TUBE EVACUATED SOLAR COLLECTORS

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ABSTRACT

Tube evacuated collectors have an excellent position in comparison with properties of other types collectors. This article describes construction of tube evacuated collectors with flat lamelar absorber and possibilities of their utilization.

1. Introduction

Economical development of countries is close connected with development of their energetical basis. At this time for the increase of national income about 1% it is necessary to ensure 1% accession of energetical sources. Therefore all economically developed countries look for new possibilities of ensuring the energy for future. Perspective of solar energy consists not only in its unexhaustibility, but especially in the fact, that it is the necessary condition of life on the Earth.

2. Possibilities of utilization of solar energy in Slovakia

On the map of climatic zones (CZ), the world is divided into five climatic zones according to the length of solar shine per year. Our republic is situated on the interface of the second and third boundary climatic zones. Three largest towns of Slovakia are situated as follows: capital city Bratislava is situated in third CZ with 1 700- 1 900 solar hours per year i.e. 1,05 - 3,00 kWh/m^2 day, town Žilina is situated in the second CZ with 1 500-1 700 solar hours per year (2,475kWh/m^2 day), town Košice is situated on the boundary of the second and third CZ with 1 600 - 1 800 solar hours per year and 1,5-2,7kWh/m^2 day. Košice and its background have very suitable location in connection with utilization of solar energy. According to the prognosis for the year 2 000 it is assumed that by solar energy utilization will be obtained about 2% of total energy consumption in our country. In the last decade more types of solar collectors were developed in Slovakia. Tube evacuated collectors are the most important from them.

3. Tube evacuated collector construction

Our workplace participated on development of tube evacuated collectors (TEC). We were orientated on the optimization of their construction, preparation of their serial production and also on spreading the possibilities of their utilization (especially with concentrators).

Basic elements of tube evacuated collectors are shown on Fig. 1.

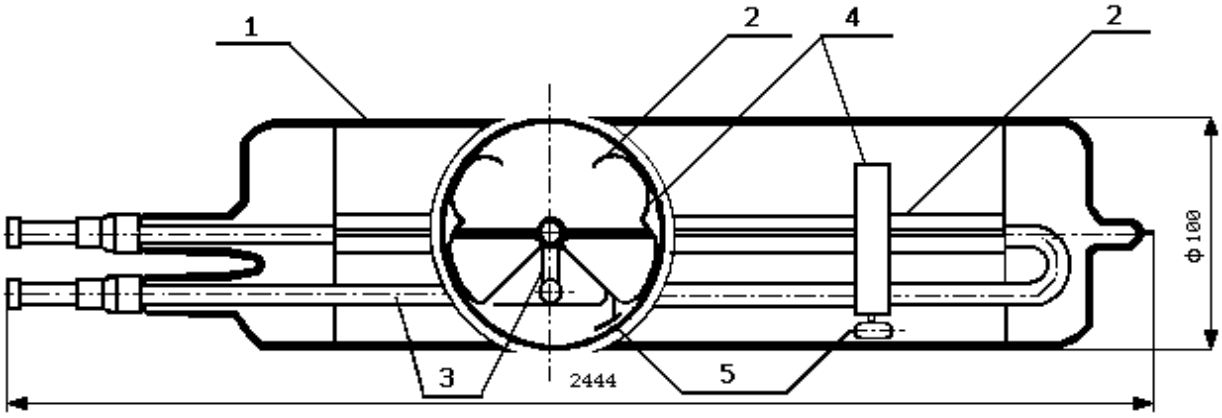

Fig. 1 Tube evacuated collector

Tube **1** with diameter 100mm was made of glass material - Simax. The most important part of collector is flat lamellar aluminium absorber **2** with expanded heat-conducting copper tube **3** in which heat-carrying medium flows. The most important influence on parameters of absorber has special black selective layer. This layer was developed in the factory SNP Žiar nad Hronom Slovakia. It is made of black nickel or cobalt and its parameters are comparable with these ones from the world´s famous producers. This layer absorbes solar radiation with very great efficiency and changes it on heat that is not radiated into surroundings. The location of individual parts in tube ensures distance piece **4**. Absorber is situated in glass tube with vacuum $2\text{-}5.10^{-2}$ Pa which is reached by getter **5**. Technical parameters of tube evacuated collectors are in Tab. 1.

Table .1 Technical parameters of tube evacuated collector

Diameter of tube	100 mm
Total length	2 444 mm
Minimum wall thickness	2 mm
Mass	5,90 kg
Material: glass-cover	SIMAX
absorber	Al
heat-conducting tube	Cu
Absorber area	0,2 m^2
Conversion layer	high selective on the basis of Al oxide and black Co or Ni
Vacuum	$2\text{-}5.10^{-2}$ Pa
Efficiency	69 %
Maximum working temperature	250^{o}C
Minimum life-time	12 years with nominal parameters

