GEOTHERMAL HEAT SUPPLY SYSTEMS SMART HOME. USE OF MATHEMATICAL MODELS TO ANALYZE THE EFFECTIVENESS OF THE HEATING SYSTEM

A. O. Gorkunov, S. V. Shidlovskiy
Tomsk Polytechnic University

In this paper, we investigate mathematical models of geothermal heating systems, smart home. Comparing two space heating system: radiator and floor heating. The review illustrated distributions of temperature fields and flow rate on the premises.

Key words: alternative energy, geothermal energy, petrothermal, heating system, floor heating, alternative energy, smart home.

At present, the rapidly developing low-rise building houses organized by the "smart house". Such housing provides high levels of comfort, autonomy and sustainability. In connection with these requirements relevant to explore several types of heating systems of "smart" home.

The purpose of this paper is to examine the mathematical models of geothermal heating systems, as part of the "smart home".

Problems solved during the execution of work:

• overview of geothermal energy;

• the creation of mathematical models of the systems under consideration;

• comparison with standard heating system;

• analysis of the effective implementation of geothermal heating system in smart home.

In the private sector, on the basis of a smart home, it is possible to arrange with low power consumption through the introduction of alternative energy supply. Technical reliability of such systems is quite high, in addition durability can be on the order of 25-30 years.

Geothermal energy - the energy direction, based on the production of electric energy due to the energy contained in the bowels of the earth, geothermal plants.[1]

Basically, geothermal energy is divided into two areas: petrothermal energy and hydrothermal energy.

The basis of this type of energy is the energy contained in petrothermal hot rocks (Fig. 1) is heated by deep conductive heat flow.

It is now widely used petrotermal energy shallow wells (up to 1 km.), Which establishes the borehole heat exchangers using a fluid with a low boiling point (eg, freon) to provide homes with electricity, hot water and heating. Petrotermal energy deep wells (over 1 km), at the moment, is hardly ever used. [2]

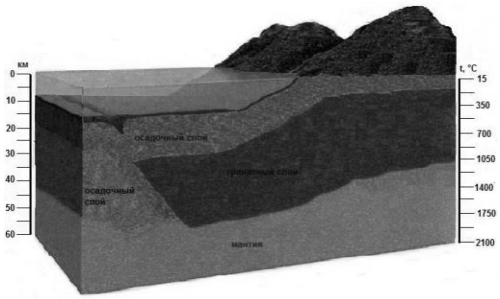


Figure 1 – The geothermal gradient in the specific area of the earth's strata

Structurally petrothermal energy can be divided into two types: external contour with horizontal and vertical outer contour.

With horizontal outer contour - the most common type of construction (Fig. 2) for petrothermal energy for heating and hot water systems of buildings with relatively small areas and a large area of the site is not provided to any other constructions.

A vertical outer loop. The main advantages of this type of construction the outer contour of the heat pump are easy stacking circuit, short installation and high efficiency.

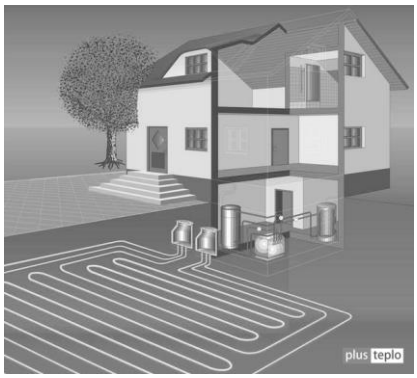


Figure 2 – Horizontal outer contour of the heat pump an apartment house

The main disadvantage of this system is a significant effect of low temperatures on the ground, since it affects the depth of soil freezing.

Figure 3 – The outer loop heat pump vertical type

In the prepared project design with selected external horizontal loop at a depth of 2.5 meters. The average temperature of the heating season in the city of Tomsk – minus 6,7ºC, the depth of soil freezing 2,2-2,4 meters.

The advantage of the chosen heat pump system with a horizontal outer contour is the high efficiency of conversion of low-grade energy (expended on 1kW output 4-7kW) land (4 °C) when the outside air temperature is not lower than -20 °C. To generate the necessary power installation at lower outdoor temperatures connects electro.

To analyze the number of characteristics in the room are two 2D-models[3,4]. The first model (Fig. 4) is a cross-section of the room with the initial conditions wall - floor heating, velocity_inlet - window, outflow - vent.

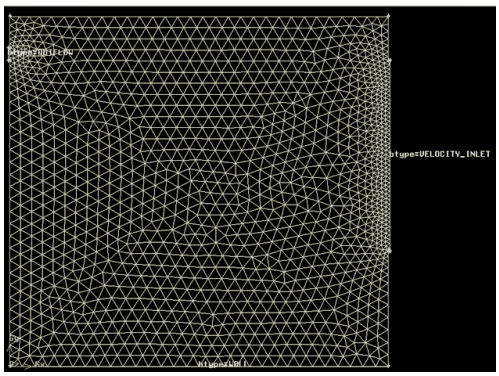


Figure 4 – Model room with underfloor heating

The second model (Fig. 5) is also a cross-section of the room with the initial conditions wall - radiator (battery), velocity_inlet - window, outflow - vent.

