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Școala Doctorală de Studii Inginerești

Behavior of certain types of buildings, connected to central heating systems or with local heating systems, to the partial or total disconnection of some apartments

Doctoral thesis - Abstract

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When establishing the topic of the doctoral thesis, we started from some findings related to the heating of living spaces.

In the case of heating blocks of flats, whether it is individual heating with apartment gas boilers, heating with a single boiler for the whole block or heating by connection to the district heating system, the following situations often occur: in a room in one apartment, one apartment, or even several apartments in a block of flats are temporarily suspended, in winter, their heating.

The interruption of the heating of some spaces in a condominium, leads both to problems related to thermal energy, but also to financial problems, related to the payment of heat by users.

These problems will become more acute as fuel, electricity and heat prices rise.

Heating of living spaces has always been a major issue, from the caves of primitive people to the present day, starting with family homes and ending with mega constructions.

The doctoral thesis deals with the issue of an equal heat demand in terms of the correctness of heating a room, by systematizing the information and experience gained during the actions carried out in this thesis.

At the structural level, the thesis is divided into five chapters, the first chapter defined the features of local heating systems and central heating systems and operational concepts used in research, and the four chapters present the chosen calculation program and analysis of results for the present situations. in the thesis. The role of the literature was to define the main operational concepts from general to particular cases of calculation of heat retention processes.

In Romania, the concept of individual heating based on natural gas has experienced a significant increase with the development of the natural gas distribution network. Natural gas heating is one of the most efficient ways to heat your home.

Although there are certain advantages, the consumer faces a certain degree of limitation in terms of thermal comfort.

This limitation is determined by how the system can respond to variable loads or operate economically under load-limiting conditions. This inconvenience can be mitigated or even eliminated by means of a dynamic adaptation of the system to the variation of the thermal load required by the consumers.

The first chapter begins with theoretical concepts on local and central heating systems for buildings or apartments.

Each of these systems has advantages and disadvantages.

For example, local heating systems ensure that the occupants of the house or apartment are independent of their neighbors; but they also have the disadvantage of the obligation to maintain and monitor the operation exclusively by the owners. Central heating systems have the advantage of customers not having to ensure the operation and maintenance of installations; but also the great disadvantage of being captive to that system, to the way it works and to paying a monthly bill, which depends on the management of the centralized installation, the fuel used, the wear of the entire installation, the human quality of the operators of this system.

Individual heating systems have been widely used in family-type homes and until the widespread development of centralized systems, they have also been used in large buildings, such as schools, hospitals or administrative buildings. Obviously, they had the great disadvantage of uneven space heating, of transporting fuel (wood and coal) to each stove and of cleaning each stove.

The first district heating systems appeared in antiquity in the Roman Empire. They worked with heat, hot air, distributed through ducts throughout the house. Then came declines and returns throughout history.

The best solution for heating a city is the district heating system. Optimal is the production of heat in a district heating plant (CET), but also the production of heat in thermal power plants (CT) is superior to the use of individual apartment plants or even block plants.

In the last 30 years in Romania, dozens of urban district heating companies have been disbanded, their place being taken by thousands of apartment plants.

In the first chapter, the central heating system in the city of Timisoara was described. Timisoara has a well-developed central heating system, hydraulically and thermally balanced, capable of providing the necessary to consumers in non-stop operation, both for domestic hot water and for heat. The heating system is 75% automated, and the equipment and machinery correspond to the latest technology, 75%.

If we talk about the heating of apartment buildings, whether it is individual heating with apartment gas boilers, heating with a single boiler for the whole block or heating by connection to the city district heating system, the following situation often occurs: an apartment or more many apartments in the apartment building suspend in winter for a period of time the heating of the apartment or several apartments.

In the following, the emphasis is on the thermal calculation for certain apartments and the temperature that is established in an unheated apartment is monitored, all the other apartments being heated. Several materials used for the thermal insulation of the building or apartments will be used. We will work on a real GF + 4 block case, in which we will choose some apartments that will be divided in such a way that we can use the calculation program used in the following chapters.

Buildings have different destinations, shapes and construction characteristics, and to establish the technical characteristics of heating equipment it is necessary to calculate the heat demand that expresses the amount of heat released by each room in the environment. Based on thermal comfort considerations, interior design temperatures are established for most rooms. In some cases, this may be due to technological considerations. In the case of unheated rooms, indoor temperatures can be determined on the basis of heat balance equations.

