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APPLICATIONS OF SIMULATION IN ENERGY BUILDING PERFORMANCE

Article Particulars

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Abstract

In this paper deals with energy consumption for Czech Republic and energy efficient technologies and installing emission control devices. This paper approach analyses the variation of energy consumption for heating in panel houses depending on different parameters. This paper deals with the general problem of high heating energy consumption which affects a significant group of flat owners. The results provide an insight in indoor environment of large ventilated enclosures which can be used for design purposes.

Keywords: *Energy consumption, Ventilation, Heat consumption.*

Introduction

The Czech Republic (CR) belongs to the group of countries with greatest energy consumption. The energy consumed for $1000 of gross national product was 19.33 GJ in 1987 (USA 15.11GJ/$1000, Japan 6.98 GJ/$1000). This situation has improved since then but not significantly. In the past, the price of energy used to be heavily subsidised by the government. This is not acceptable in the current introducing of market economy principles in the CR. The high level of energy production was accompanied with high level of air pollution since most of the energy was produced in power plants burning brown-coal with low heating value and high sulphur content (up to 4%). Because of that the CR was one of the most polluted countries in the world.

The last few years have seen an increase in the activities and a number of organisations are trying to improve the energy situation and the associated impact on the environment by introducing more energy efficient technologies and installing emission control devices. There is a drive to switch to other fuels like natural gas.

Parametric Study of Heat Consumption in Flats

Problem Description

The amount of energy used for residential heating is relatively as much as in the Czech Republic. This problem is happen in the case of prefabricated apartment buildings at 70% of the present housing stock. The peoples were not aware of controlling energy and reducing energy. Since the energy consumption for heating of the flat was calculated only according to the floor area. Even today when energy consumption measuring devices are being introduced to the flats, the most common reaction when it gets too warm is to open a window. As shown in the following, the variation in heat consumption of similar flats can be very high.

Model Description

The analysis of four different parameters having an influence on the residential building heating energy consumption was carried out. The parameters under consideration were as follows:

- Location of the apartment in the building (A)
- Set-point increased up to 24°C (B)
- Heating pattern of neighbouring flat (C)
- Excessive continuous ventilation (D)

The "standard "prefabricated house, typically built from the 60s to the 80s, was selected as an object of investigation. The average apartment size is 45 m^2 floor areas. The buildings were built from the prefabricated concrete panels with almost no insulation (external walls U-value = 1.09 W/m^2K, roof U-value = 0.5 W/m^2K, windows U-value = 2.6 W/m^2K, internal walls U-value = 2.9 W/m^2K) and therefore relatively high energy consumption.

Simulations and Results

The simulation was going through the period of one typical winter week in the Czech Republic (10 to 16 January) when external temperature reaches -5°C during the day and -12°C at night (Dunovska, 1995). The resulting heating energy consumption obtained by simulation for different cases are graphically shown in Figure1. To make the study more "realistic", the cost of one-week of heating expressed in KC (1 US$ » 29 KC) is presented. When calculating the heating cost, a price of 163 KC per GJ (Czech official price for district heating in 1996) was assumed. The heating consumption starts at 100% base-case heat consumption. The base-case denotes the space heating energy consumption of the flat situated in the Centre of the building when heated up to 20°C. The heating energy consumption for the base-case during the simulation period was 323 kwhrs and is referred to as 100%. Case A2 shows an increase in energy consumption of up to 217% when the same flat is situated under the roof and in the corner of the building, i.e. about 50% of the walls are external.

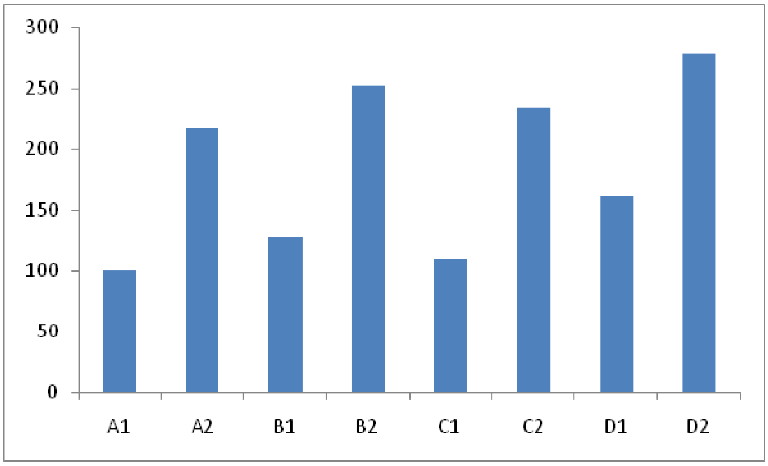

Figure 1

Variation of costs and energy consumption for heating of the flat during one-week depending on flat location, increased set-point, neighbouring apartment and excessive ventilation (price is 163KC per GJ) Case B1 had a heating energy consumption of 128% which was caused by the set-point increase to 24°C (internal air temperature). The effect of the heating pattern of the neighbouring apartment was modelled in case C1, which had a resultant energy consumption of 110%.

In case C1 it was assumed that the neighbouring apartment on one side (partition wall of 20 m2) was not heated at all. In case D1, the natural ventilation rate was assumed to be ACH which is double that of the base-case value, and the heating energy consumption was found to be 162%.

This represents the situation when, for example, a small"ventilation window"is opened during the whole period. The other factors influence on the heating consumption with the reference case A2 (of 217% energy consumption).The energy consumption was 253% when the flat under roof was heated up to 24°C. The unheated neighbouring apartment increased the energy consumption to 234% (case C2) and in case D2, the energy consumption increased by excessive ventilation to 279%.

The effect of higher desired internal air temperature on the length of the heating period was analysed. The simulation was run through the whole year period with heating set points of 20°C and 24°C respectively for the flat located in the centre and in the corner of the building. The energy consumption for the heating, and the length of the heating period, were compared for different cases and are summarised in Table 1 together with the cost of heating in KC. It can be seen in Table 2 that the length of the heating period differs from the base case situation by 1,398M hours only because of the location of the flat in the corner position.

Setting the internal air temperature to 24°C instead of 20°C increases the heating period by 916 hours for the central flat and by 1,076 hours for the corner flat. The annual energy consumption and hours of heating for the flat located in the central and corner part of the building. The corresponding cost of heating in KC.

Table 2

Flat location	t_i(^{0}c)	Heating energy consumption (GJ,%)	Heating period (hours)	Cost of heating (KC)
Central	20	16(100%)	3674	2609
	24	24.3(152%)	4590	3976
Corner	20	45.3(283%)	5072	7384
	24	64.2(401%)	6148	10475

Conclusions

From comparing the above simulation results it can be concluded that the most significant parameter influencing the heating energy consumption (out of the investigated ones) is the location of the flat. The second most important parameter is that of excessive ventilation ("ventilation window" opened), a result of overheating, which is a common problem today. On the other hand the heating pattern of the neighbours had a surprisingly low influence on heat consumption. However, it must be noted that these results were obtained for the specific case and for a one week-period.

It follows from the whole year simulation that in the same building the heat consumption of the same flat can vary from 100% up to 400% depending on the flat location and the desired internal air temperature (4°C variation in this case) and the heating period can be 1.6 time s longer as a result of that.

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