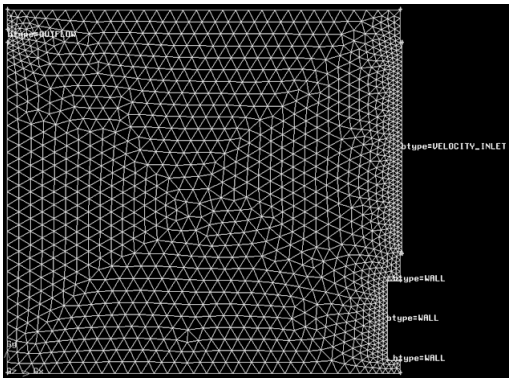
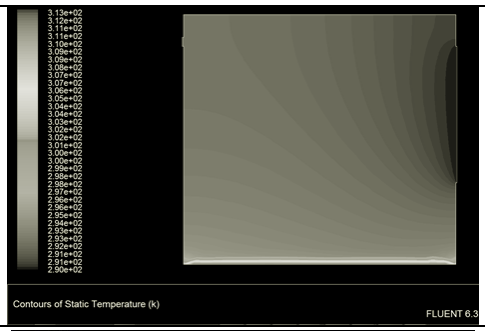
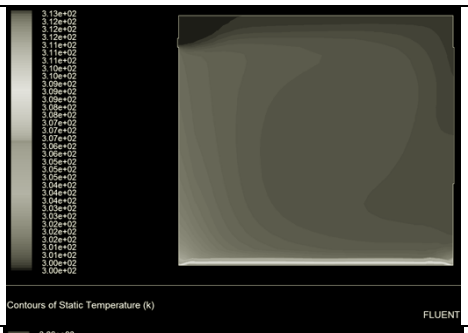
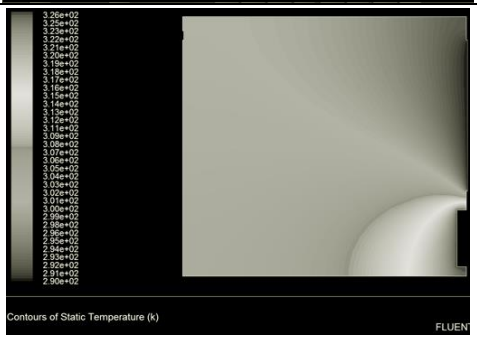
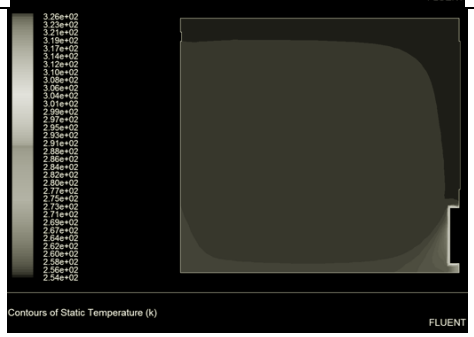


Figure 5 – Model of the room with radiators

For investigation distributions of the temperature and velocity of air in the room, the input conditions such as the temperature of the heating surfaces, flow type flow characteristics of the working fluid, the flow rate of inlet flow.

The simulation results are shown in Table 1.

Table 1 – Comparison of heating systems

Type of system	With closed window	With open window
Warm floor		
Radiator		

The studies we can conclude that the heating system is a floor heating with the most comfortable for the person in finding the room (the most uniform temperature distribution in the room), in addition to this, it is more economical in energy consumption and hi-tech. According to the results, we can say that the systemheat pump units with under-floor heating system meets the requirements of "smart home" and recommended for implementation.

REFERENCES

1. Dvorov I.M. geothermal heat / Editor.Ed. Doctor of Geological and Mineralogical Sciences A.V.Shcherbakov. - M .: Nauka, 1972 - 208 p.
2. Shetov W.H., Butuzov V.A. Geothermal energy // Energy saving. - 2006 - № 4. - S.70-71.
3. The construction of computational models in the preprocessor Gambit universal software package Fluent: Proc. Manual / O.V.Baturin, N.V.Baturin, V.N.Matveev - Samara: Publishing House of Samar. state. aerocosm. University Press, 2009.– 172 p.: ill.
4. Calculation of flows of liquids and gases using a universal software package Fluent. Proc. Manual / O.V.Baturin, N.V.Baturin, V.N.Matveev- Samara: Publishing House of Samar. state. aerocosm. University Press, 2009.– 151 p.: ill.