The heat demand for a home is determined by the heat loss through the walls, the heat demand for domestic hot water and the heat demand inside, taking into account other losses that may occur, such as heat loss. due to open doors or windows. The heat demand directly determines the energy consumption. In order to reduce energy consumption, the possibilities of reducing the heat demand by reducing the heat loss through the walls, the production of domestic hot water in storage mode, the decrease of the heat demand are first studied.

In calculating the heat demand, we must take into account both the calculation temperatures for the studied space and for the indoor spaces or those that provide the outdoor temperature. In this case we are talking about the uninhabitable apartments, where the thermostat valve is set to 0, the tenants being obliged to pay for the heat that will go directly to the uninhabitable apartment.

As for the spaces that are no longer heated, depending on the outside temperature and the heat inputs from the neighbors, a higher or lower indoor temperature will be achieved. In temporarily heated spaces, an indoor temperature will be achieved depending on the time and intensity of the local heating used, as well as the heat inputs from the neighbors.

Disconnected spaces will never reach temperatures equal to the outside temperatures, as these disconnected spaces will be heated indirectly by the adjacent warm spaces. In an individual building that is not heated, relatively quickly it reaches an indoor temperature approximately equal to the outdoor temperature, because in winter, in such buildings, the water freezes even inside the rooms.

It is very important to implement legislation in the future to structure equal consumption and I mention the fact that, at present, there is no legislation in which the tenant who does not live in that building is obliged to pay a share of the heat. There are certain occasional expenses of current monthly activity within the association, by the proportional distribution of the individual quota of each owner.

The need for heat depends on various factors, which usually cannot be controlled. In the case of residential buildings, the habits of the tenants influence the total energy consumption, while in office buildings, the pace of daily activity is predictable. The key is energy management and energy delivery.

Modern technologies provide sufficient methods for adjusting the entire equipment so that energy consumption is kept to a minimum. The main method of improving energy savings is to regulate heat consumption by season and day. The total heat demand of a building consists of the loss of heat through the building envelope, ventilation and domestic hot water. An important part of the thermal energy comes from independent sources such as: tenants, household facilities and solar radiation.

The need for heat varies considerably depending on the season and the time of day. In summer, heat is consumed only for the supply of domestic hot water and through network losses.

Increasing energy efficiency is a national and a European goal in the context of sustainable development.

In order to increase the energy performance of buildings, the climatic conditions of the exterior and location, the comfort requirements for the interior, the optimal level of costs, the requirements of energy performance, but also the urban aspect of housing are taken into account. In calculating the heat demand, we take into account both the calculation temperatures for the studied space and for the indoor spaces or those that offer the outdoor temperature.

As for the daily use of an apartment, its temperatures can vary, down or up.

Heat loss is taken into account in the calculation of heat exchange through all exterior surfaces and all interior surfaces of a room.

The calculation of the heat demand for heating a room is of particular importance, as it is the basis for sizing the entire heating system.

The heat demand of a space can be calculated with specially chosen programs that provide us with indoor temperatures depending on the situation of an apartment. In order for the theme of the paper to come as a solution to emphasize the heat requirement in a room or apartment, I developed a calculation program.

I adapted the program to the structure of the thesis and the size of the apartments studied, based on the following temperatures 24, 22, 20 and 18 degrees C, respectively. these being analyzed in the following chapters.

The program calculates, as I said, the effect of disconnecting from the central heating installation of an apartment located in one of the six zone variants of a block, on the temperature achieved in the neighboring apartments, both at the current level and at the upper and lower levels.

The program also calculates in particular the indoor temperature that is achieved inside the apartment disconnected from the central heating network. The temperature is also determined according to the location of the apartment, in our case central or on the corner, horizontally.

After these specifications and after entering the necessary data, the program recalculates the indoor temperatures in the disconnected apartment and in the apartments on the current floor, on the upper floor and on the lower floor, respectively.

Also, the apartment in question can be found on a middle floor, with a heated apartment above and below, can be found on the ground floor of the block, with a heated apartment just above, or can be found on the top level of the block with a heated apartment just below.

In the second chapter, the following areas were taken into account for the calculation program: Se11, Se21, Se31, Se12, Se22, Se32 of 6m2, and Si1, Si2, Si3, Si1a, Si2a, Si1b, Si2b of 1m2 with double glazed windows, non-thermally insulated walls on the outside, inside they are insulated with moisture-resistant plasterboard.

