PARTICULARS OF RESEARCH ON SOLAR COLLECTORS USED IN A HOUSE IN THE MOUNTAIN

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Abstract : *This paper highlights some features of solar collectors that can be used in mountain resorts for domestic hot water preparation during the warm period but also during the rest of the period.*
In winter, efficiency is lower for some solar collectors. Direct capture of solar energy involves artificial means, called solar collectors, which are designed to capture energy, sometimes by direct focusing of the sun's rays. The energy once captured is used in thermal, photoelectric or photovoltaic processes.

Keywords): *solar energy, solar collectors, vacuum tubes*

1. INTRODUCTION

Solar energy has proven to be an alternative source of energy. Today solar power is used worldwide to produce various types of energy, lighting energy, photovoltaic modules, domestic hot water, solar collectors.
Lately, on the background of reducing energy consumption from conventional sources, it has been speculated that an alternative might be solar energy, more specifically solar energy.
The availability of this energy depends on the day-night cycle, the latitude of the place where it is captured, the seasons, and the degree of cloudiness. Against the backdrop of reducing gas emissions and pollution a viable alternative may be the use of technologies that work with solar energy. In thermal processes, solar energy is used to heat a gas or liquid, which is then stored or distributed.

2. MATERIAL AND METHOD

The energy potential of Romania, resulting from the amount of solar energy, is estimated at 1000 kW / m2 and year, the geographic distribution of the potential is made up of 5 zones, of which the zero area has potential over 1250 kW / m2 and year. area 4 below 950 kW / m2 and year. Solar radiation above 1200 kW / m2 and year is more than 50% of the total area of the country. In solar-weather conditions in Romania, a thermal solar collector operates under normal safety and efficiency conditions throughout the year with yields that can reach 90%. [3]
Figure 1 shows the solar potential in Romania, depending on the regions distributed by color codes depending on the intensity of the solar radiation. [1]
The solar collector is the essential element of an installation that converts the solar radiant energy into another useful energy form. The solar collector works by heating a liquid (usually water, oil, air or glycol), which then crashes the heat of the heat system
At the present stage of development, the cost of the collectors is 70 ÷ 90% of the cost of the solar installation, depending on the type of installation, and the area of the collectors will be directly proportional to the power of the installation, well understood by the output. The average share of the cost of the collectors in the total cost of the plant is approx. 77%. This means that a 70% reduction in the cost of the collector leads to a reduction of approx. 37% of the total cost of the plant, which led the largest research effort to study the possibilities of increasing the yield of the collectors.
Other proposals to increase the efficiency of solar installations include the possibility of operating the collectors at high temperatures, which would mean a further increase in plant efficiency.

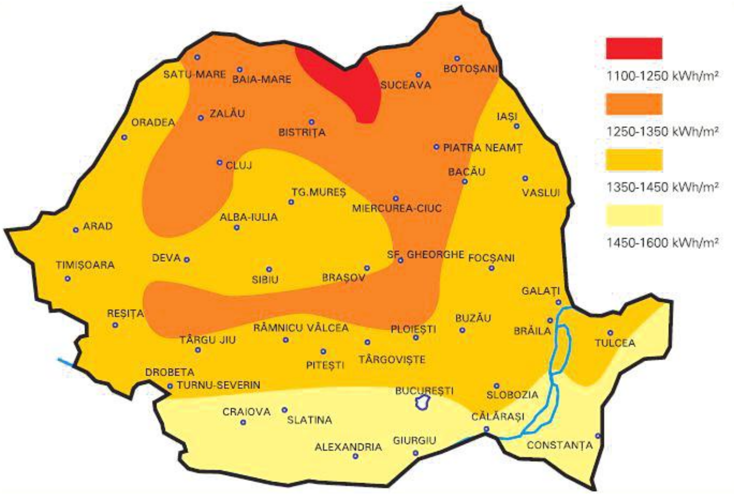

Figure.1 *Shows the map of solar radiation in Romania [2]*

In addition, high-temperature capture devices allow simpler and therefore cheaper storage.
Solar collectors can operate with superior efficiency in hybrid mode with other conventional, conventional or unconventional heating systems. In order to increase the efficiency of the systems, lighter materials have to be used in the construction of thermosolar collectors. [3
Solar plugs can be:
-without the concentration of solar radiation;(flat plate collectors);
-with the concentration of solar radiation; (solar collectors vacuum tubes)

