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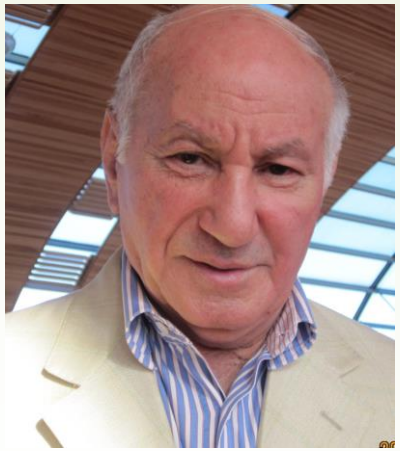

Development of Solar Heating Facilities for a House and Method of its Design

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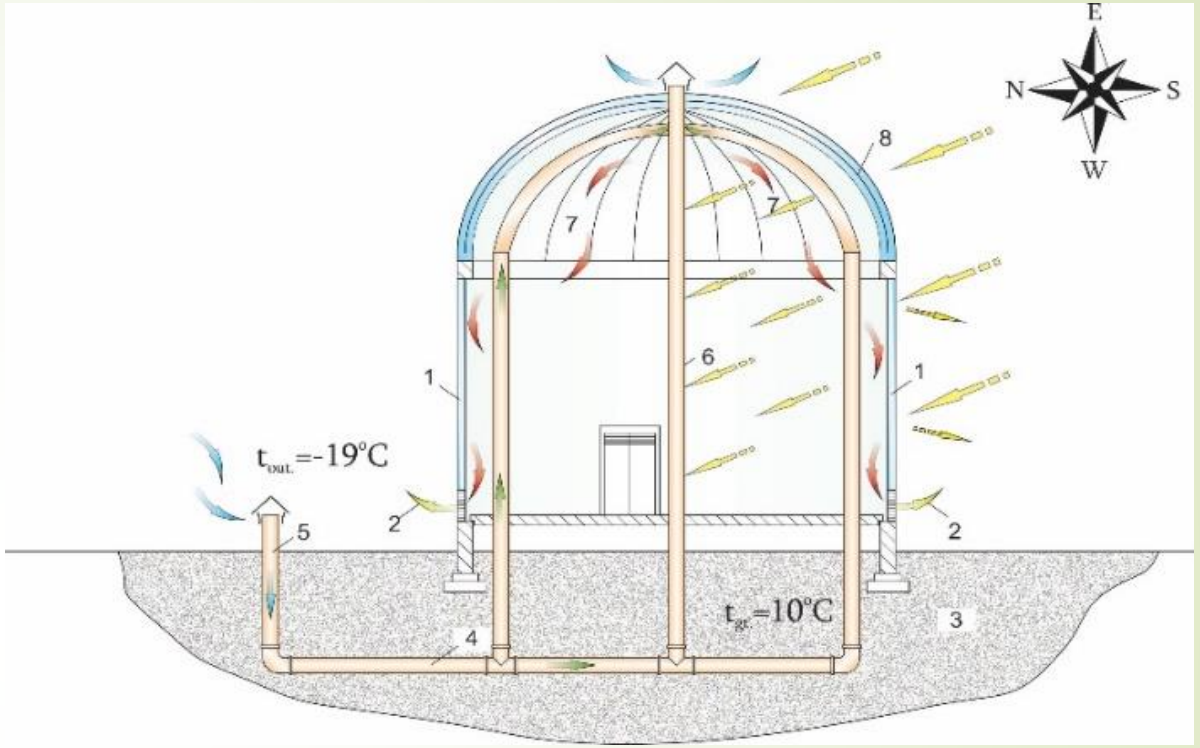
ABSTRACT

- In recent years the solar energy has found wide use for different purposes. It has been energy resource for hot water preparation and supply, for generation of electricity, for ventilation of buildings, and in a range of industrial buildings, etc. The exception in this areas have made the wintertime solar heating of residential, public and industrial buildings, which is due to the climatic conditions of the geographical areas. As well as the insufficient energy intensity of the sun and the large fluctuations in temperature during the day. Apart from above-mentioned reasons, the problem has not been solved due to the lack of necessary technologies of efficient use of solar energy for heating purposes. In order to eliminate the mentioned disadvantages, the authors of this article have suggested new type of heating and ventilation combined systems. For both of mentioned heating and ventilation systems as working substance have been chosen the outside fresh air.