This type of collector reaches the excellent parameters. Each of its parts must fulfil the important requirements. Location of absorption area in vacuum significantly decreases the heat losses of collector system and so allows its utilization during the whole year. Two-sided selective absorption layer enables collector to reach the greater efficiency of solar radiation transformation on heat also by absorbing of diffusion radiation. At utilization of solar energy the relative great energetical losses are in individual parts of collectors. To decrease these losses of tube evacuated collectors and also to increase their effectiveness it is necessary to create the layers with special optical properties on the surfaces of transparent cover and absorber. On the surface of transparent cover the reflection of incident light occurs what causes relative great losses. These losses can by eliminated by arrangement of transparent cover surface by creation of antireflection layer. On its creation MgF_2,Na_3AlF_6,CaF_2 are the most frequently used. Their application enable us to decrease these losses about 75%. The increase of effectiveness of tube collectors may by reached also by utilization of reflection coatings for infrared radiation on inside part of glass cover. These coatings are transparent for visible light up to 1μm but they are reflective for infrared radiation. The selective absorber layer which prevents the radiation of heat from its surface is another important requirement for reaching of suitable parameters. Also high vacuum in inner part of tube collector helps to decrease of heat losses. These arrangements increase the price of collector but they improve its properties in the great measure. Possibilities of the increase of profit of tube vacuum collector by utilization of antireflection infrared layers we verified by calculation which showed that these ones are suitable especially for high temperature applications (over 150^{o}C). Experimentally we also verified the possibilities of selective black layer creation on glass. In our research we were concerned with suggestion of production technology of vacuum-tight connection between metal transition point (Kovar, FeNi2) and hot-conducting copper tube by utilization of induction heating. Induction heating was experimentally verified and tested from the point of view of both the speed of connection creation and also their quality.

4. Utilization of tube evacuated collectors

Tube evacuated collectors are the most frequently used in the plain arrangement. On Fig. 2 the connection of 10 collectors in the frame is shown. Tube evacuated collectors reach the high temperatures up to 250^{o}C (with cobalt black layer 380^{o}C), low heat losses 2,5Wm^{-2}.^{o}C^{-1} and high life-time. That in expressive way spreads the possibilities of their utilization compared with other types of plain collectors - especially at high temperature application and also with connection with heat pump. We also work in the area of TEC and concentration collectors at utilizationing these tube collectors in the function of their absorbers. These collectors are characterized with reduced request on rotation or they work without rotation because they are characterized with the high acceptance angle 90-120^{o}.These collectors are equivalent to collectors utilized in the solar plants type DCS.

5. Conclusion

With their parameters the tube evacuated collectors belong to peak ones and in expressive way they contribute to spreading the possibilities of solar energy utilization in our country. Although Slovakia is a small country it has a great energy consumption per its inhabitant. Lack of own classical energy sources and also their gradual global exhaust requires to look for the new energy sources. The solar energy is one of these non-conventional sources. In Slovakia the appliances for photothermal transition of solar energy are developed and produced, and their sortiment and quality is comparable with the products of the world´s famous producers

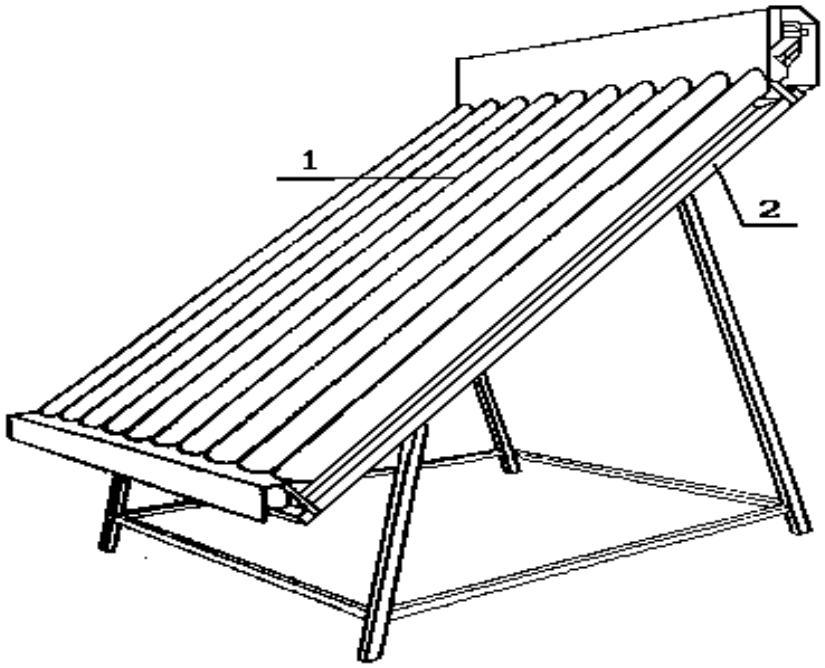

Fig. 2 The use of TEC in plane arrangement
(1 - connection of 10 TEC, 2 - frame)

Despite the fact that we have enough high quality solar appliances from the domestic production we are behind neighbouring states in their utilization. These countries provide 40 - 50 percent grants for building of solar systems. But for users in Slovakia the collectors without grants provide a low returnability of investments. For that reason although these collectors are produced in our country they are especially applicated abroad.

Although in near future we cannot suppose that the solar energy will solve the energy problems in our country or in the world, it enables us to reach non-neglectable benefits already at present. The geographical location of Slovakia enables us to reach up to 1,3 MWh of energy per year from 1 m^2 .

6. References

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