Capturers without concentration of solar radiation

They are solar collectors in which the surface area that absorbs a certain amount of solar radiation is identical to the surface area that intercepts that amount of solar radiation
Their main advantages are:

- uses both direct sun radiation and diffuse radiation ;
- does not require precise orientation to the sun;
- have simpler construction ;
- requires easy maintenance

The range in which it is used is that of moderate temperatures where the heat carrier fluid does not exceed 100 ºC (water, air, etc.). The temperature of the heat carrier may vary from several degrees above the ambient temperature when the collector absorbing surface is uncovered and can reach values that are tens of degrees above ambient temperature when the absorbent surface is protected by a layer or multiple glazing layers (greenhouse effect), figure 2

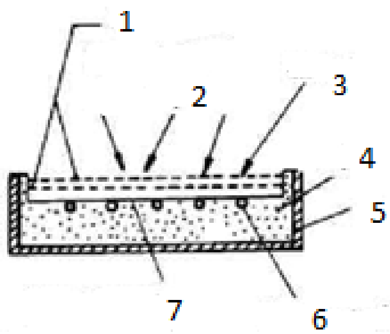

Figure 2. *Components of the planer collector without the concentration of solar radiation*

1- glass, 2-diffuse radiation, 3. direct radiation, 4- insulation, 5-shell, 6-tube fluid, 6-tube fluid,7- absorbent surface

The absorbent surface is generally made of a metallic or other material covered with a black paint layer in order to increase the absorption of the solar radiation and the decrease in emissivity. This property is obtained by coating the surface with thin films of CuO, CuS, MnO2, NiS and iron oxides, making a selective absorbent surface. If the absorbent plate itself does not constitute the protective surface of the heat carrier fluid, there are pipelines on the plate that circulate the same fluid to capture the solar heat

If the absorbent plate itself does not constitute the protective surface of the heat carrier fluid, there are pipelines on the plate that circulate the same fluid to capture the solar heat. The transparent surface (glass) is made of one or more rows of glass plates with a thickness of 3 ÷ 4 mm. The majority of planar collectors are made with 2 rows of plates, one of which is made of glass and the other one is a plastic foil.

The role of the transparent surface is to allow the passage of solar radiation with wavelengths of 0,3 ÷ 0,4 microns to the absorbent plate and to reverse the passage of the infrared radiation emitted by the absorbing surface.

Also, in order to reduce the convective currents between the transparent plates, and consequently the convection heat losses, the distance between the plates must not exceed 20 ÷ 30 mm.

The heat carrier fluid circuit is formed either from two plates, one of which is absorbent, or from a pipe register attached to the absorbent plate. Thermal insulation has the role of reducing the heat loss of the collector. It is made of materials with low conductivity such as: glass wool, mineral wool, polystyrene etc

The housing protects the entire assembly of the collector against mechanical shocks. It is generally made of shock-resistant and corrosion-resistant materials such as: galvanized or painted steel sheet, aluminum sheet, plastic plates,

Flat collectors without concentrating radiation is used to:

Heating; hot water preparation; drying; desalination.

There are many configurations of flat collectors. The advantage of these capture devices is that the absorbent surface is so shaped as to ensure good fluid circulation and better capture of solar radiation. Crushers made of aluminum or corrugated steel have the advantage that the heat carrier fluid scoured the entire absorbent surface.

The performance of a solar collector is appreciated by the "collector efficiency", which is defined by the ratio of useful heat Qu, obtained over a period of time to incident solar energy, Ei, on the collector surface over the same period of time.

$$\eta = \frac{\int Q_u d\tau}{S_c \int_\tau KEd\tau} \quad [1]$$

where in: *Qu* is the useful heat transmitted to the carrier fluid in the time unit(heat flux), - radiant power density incident on a horizontal surface, *Sc* - area of absorbent area, *K* - global coefficient of thermal losses, - time.