INTRODUCTION

- The main goal of this research first of all is the belief persuasion and conviction in possibility of creation and maintaining of worm environment in houses during heating season without consuming of natural or artificial heat sources for heating of houses which are located in cold climatic conditions and do not consume natural or artificial energy. This system allows creating comfortable environment for aged people who are staying in the rest houses for "Holyday Inn" The subject of investigation is given in Figure1.



- Figure 1. Newly developed structure of solar house.
- 1- glass walls of the experimental house, 2-heat recuperation from used ventilation exhaust air, 3- ground layer, surrounding the house, 4- 6- pips for transportation of air to the dome space, 7- dome space, 8- glass dome.

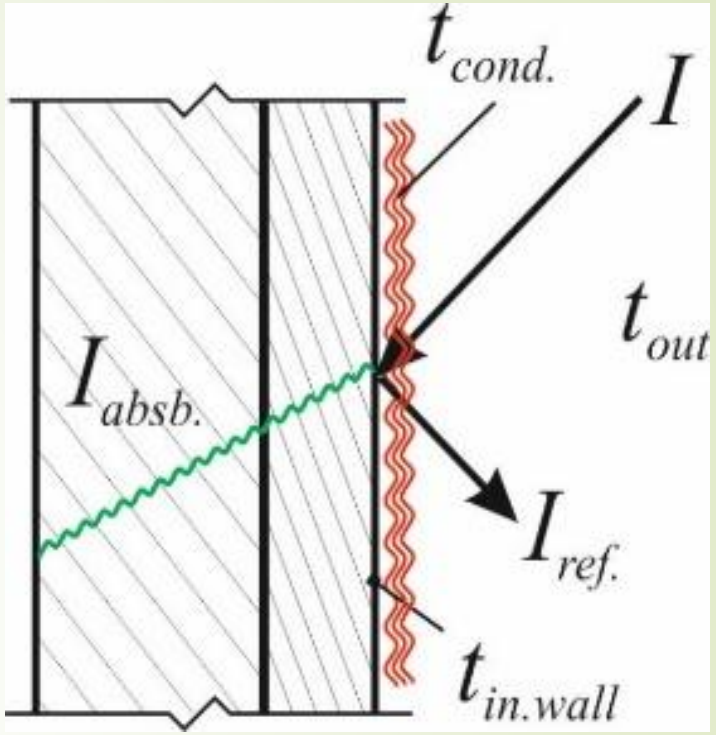
Operation of the System

- *Winter regime*
- The main structural elements of the house are 5 mm thick glass sheets and pipes serving for transportation of substance air to the dome space. The operation of this system is executed in the following way: the outside air enters into the duct (5) and flows to the underground pipe (4). During of this dislocation the air absorbs geothermal heat from the ground and gets warm up to the temperature of the ground, which makes approximately t_{gr}=10°C. Then the warmed air enters into the vertical pipe (6) which is lighted by solar rays that penetrated into the house through the 5mm thick glass sheets of the wall. In this process the solar heat is transferred to the substance air which is flowing in the pipe (6). Then warmed air up to the (7). Here the heat of the air is rejected from surface of pipe (6). Then warm air is spread under dome space (7) and then evacuated through (2) recuperator.
- The natural heat sources which are available in the proximity of the house: direct solar radiation, penetrates into the house through 5 mm thick glass walls and gets absorbed by the inside surfaces of the house. For this reason, the average value of radiation temperature of the walls' surfaces should be determined by the method of conditional temperature which is given in this article.
- *Summer regime*
- In the summer cooling regime, hot air enters into the air duct (5), and then moving through the underground pipe (4) transfers heat to the ground is cooled approximately to the ground temperature. The cooled air through the vertical pipe (6) enters into dome space (7) and after absorbing the internal heat is discharged to the outside through the recuperator (2).

