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SOLAR COLLECTOR WITH DARK LIQUID AND EFFICIENCY COEFFICIENT

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ABSTRACT
In this paper are analyzed the solar collectors with dark liquid respectively advantages of using solar panels as opposed to their usual. So, here are presented the technical characteristics of solar collector, thermal and physical parameters which influence to collector efficiency coefficient. In the presented diagrams is represented the collector efficiency coefficient with dark liquid by comparison with copper pipe, for changing temperature of 0 ^{0}C and 30 ^{0}C, as well as effective transmission – absorption coefficient, and reasons of their production.
Keywords: solar collector, dark liquid, efficiency coefficient

1. INTRODUCE

These devices and equipments can have a wide application of solar energy to the preparation of hot water in hotels, households, industry, agriculture, livestock breeding, construction, etc., mainly in the summer period. The main reason for few current solar systems application is their high price and long amortization investment. Therefore, here is presented a type of solar collectors which is better or at least with the same degree of beneficial effects as most collectors, and the price is half, even a third of the price of other types of solar energy collectors. In addition, this collector is less thickness and weight (even much more light) than others, so that it can be made in existing buildings without any risks or problems. The main difference between this type collector and others, available on the market is in the way of receiving energy solar radiation, and liquids - the carrier of heat - which used in the collector. The liquid in conventional collectors receives heat by conduction from the copper tubes and plates, which thermal energy received from the sun radiation. In this collector type with special liquid dark color, into particular plastic panels, absorbs solar energy directly, without intermediaries. Heating of liquids and not constructive parts of collectors means less loss of heat to the environment. Waste also the related problems to selection the best absorption coating, as the panel’s surface have a primary task to release and not to absorb solar energy. Collector works in closed system, where the pump used to circulate fluid and heat exchanger to give energy from gathering panel.

This system provides the work in the winter with the minimum amount of ethylene – glycol [1]. Collector panel is made of plastics mass. Fluid in the panel comes from the bottom, flows through the panel and exits through a collector to the top panels, whereof carries to the heat exchanger and back to the panel by circulation pump. The liquid that used in the collector is resistant to low temperatures. The composition of liquid is such that provides stability in the area of the usual working temperature of heat transmission. In this temperatures area it hasn't changing in the composition of liquid. Dark liquid received more solar energy cubically than surfacelly, by directly radiation, to provide high coefficient of utilization efficiency. As the sun radiation heated the liquid and not constructive parts of collector, does it mean that need isolation of two to three times less than the other collectors. Collector with a dark liquid has a lightweight and therefore has an easy construction for fixing. Maintenance and repair of the panels are simple. All listed properties of these collectors have carry to the base - low price with the same efficiency. This efficiency is very high - coefficient of utilization efficiency by temperature difference 0°C is 86%.

2. THERMAL SPECIFIC POWER AND COEFFICIENT OF UTILIZATION EFFICIENCY

Thermal process in this collector can expresses by equation [2]:

$$q_k = \frac{Q_k}{A_k} = (\tau\alpha) I_{rr} - k(T_h - T_0) = F_R\left[I_{rr} - k(T_h - T)\right] = \overset{\circ}{m} \cdot c_p (T_d - T_h) \quad (1)$$

Where:

q_k, W/m^2 – thermal specific power of solar collector;

$I_{rr} = H_t \cdot (\tau\alpha)$, W/(m^2) – intensity of global solar radiation;

$F_R = \frac{\overset{\circ}{m} \cdot c_p}{k \cdot A_k}\left[1 - e^{-\frac{k \cdot F' \cdot A_k}{\overset{\circ}{m} \cdot c_p}}\right]$, / – efficiency factor of heat transfer from the collector in the working fluid;

F', / – collector factor;

A_k, m^2 – collector surface;

k, W/(m^{2}K) – overall heat transfer coefficient;

$\overset{\circ}{m}$, kg/h – fluid flow;

c_p, Wh/(kgK) – specific heat;

τ, / – transmission factor;

α, / – absorption factor;

T_h; T_d, K – input and output temperature of a dark liquid;

T_0, K – environment temperature;

H_t, W/m^2 – insolation on tilted surfaces;

Thermal coefficient of solar utilization efficiency can expresses by equation [3]:

$$\eta = F_R\left[\tau\alpha - k\frac{T_h - T_0}{I_{rr}}\right] = F'\left[\tau\alpha - k\frac{T_m - T_0}{I_{rr}}\right] = \eta_0 - F'k\frac{T_m - T_0}{I_{rr}} \quad \ldots (2)$$

