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Impact of Material on Energy Efficiency of Distribution System

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Abstract:

The article focuses on technologies that are closely linked to the use of renewable energy sources. We are living at a time when the emphasis is on increasing the share of production and use of heat and electricity generated by technologies using the sun, wind, water and earth. By transforming energy from sources like the Sun and the Earth, we use solar, photovoltaic collectors, heat pumps and circulation systems. Energy production in these ways is limited, therefore the research and development of individual systems is pushing the possibilities of using renewable energy sources forward. The main objective of obtaining energy from renewable sources is to cover the energy performance of buildings and people's requirements to ensure optimal thermal comfort with maximum use of energy from renewable sources. When designing the required technologies, it is necessary to emphasize the choice of construction material for individual parts of the energy system. If we want to extract energy from the earth it is necessary to design a material suitable for aggressive soil environment - the Earth's shell. The negative impact of soil chemical and physical properties affects not only the material structure of a part of the technology, but also the overall efficiency of the energy system.

Keywords: accumulation; corrosion; exchanger; soil; solar system

1. Introduction

Increasing the share of the use of renewable energy sources is one of the most important goals of the European Union countries through which energy independence can be achieved. First of all, the focus is on renewable sources (solar, wind, geothermal, water, biomass), which are most accessible to the regions / countries concerned (Dudak, 2017). The most accessible source is the Sun and its energy, which can be transformed by several devices (collectors - flat, concentric), depending on the intensity of solar radiation and the useful life during the day (Hoskins, 1997).

In Slovakia, but also in other similar European countries, depending on the seasons, it is necessary to ensure the transformation of energy into heat (winter, spring, autumn), but also during the summer, when it is necessary to cool the buildings. Typical ways to achieve cooling

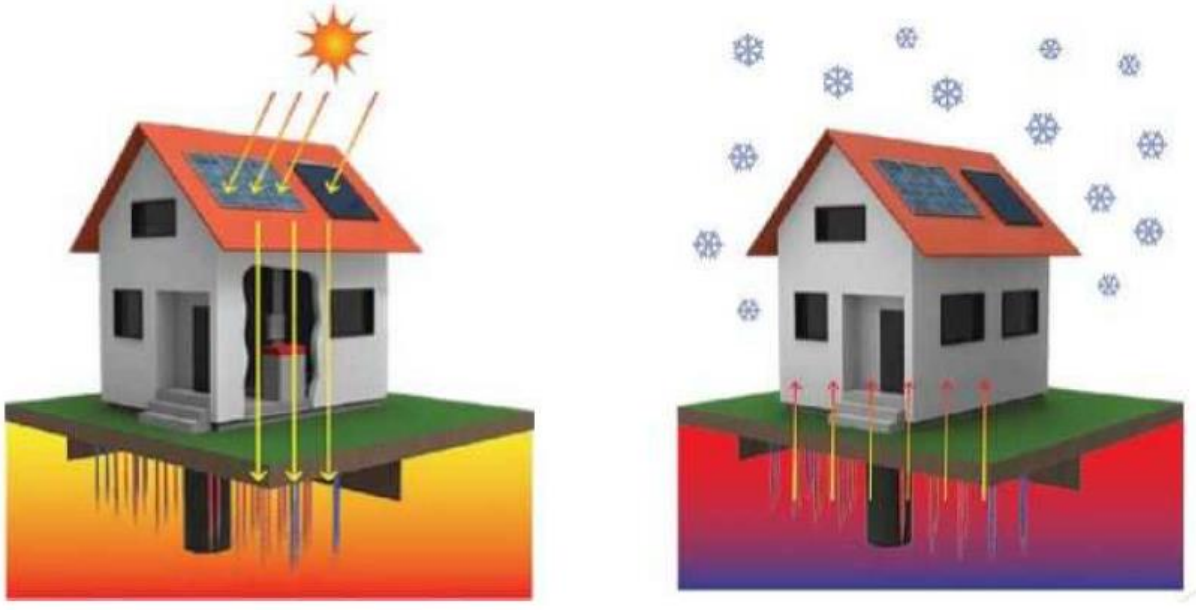
of objects is to use air conditioners (Florkova, 2017). Based on the studies carried out, it is possible to consider these devices as energy-intensive and in the case of incorrect adjustment and maintenance, they are harmful to health. From the point of view of elimination of operating costs and harmfulness of air-conditioning systems, the article will introduce a system of utilization of heat and cold from the ground, which represents a comprehensive solution for buildings in terms of ensuring thermal comfort with efficient use of renewable of resources throughout the year (Kalra, 1998).

