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Storage Heat in Buildings Elements is an Option to Reduce the Energy Consumption in Buildings Keeping the Comfort Parameters?

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***Abstract* – Storage energy in buildings elements, in residential buidings, is a way to obtain low energy consumption for heat the buildings and keep the comfort parameters to the minimum require. We present a calculus of heat variation in walls with differents structure using Fourier law of conduction. In a building if heat plant operate continuu and the external temperature is variable the heat transfer cause the variation of temperature on the surface of external wals (buildings elements) and the variation of internal temperature, variation of internal temperature more than. The variation of internal temperature is adicted by the thermotechnical characteristics of constructions materials use to realize the building.**

Keywords* – *buildings, buildings elements, consumption, energy, storage

1. INTRODUCTION

Directiva 2010/31/UE[1] the energy performance of buildings provided that after December 31, 2018, new occupied buildings as well as buildings owned by public authorities are buildings whose energy consumption is almost equal to zero. nZEB concept has three principle esentiale

- Lower Energy consumption;
- Minimum CO2 emmission;
- Minimum 30% from energy consumption must be assured by renewable sources of energy.

Energy consumption in residential buildings increased, reaching 40%. For this reason, the energy efficiency of buildings is today a primary objective for energy policy in all countries The increase in energy consumption in HVAC systems is particularly significant at somewhere around 50% of building consumption and 20% of total buildings consumption [2]. At this moment in the given conditions (deep energy crisis), we must consider the economic and environmental consequences of our dependence on fossil fuels, the environmental risks associated with their extraction and the environmental damage caused by their emissions. No source of primary energy, be it renewable or non-renewable, is free from environmental or economic limitations and as a result it could be difficult to meet EU requirements [3]. For the residential sector, the most cost-effective means of reducing energy costs is to maximize the energy efficiency of buildings envelope and to use low-carbon energy sources [4]. Effectively improving the energy performance of existing buildings should be done by accurate measurements [5]. The thermal performance of a building envelope is one of the most important parameters for calculating the energy demand of a building because it is directly affected by the external environment. The U-value is defined by ISO 7345 [6] as "the steady-state heat flow divided by the area of a system and the temperature difference between the surroundings on each side." [7], [8]. When we talk about limiting heat transfer, we must not forget to solve the problem of thermal bridges. Thermal bridges are places through which heat is lost, places where there is a risk of condensation and implicitly of mold. The loss of heat at the level of thermal bridges is significant and must be treated with great responsibility. What does this mean? If we treat the thermal bridges properly, the heating plant will work for a shorter time and the comfort in the rooms will be kept within the required limits. Studies using statistical models have been carried out to provide designers with simple and practical tools for evaluating the most common thermal bridges [9].

The idea of thermal energy storage of passive latent heat incorporating phase change materials (PCM) is a technique to address the problem of high energy consumption in buildings. The results of the studies show that the performance of the PCM-based wall is strongly influenced by the thermal conductivity, phase change enthalpy and melting temperature of the PCM. Furthermore, thermal conductivity takes precedence over other PCM thermophysical properties [10].

A factor that influences the energy storage in the walls is the variation of the convection coefficients on their surface. Detailed analytical and numerical studies were carried out to study the fundamental aspects of the problem. Various simple wall geometries have been analyzed in numerous scientific works with conclusions that the efficiency of massive walls is quite sensitive to the variation of convection coefficients [9].

2. EXPERIMENT DESCRIPTION

Depending on the operating mode of the heating installation and the variation of the outside temperature, heat transfer through the delimiting elements of the rooms can be done in stationary or non-stationary mode.

If the heating installation works permanently, and the temperature of the outside air remains practically constant, the heat transfer is done in stationary mode. If the heating system operates intermittently and the temperature varies a lot (due to solar radiation), the heat transfer takes place in an unsteady regime, which has the effect of varying the temperature of the inner surface of the boundary elements of the room.

Large variations of the microclimate in the room can thus be produced, which can lead to exceeding the limit of thermal comfort (θ_i-θ_{si}≤6°C) θ and its variation by more than 3°C). These phenomena are particularly influenced by the accumulation of heat in the construction elements, i.e. by their ability to retain a greater or lesser amount of heat. The order in which the layers are placed in a flat composite wall influences the amount of heat accumulated in the building element.

In Figure 1, the line θsi'-θse' represents the initial stationary temperature regime, and the line θsi"-θse", represents the final stationary temperature regime.