Method for Calculation

- For the correct design of suggested new solar house structure, the following needs to be determined.
- conditional temperature,
- heat gain through windows,
- underground pipe diameters and length
- *3.1 Determination of the conditional temperature of boundary layer of air on the surfaces*
- On the surfaces of opaque constructions, because of the simultaneous influence of temperature and solar radiation the temperature of the surface become higher than outside air temperature. The absorbed part of the solar rays depends on the properties of the surface. Ideally it doesn't depend on the kind of material, the dominant factors are the color and roughness.
- The conditional temperature is determined by the following formula:

$$t_{\text{cond}} = t_{\text{out}} + \frac{IP}{\alpha_{\text{out}}}$$



- Figure 2. processes of absorption and reflection of solar rays on the surface

- Actually the formula determines the temperature of the surface, but we call it conditional because the same temperature purchases the boundary layer of the air contacted with the surface, as shown in the Figure 2.

- *3.2 Calculation of heat gains through windows*
- Like walls the solar radiation lights the windows of different orientation at different times of the day (Melikyan). For the same reason the impact of solar radiation on heat gains should be taken into account only for the windows which are oriented to the south. Therefore, the total value of heat gains ($\Sigma Q_{h.gain.wind.}$) through all windows of a house including the south window is calculated by the following equation:

$$\Sigma Q_{h.geins.wind} = Q_{h.geins.south.wind} + \Sigma Q_{h.geins.other.wind}$$

- The heat gains through south windows take place by heat transfer ($Q_{wind.heat.transf.}$) and by direct penetration of solar radiation through the glass transparent surfaces ($Q_{wind.radiation.}$). The heat gains through south windows by heat transfer ($Q_{wind.heat.transf.}$) takes place because of outside and inside airs temperature difference ($t_{out} - t_{in}$). For this purpose the heat transfer equation for window is used:

$$\Sigma Q_{.\text{wind.heattransf.}} = F_{\text{south.wind}} K_{\text{wind}} \left(t_{out} - t_{\text{in}}\right)$$

- The heat gains through south windows by direct solar radiation through glasses ($Q_{wind.radiation.}$) the following equation is used:

$$Q_{\text{wind.radiation}} = IF_{\text{wind.}} n_1 n_2 n_3 \beta$$

- The total value of heat gains $\Sigma Q_{h.gain.wind.}$, W through all other orientation windows of a house can be determined again by the help of heat transfer equation.

$$\Sigma Q_{h.geins.other.wind} = \Sigma F_{\text{other.wind}} K_{\text{wind}} \left(t_{\text{out}} - t_{\text{in}}\right)$$

- 3.3. Underground pipe diameters and length
- To provide the necessary parameters of the microclimate in the rest houses, it is necessary to correctly select the diameter and length of the pipe laid in the ground. For these purpose necessary to know the required quantity of fresh air, which is supplied through a pipe (4) laid in the ground to the under the dome. In addition, it is necessary to correctly determine the required load of heat and cold. Besides that, necessary to determine the required load of heat and cold for the house.
- The underground pipe diameter can be determined using the following formula

$$d = \sqrt{\frac{4G_{air}}{\rho_{air}\omega_{air}}}$$

- Heat transfer process between ground and underground pipe can be determined by the help of following formula (Melikyan 2012)

$$Q_{gr} = \frac{\pi l_p \left(t_{gr} - t_{air}\right)}{\frac{1}{\alpha_{air} d_p} + \frac{1}{2\lambda_{gr}} \ln \frac{d_{gr}}{d_p}}$$

- From the formula follows the following equation, by which can determine the required pipe length laid in the ground:

$$l_p = \frac{Q_{gr}}{\pi\left(t_{gr} - t_{air}\right)\left(\frac{1}{\alpha_{air} d_p} + \frac{1}{2\lambda_{gr}} \ln \frac{d_{gr}}{d_p}\right)}$$

- A psychometrics diagram can be used to determine the required amount of heat transferred from the ground to the air flowing in the underground pipe.

CONCLUSIONS

- The suggested construction of new type building and method for its calculation allow developing, designing and implementing energy efficiency ventilation and heating of rest houses and saving large quantities of fuel,
- The proposed structural design of a solar house allows for expediently organizing a heating and ventilation system for the rest houses.
- Suggested structural design allows organizing the cooling system using natural resources such thermal potential of ground.