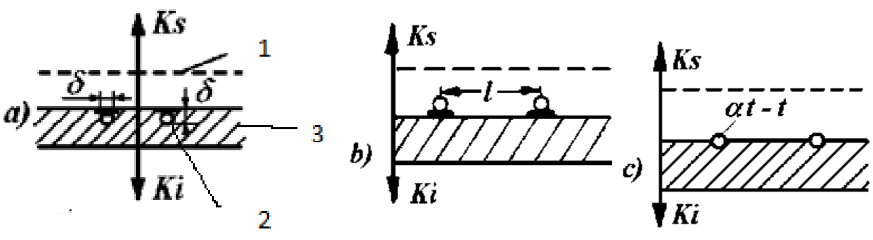

Figure 3. *Configurations of flat collectors. [3]*

1-solar glass;2-piping for the thermal agent

Because phenomena are complex, simplistic hypotheses are used: the collector's thermal regime is stationary; the properties of the materials are temperature-independent; the solar energy absorbed by the windows is negligible; the propagation of heat through the windows is made in the direction perpendicular to their surface; temperature drops in jams are negligible; the pipelines cover a negligible area of the collector;

Global thermal loss factor

$$K = K_i + K_s, \quad (2)$$

where Ki and Ks are the global coefficients of thermal losses through the inside or outside of the collector:

$$F_e = \frac{K_0}{K}, \quad (3)$$

where K0 is the global heat transfer coefficient between the heat carrier and the ambient medium, K is the global heat transfer coefficient between the absorbent plate and the surrounding medium. Concentrating solar radiation collectors

Solar collectors with vacuum tubes

Vacuum tube solar collectors are used particularly in applications where a high temperature or complex installations, which generates both heat and hot water for domestic heating. Vacuum tubes are the main element of collectors that have an increased efficiency of about 30% compared to classical planar collectors. Each tube is made up of two concentric borosilicate glass tubes (very resistant and with a high degree of transparency) welded together. The space between the two tubes is shaken and the inner surface of the inner tube is covered with a selective layer with excellent solar radiation absorption properties (> 92%) and a very low reflexivity (<8%).

The heat is transferred to the thermal agent either directly or by means of a heat pipe. The vacuum between the two tubes forms a kind of "thermos" so that, although the inside temperature reaches 150 ° C, the tube is cold outside. This property makes the installation also usable in very cold climates, with tube collectors being more efficient than flat class collectors.

The advantages of vacuum tube solar collectors are:

- high efficiency;
- improved thermal transfer;

The vacuum tubes can be

• superconductors;
• high efficiency superconductors.

Superconducting vacuum tubes are made of borosilicate glass having a tube structure in the tube. The space between the two concentric tubes is vacuumed to improve the thermal insulation properties. Unlike ordinary vacuum tubes, these tubes contain a "heat pipe" that transfers heat. The advantages are: high efficiency, pressure installations, also operating at temperatures below 0 ° C. High efficiency superconducting vacuum tubes are made of borosilicate glass and contain a "thermal tube" in contact with an absorption plate. The inside of the tube is vacuumed to improve its thermal insulation properties. This tube solves a number of shortcomings of tubes made entirely of glass.

1.glass tube
2.thermal tube
3.fluid working fluid
4.working
fluid in vapor state
5.absorbing wall
6.capacitor,
7.flexible connection

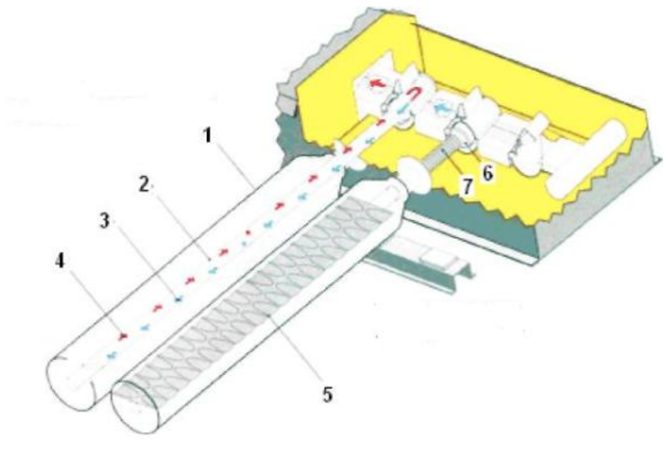

Figure 4. *The solar collector with thermal pipes [2]*

The absorber and the heat tube are placed in a glass tube in which the vacuum is 10-8 torr. This vacuum creates almost complete thermal insulation characteristic of this model. If there was air in the tube, it became a hindrance to sunlight and a medium through which heat was lost to the outside by free convection. It should be noted that the glass from which the tubes are made has a small content of metallic elements. The heat pipe contains approx. 4 ml of water under vacuum. This causes the liquid to vaporize inside the tube at 25 ºC. The water vapor then goes into the heat pipe (with a 30 degree inclination) to the condenser. Thermal transfer to the solar circuit is done through the condenser. The water vapor inside the heat pipe is transformed into liquid by autoclaving in the condenser and returns to the vaporization zone where it vaporizes again.