By integrating the differential equation of conduction for infinite parallel plane walls:

$$\frac{d^2\theta}{dx^2} = 0 \tag{1}$$

in boundary conditions, of the Drichlet type I, the equation of the temperature field results, in the form:

$$\theta = \theta_0 - \frac{\theta_0 - \theta_1}{\delta} \cdot x \tag{2}$$

in the case of figure 1, the equations can be written:

$$\theta\,' = \theta_{si}' - \frac{\theta_{si}' - \theta_{se}'}{\delta} \cdot x \tag{3}$$

$$\theta\,'' = \theta_{si}'' - \frac{\theta_{si}'' - \theta_{se}''}{\delta} \cdot x \tag{4}$$

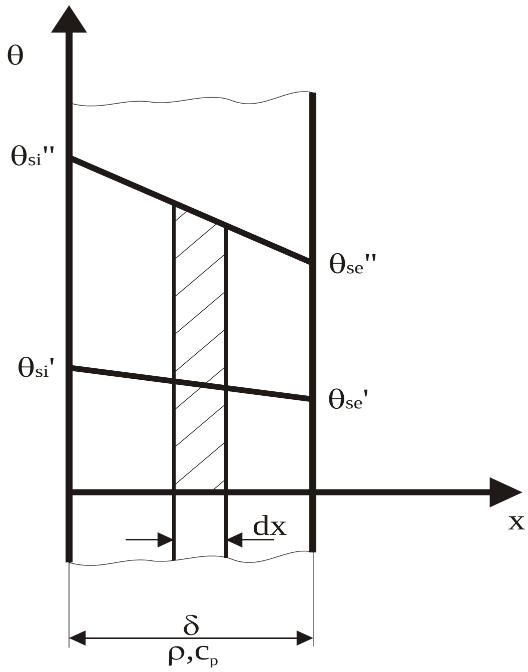

Fig. 1 Stationary temperature regimes

The heat accumulated in a volume element of thickness dx and area equal to $1\ m^2$ is:

$$dQ = \rho \cdot c_p \cdot (\theta\,'' - \theta\,') \cdot dx \tag{5}$$

where by integration is obtained:

$$Q = \rho \cdot c_p \cdot \delta \cdot \left(\frac{\theta_{si}'' + \theta_{se}''}{2} - \frac{\theta_{si}' + \theta_{se}'}{2} \right) = \rho \cdot c_p \cdot \delta \cdot (\theta_m'' - \theta_m') \tag{6}$$

In the following, we will analyze a external wall (Figure 1) where the temperature distribution inside it varies according to the law below:

$$T = a + bx^2 \tag{7}$$

The wall thickness is δ =30 cm and the thermal conductivity is λ = 0,11 W/m*K (BCA).

For coefficient „a” the value is 20 ºC and for b is -20 ºC /m². We will calculate the thermal flux inside the wall.

3. RESULTS AND SIGNIFICANCES

The differential equation of conduction under the stated conditions is [11]:

$$\frac{d^2T}{dx^2} + \frac{Q^m}{\lambda} = 0 \tag{8}$$

$$Q^m = -\lambda \frac{d}{dx}\left(\frac{dT}{dx}\right) \tag{9}$$

$$\frac{dT}{dX} = 2bx \tag{10}$$

$$Q^M = 4{,}4\,\mathrm{W}/m^2 \tag{11}$$

Heat fluxes transferred through the two faces of the wall applying the Fourier eqation are [11]:

$$Q^m = 0 \; pentru \; x = 0 \tag{12}$$

and

$$Q^m = -\lambda \frac{dT}{dx} = -2\lambda bx = 1.32 \frac{W}{m^2} \quad for \; x = 0.3m \tag{13}$$

4. CONCLUSION

In the analyzed case, of a wall made of dim BCA with a thickness of 30 cm, we will obtain a thermal transfer resistance of 0.3/0.11, that is, 2.72 m^2K/W with a thermal flux accumulated inside the wall of 4.4 W/m2. If we choose to make the wall with a thickness of 0.6m, we will obtain a thermal resistance of 0.6/0.11, i.e. 5.45 m^2K/W, a value that falls within the European requirement regarding the energy performance of buildings (R > 4 m^2K/W). Moreover, the accumulated thermal flow doubles. The wall thickness of 0.6m also solves the problem of mechanical strength of buildings.In conclusion, the accumulation of heat in the construction elements limits the heat losses and keeps the thermal comfort parameters within limits and reduces the energy consumption of the building. On the other hand, the use of building materials with low thermal conductivity contributes to limiting the thermal transfer from buildings.

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Note:

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