Where:

$T_m = \frac{T_h + T_d}{2}$, K – medium temperature of working fluid;

Decrease of efficiency for the case with the same collector and two work states [4]:

$$\Delta\eta = \frac{F'k}{I_{rr}}(T_{m2} - T_{m1}) = \frac{F'k}{I_{rr}}\Delta T_m \quad \ldots (3)$$

3. ANALYSIS OF COLLECTOR THERMAL POWER AND UTILIZATION EFFICIENCY

In view of expressions that are above mentioned, by means of the simulations respectively the diagrams which are presented in continuity, it is analyzed the collector thermal power and utilization efficiency. This collector performed its work with these characteristics: $F'k$=6.09W/(m^{2}K); I_{rr}=200; 500; 800 W/m^2,

$\overset{\circ}{m}$=108kg/h, $F_R(\tau\alpha)$=0.8, $F_R k$=7.6W/(m^{2}K); t_0=20^{0}C.

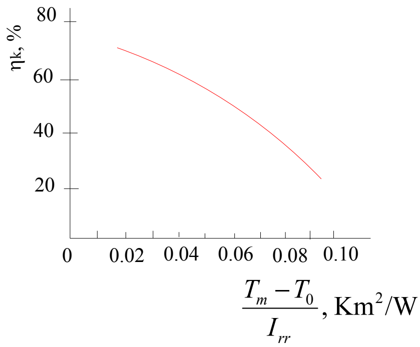

Figure 1. Efficiency curve of double glass flat panel with cooling agent (0.0136kg/(sm^2), $t_0=20^0C$, $t_m=35\div100^0C$, $I_{rr}=590\div980W/m^2$, w=3.1m/s)

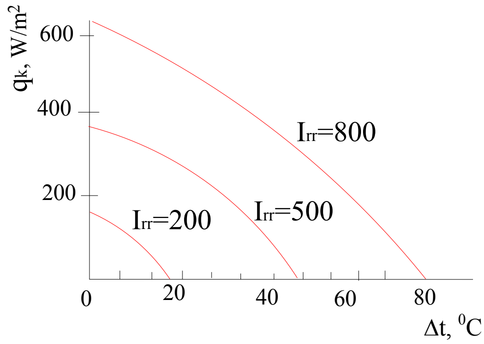

Figure 2. Changes dependence q_k of Δt for different values I_{rr} (200, 500 dhe 800W/m^2, $\dot{m}$=108kg/h, $F_R(\tau\alpha)=0.8$, $F_Rk=7.6W/(m^2K)$; $t_0=20^0C$, $\eta k=0.77-4.79\Delta t/I_{rr}-35.7(\Delta t/I_{rr})^2$)

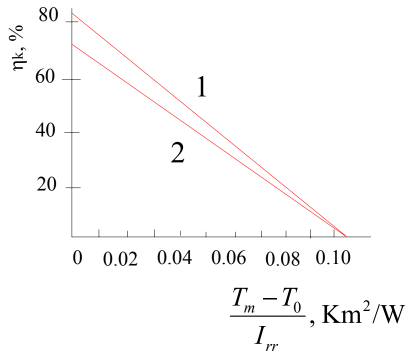

Figure 3. Efficiency curve, when $\Delta t=0^0C$:
1- collector with dark liquid, 2 – collector with copper tube)

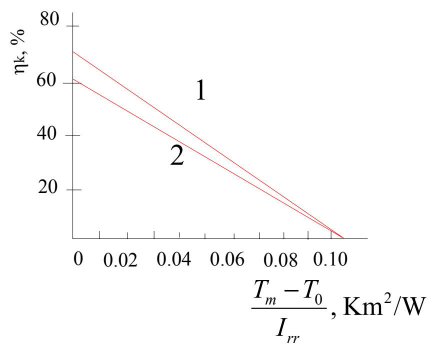

Figure 4. Efficiency curve, when $\Delta t=30^0C$:
1- collector with dark liquid, 2 – collector with copper tube)

4. CONCLUSION

Solar collector with a dark liquid in comparison with the flat collectors which can be found on the market, therefore, is: better or even with the same utilization efficiency degree, less weight (panels and supporting structures), thinner insulation, the possibility of turning from a defined strictly set of a plane angle, and therefore, more possibility of using already built roofs, more simple repairs and, because of all this, much less cost.

5. REFERENCES

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