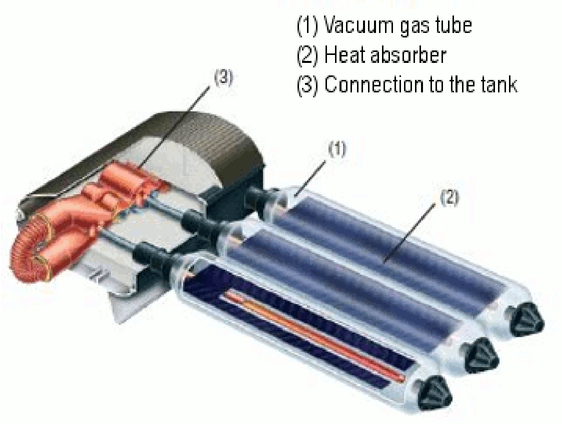

Figure 5. *The solar collector with vacuum tubes [2]*

Vacuum tube solar collectors (Figure 4) are made of unidimensional vacuum tubes, which gives the collector high stability and in case of a tube failure it can be replaced with a new one. The collector construction allows correlation of position deviations to the south direction by axial rotation of the max. ± 25º, ensuring optimal orientation of the capture element. Vacuum tubes work according to the heat pipe principle. According to this principle, the tube is not passed through the solar thermal circuit (glicool), each tube having its own circuit. Due to the vacuum technique of the collector tubes, maximum thermal insulation is achieved and heat losses are reduced. The high quality absorbent layer deposited on the copper support has a high yield of up to 15% more energy than similar absorbents

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The use of quality panels is a necessary but not sufficient condition for the optimal operation of the solar plant. great role has the complete system configuration. Solar collectors can be used in bivalent mode for domestic hot water heating and heat input for building heating, swimming pool water heating in combination with any of the masonry boilers. The most efficient in terms of temperature regimes is the domestic hot water heating unit, consisting of the solar plant and a modern low temperature boiler or condensing operation. The solar plugs have a lifetime of 25 years. Solar collectors can be used in an efficient manner (80%) even in sunlight during periods of transition (autumn-winter) when they are skewed. The concentration factor is up to 3, and. the absorption coefficient of the diffused light is quite high (k = 0.87). They are adapted for domestic hot water heating, swimming pools and partial heating of the environment. Solar plugs can be used to heat pool water with the following features: direct heating for the pool; economical, environmentally friendly and easy to install; Various construction (1 collector tube, 2 collector tubes, 4 outputs); multiple mounting possibilities; high yield; rapid heating; made of polyethylene (high molecular weight polymers).

3. CONCLUSIONS

1. Romania's potential in terms of solar energy can be capitalized by the use of installations that convert solar energy into thermal energy, electricity needed for domestic applications and not only
2. Solar collectors can be used for installations using collectors to produce hot water needed for domestic hot water.

3. Solar collectors without solar focus may be used in various installations that can convert solar energy into electric, thermal and other forms of energy.
4. The solar collectors without the concentration of solar radiation have the great advantage that they do not require precise orientation which makes their mounting relatively easy from this point of view.

REFERENCES

1. Bratucu Ghe. Căpăţână I. Using Renewable Energy Sources to Efficiency Farmhouses and Agrotourism Pensions in the Agricultural Mechanization Magazine, number. 9/2007, page 17-22 ISSN 1011-7296. [1]
2. Mugur B: *Renewable energy*, Cluj Napoca editura U.T. Press 2007, ISBN 978-973-350-9.[2]
3. Neagu A. Mugea N. Use of flat solar collectors in hot water preparation in insulated lines National Session of scientific Communications 26-27 November 2004. [3]