A soil temperature of 5˚C and an outdoor temperature of -15˚C were also taken into account, while the indoor temperatures will be 24˚C, 22˚C, 20˚C and 18˚C.

The calculation of the heat demand allowed me to conclude that, in the case of an outdoor temperature of -15 ° C, a lower indoor temperature is achieved in the apartment disconnected from the central heating network, because this temperature level is achieved exclusively. based on the input of heat from the surrounding apartments. But a thermal balance is achieved, which is favorable to the disconnected apartment and totally unfavorable to the surrounding apartments.

It is observed that the most disadvantaged apartments are those that come in direct contact with the disconnected apartment, but also the apartments located above and below the disconnected apartment. This disadvantage can also be seen in the heat transfers made, as the apartments above and below contribute the most.

Following the thesis, it is desired to analyze the influence of the insulation of the exterior walls of an apartment on the energy consumption with heating of the constituent rooms and for this reason

Choosing the best type of thermal insulation for a building can be a real challenge, but the goal is always the same, forming a building envelope that prevents heat transfer from the inside to the outside or vice versa, thus giving energy performance.

To be considered thermal insulation and suitable for the thermal insulation of a building, a material must meet the following characteristics: the thermal conductivity of the calculation must be less than or equal to 0.10 W.

The material used for thermal insulation of the building can be classified according to several criteria, but the most important factor is the overall thermal insulation coefficient of a building (G), which is an energy parameter of the building envelope as a whole and has the significance of a sum of dissipated heat fluxes (heat loss by direct transmission) through the surface of the building envelope, for a temperature difference between inside and outside from 1K, relative to the volume of the building, to which are added those related to the refreshment of indoor air and infiltration additional cold air.

The thermal insulation for the walls of the building can be internal, external, depending on the thermal area of the building.[44] From the multitude of thermal insulation materials, we chose for the comparison of heat loss the following materials: expanded polystyrene with a size of 8 cm, brick with insulating filling and here we will discuss POROTHERM TERMO PLUS of 36.5 cm, extruded polystyrene and basalt mineral wool.

For the calculation program used on disconnecting a room for exterior walls insulated with expanded polystyrene with a size of 8 cm, the following dimensions were taken into account: L1, L2 and L3 of 10m, H1 and H2 of 3.4 m and H of 2.7 m. Regarding the surfaces, we find the following dimensions: Se11, Se21, Se31, Se12, Se22, Se32 of 6m2, and for Si1, Si2, Si3, Si1a, Si1b, Si2a and Si2b we find an area of 1m2.

For longitudinal exterior walls, we have a thermal coefficient of 0.312 W / m^2.K, for transverse exterior walls, the coefficient is 0.348 W / m^2.K, for ceiling and floor is 0.5 W / m^2.K, interior walls are 1.7 W / m^2.K, exterior doors and windows are 2.3 W / m^2.K and interior doors and windows are 2.5 W / m^2.K.

In the case of exterior walls insulated with thermal insulating brick, for longitudinal exterior walls, we have a thermal coefficient of 0.21 W / m^2.K, for transverse exterior walls, the thermal coefficient is 0.21 W / m^2.K. The heat loss shall be calculated for the schematic building used in the calculation in Chapter 2, having the outer walls insulated with 10 cm extruded polystyrene, but also insulated with 10 cm basalt mineral wool. Only a calculation will be made for these materials.

In this case, for the longitudinal exterior walls, we have a thermal coefficient of 0.259 W / m^2.K, for the transverse exterior walls, the thermal coefficient is 0.263 W / m^2.K. For the four cases, the indoor temperatures of 24˚C, 22˚C, 20˚C and 18˚C were used.

The results of these calculations in Chapter 3 suggest some discussion of the different thermal and economic insulation. It can be concluded that there is an increasing emphasis on the most efficient use of energy in buildings because the building sector is responsible for the final energy consumption.

Energy efficiency spending should rather be seen as an investment that can lead to a revitalization of the construction sector and, in the long run, to a reduction in energy consumption and, consequently, energy costs.

This subchapter will cover issues related to the indoor temperatures of insulated rooms with the materials analyzed in this chapter, while providing a comparison of temperature results for insulating materials.

In construction, the laws of heat transfer have certain application features, generated by the geometric shape and the complex construction of most elements of the building envelope.

The response of buildings to heat transfer can be appreciated by their ability to keep the oscillations of the temperature of the indoor air and the temperature of the interior surfaces of the closing elements within the limits of thermal comfort.