2. Earth energy storage

The system of natural energy storage is the connection of energy sources (thermic, photovoltaics, heat pumps) with the system of heating, hot water production, cooling, heat energy storage and utilization of waste heat in buildings, buildings, greenhouses, family houses, apartment houses, heating plants, buildings and agricultural buildings with the cooperation of solar radiation with technological equipment to the ground floor around the buildings. This energy system was developed for the purpose of energy security, exclusively through the use of renewable resources (Orazem, 2014) (Sposito, 2008).

The main motivation in the development of this system was to use installed systems in the area of renewable resources in the most effective way in order to prevent their stagnation. The question was how to deal with excess energy and how to save the energy obtained for the necessary period until consumption. Therefore, the idea arose to exploit the energy potential of the geological subsoil, which, in terms of availability and energy storage capacity, has a wide range of options under certain conditions.

Figure 1: Operation of the earth energy storage system in summer and winter mode.



Based on this requirement, research and development activities were carried out in the field of exploring the potential for storing excess thermal energy in the geological subsoil. A special energy needle is used to transport energy to and from the geological subsoil. The system for transporting thermal energy through energy needles during the winter and summer periods is shown in (Fig. 1).

Overall, the system itself consists of energy sensors, energy exchangers, energy reservoirs and energy needles (serving as a heat exchanger in the subsoil) using several well-known devices along with industrially protected elements. The stored energy in the underground storage can be distributed to the building via floor, wall and ceiling systems with the assistance of mini-heat pumps and in the future other equipment currently under development. ([6,8,9])

2.1.1 Implementation of research and development activities

Research and development activities were divided into several areas. As part of the initial considerations, it was addressed how thermal energy will be transported. From the economic point of view, the shape of the energy needle was developed and its installation into the geological subsoil was realized on the basis of the helix formation around the periphery of the energy needle. ([5,7,10]) In this way, two important aspects have been achieved. The first allowed easy installation - the location in the form of screwing and the second was in the form of increasing the heat exchange area. The screwing principle also contributes to the compaction of the subsoil around the energy needle, resulting in an increase in the overall heat transfer coefficient. After the development of the energy needle, laboratory measurements were carried out (Fig. 2), where the process of overall transport of thermal energy into the soil was investigated and its thermophysical properties were determined.

Figure 2: Testing of transport of thermal energy to geological subsoil in laboratory conditions by means of energetic needles.

Soil temperatures and moisture levels were recorded at various levels of the experimental apparatus, from which it was possible to determine how thermal energy propagation processes were taking place. The overall process of heat transfer and propagation was carried out by means of computer technology and software support various simulations, where the cases of geological subsoil properties were analysed in dependence on increasing and decreasing the percentage of moisture.

