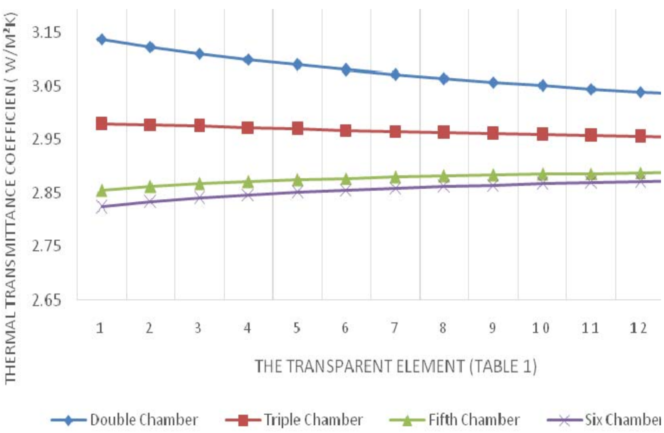

Figure 6. Heat transfer coefficient double glass and different number of chamber

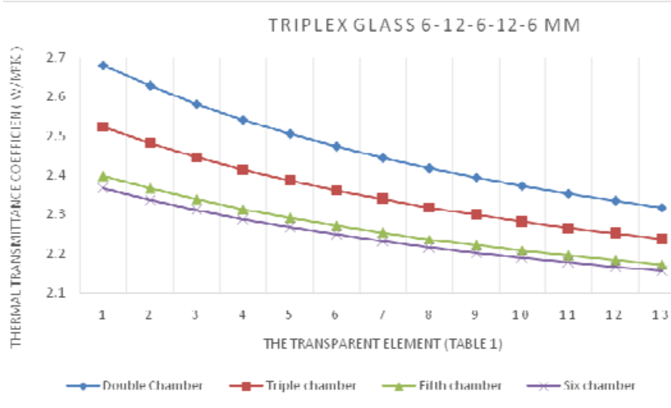

Figure 7. Heat transfer coefficient triple glass and different number of chamber

Therefore, one can conclude that the most effective for heat saving is the glass type (triple or double), than the surface of transparent elements, whereas the number of chambers has negligible effect.

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