From a technical point of view, the response of buildings to heat transfer can be assessed by the heat flow through the closing elements or by the thermal resistance that the closing elements oppose to the propagation of the flow.

In the following, a case study (Chapter IV) is proposed on a P + type residential building with a number of 6 apartments.

After presenting the usefulness of the calculation program, applied to a theoretical set consisting of 6 identical spaces in plan dimensions, the emphasis is on the behavior of real spaces, when a room is completely disconnected from the heating system of the building of which it is part.

For this real case, in the case study, we chose an existing block of flats, named by the designer, block C 34.

The calculations will be performed only for two indoor temperatures: 24 ° C (for residents eager for higher thermal comfort) and 20 ° C (for residents who endure a lower indoor temperature, but also achieve financial savings at the same time).

The first calculation will be made for walls without thermal insulation. The second calculation will be made for exterior walls insulated with a layer of expanded polystyrene. The third calculation will be made, considering the walls made of thermally insulating bricks. The two thermal insulation materials were discussed in Chapter 3.

In the same chapter, the constant data for the indoor temperature of 24˚C and 20˚C are calculated. The following dimensions are used: L1 and L2 of 4.2 m, L3 of 3.6 m, H1 and H2 of 4.8 m and HH of 2.7 m.

Within the surfaces, we find the following data: Se11, Se21, Se12 and Se22 of 2.6 m2, Se31 and Se32 of 1.3 m2. For Si1, Si2, Si3 we have an area of 0 m2, and for Si1a, Si1b, Si2a and Si2b an area of 1.6 m2. The indoor temperature, in all three cases, is 24˚C and 20˚C.

In the case of normal brick exterior walls, for longitudinal exterior walls, we have a thermal coefficient of 1.2 W / m^2.K, for transverse exterior walls, the thermal coefficient is 1.3 W / m^2.K, for the ceiling and floor 0.5 W / m^2.K, 1.5 W / m^2.K interior walls, 1 W / m^2.K exterior doors and windows and 1 W / m^2.K interior doors and windows.

In the case of exterior walls insulated with expanded polystyrene with a thickness of 8 cm, for longitudinal exterior walls, we have a thermal coefficient of 0.312 W / m^2.K and for transverse exterior walls, the thermal coefficient is 0.348 W / m^2.K.

In the case of exterior walls insulated with brick, thermal insulation with a size of 36.5 cm, for longitudinal exterior walls, we have a thermal coefficient of 0.21 W / m^2.K and for transverse exterior walls, the thermal coefficient is 0.21 W / m^2.K.

I would like to point out that all the calculations made according to the proposed topic for the doctoral thesis and the results of these calculations are less addressed to specialists in the field of thermal energy and heating installations in residential buildings - who know very well the problems raised in the doctoral thesis. -it is addressed to all persons who have decision-making power (from the local level to the highest level in our country) and who can introduce regulations or laws in this field.

All the calculations clearly showed that in the case of residential buildings (blocks with several apartments) by temporarily suspending the heating of a room, an apartment or even several apartments during the winter, in unheated spaces their temperature will not reach equal to the temperature external, but will always have positive values.

It was determined by the calculations that the temperature of these unheated spaces will be higher or lower, depending on the indoor temperature of the heated spaces, adjacent, the location of these spaces in the building and the quality of the exterior walls of the building (uninsulated or thermally insulated walls).

The calculations made in different working hypotheses were presented in detail in chapters 2, 3 and 4 of the doctoral thesis.

The conclusions resulting from the research within the doctoral thesis open the following perspectives:

- If a room in an apartment is not heated, the owner of the apartment will have a lower gas bill. But the calculations made in the thesis show that the owners of the neighboring apartments with the unheated space will have higher gas bills, in proportion to the heat transmitted through the walls to the unheated space.
- If a room in an apartment is not heated, the owner of the apartment will have a lower bill. But the calculations made in the thesis show that the owners of the neighboring apartments with unheated space will have higher bills, in proportion to the heat transmitted through the walls to the unheated space.
- If a room in an apartment is not heated, the owner of the apartment will have a lower heat consumption, so a lower bill. But the calculations made in the thesis show that the owners of the neighboring apartments with unheated space will have higher bills, in proportion to the heat transmitted through the walls to the unheated space.
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Heating systems have diversified and mainly switched to local heating with apartment heating systems, with natural gas.

In some blocks, all the apartments were disconnected from the central heating system, switching to local heating with natural gas, in other blocks some apartments were disconnected from the central heating system, others remained in the central heating system.

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