2.1.2 Earth heat accumulator

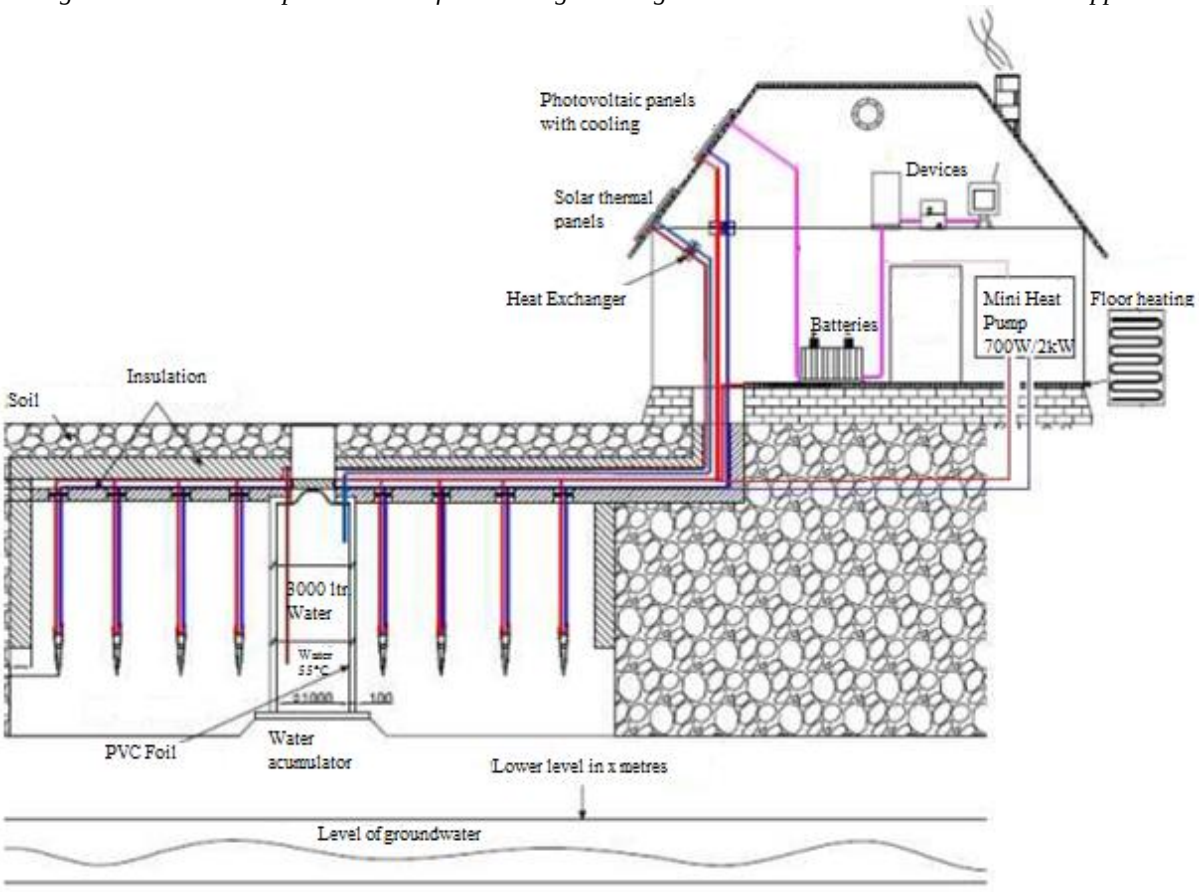
A natural heat storage is a device whose task is to store energy for future use, that is, to transfer, store energy from summer and use it efficiently in winter ‘‘. The implementation of the natural gas storage is based on the following data:

- thermophysical properties of the geological subsoil (subsoil composition - gravel, sand, clay, rocks, etc.),
- groundwater level,
- The required amount of thermal energy storage.

The size and capacity of the earth tank is always dependent on the energy requirements for achieving thermal comfort of the objects. In the case of agriculture, energy from the natural gas storage can be used to extend the production time of crops.

An essential part of the earth reservoir are energy needles, whose task is to transport thermal energy to and from the earth reservoir. The energy needles are connected to the energy sources (solar thermal collectors, photovoltaic panels - driving mini-heat pumps). When using thermal collectors, the thermal energy is directly distributed through the heat transfer medium and by means of a circulation pump to the energy needles. In the case of using photovoltaic panels, the obtained electrical energy is used for the operation of the mini-heat pump, which draws low-potential energy from the air during the summer (either in the building - cooling or directly from the surroundings). The utilization of stored energy in the earth reservoir is based on the fact that if the temperature of the subsoil in the earth reservoir is more than 30 ° C, this energy is directly supplied to the floor system. If the temperature in the ground storage compartment is below 30 ° C, a mini-heat pump is used, which, by supplying electrical power, raises the temperature to a higher potential, which is then supplied to the floor system.

Figure 3: Schematic representation of a natural gas storage tank with connection to sources and appliances.



The earth tank can also be used for cooling purposes. Energy needles are not connected to energy sources (thermal panels, heat pump, ...), but are connected to ceiling panels, located in buildings that provide radiant cooling. In this case, the fact that the geological bedrock is lower than the ambient temperature is exploited. The advantage of this cooling system is that it has no noise and is significantly less energy-intensive compared to air conditioning. As part of the health impact of the systems, it does not create room for bacteria to multiply, nor does it create a forced air flow in the interior, resulting in a reduced susceptibility to cold.

3. Conclusion

The aim of the changed energy storage is to achieve, as far as possible, energy independence from fossil fuels while ensuring sufficient thermal energy storage. Currently, the results of research and development are implemented in objects - installation of systems within an innovative project with a controlled control system. By means of the mentioned systems and elements of architecture - design (Socratic and Hypocaust principles) it is possible to achieve energetically active and positive object. This means that by using different geometric shapes the object is designed in such a way that the object does not overheat during the summer (minimizing the cost of running air conditioners). In winter, the geometric shapes of the building and geology allow the use of solar rays to transform heat and electricity directly, ie without loss. The implementation of these principles will achieve an object that will produce more heat, cold and electricity during its existence than it will need for construction and operation, but also for final demolition and recycling.

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