pitatelnoy vody diffuzionnykh apparatov sveklosakharnogo proizvodstva / Yesikov S.A. // Diss. kand. tekhn. nauk. – Kiyev, 1988. – 263 s 7. Chervjakov, A.V. Perspektivy primenenija nanostrukturirovannoj vody v sel'skom hozjajstve / A.V. Chervjakov, P.Ju. Krupenin, V.P. Pshenko, A.S. Cirkunov // Nauchno-tehnicheskij progress v sel'skohozjajstvennom proizvodstve: materialy Mezhdunar. nauch.-prakt. konf. – Minsk, 2009. – T.2. – S.134-139. 7. Viten'ko T. Zastosuvannya hidrodynamichnoyi kavitatsiyi u sorbtsiynykh protsesakh doochyshchennya vody / Viten'ko T., Zarets'ka T. // Visnyk Ternopil's'koho natsional'noho tekhnichnoho universytetu, №1 (65), 2012. – S. 238-243. 8. Viten'ko T.M. Intensyfikatsiya protsesiv kondytsiyuvannya vody z vykorystannyam hidrodynamichnoho kavitatsiynoho reaktora / Viten'ko T.M. // Dys. Kand. tekhn. nauk. – Ternopil', 1996. – 179 s. 9. Metod opredelenija himicheskogo potreblenija kisloroda. GOST R 52708-2007. M.: Standartinform, 2007.– 8 s.

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COMBINED SOLAR COLLECTOR

In this article was analyzing the efficiency of the combined solar collector for heating buildings. This enhances the efficiency of solar system by increasing the area of the absorption of solar energy. There are describes the results of the research on solar radiation input on a combined solar collector.

Key words: combined solar collector, solar radiation, solar heating supply.

Проаналізовано ефективність використання комбінованого сонячного колектора для теплопостачання будівель. Він забезпечує підвищення ефективності геліосистеми за рахунок збільшення площі поглинання сонячної енергії. Описано результати досліджень надходження сонячного випромінювання на комбінований сонячний колектор.

Ключові слова: комбінований сонячний колектор, сонячне випромінювання, геліосистема.

Introduction

The issues related to the future ways of energy development escalate more and more every year. On the one hand, the population growth, the desire to improve the living standards of people dictate the expediency of accumulation of energy capacity, moreover, on gigantic rates, on the other hand, the environmental problems arising, exhaustion of natural sources of raw materials, and, above all, oil and gas, require more economic and efficient use of the energy obtained. Fuel and energy resources become more expensive every year both for the industry, and for the population.

Therefore there is a need to implement complex measures on the use of new alternative energy sources. The solution of this problem requires significant changes in the global energy balance. An alternative in this field is the use energy of the sun. It is completely free for the mankind and given to us in virtually unlimited quantities.

Formulation of the problem

Using solar energy is sufficiently promising to improve the environmental situation, reducing costs of fossil fuels, and for domestic and process needs. The annual amount of solar energy by almost 15 000 times higher than the needs of the world's population. To date, it is important to improve and develop new solar collectors, which would have reduced the cost of the heat supply system and improve its efficiency. Therefore, the proposed use of combined solar collector, a feature of which is that the solar tubes situated over the solar energy absorber and solar energy absorber performed corrugated.

Presentation of the basic material

The experimental setup consists of combined solar collector, accumulator box, source of radiation and measuring devices. The experimental setup is shown on fig. 1.

The tasks was to improve the flat solar collector. This is done because the solar energy absorber is made corrugated and solar tubes located above it. This enhances the efficiency of solar system by increasing the area of the absorption of solar energy.

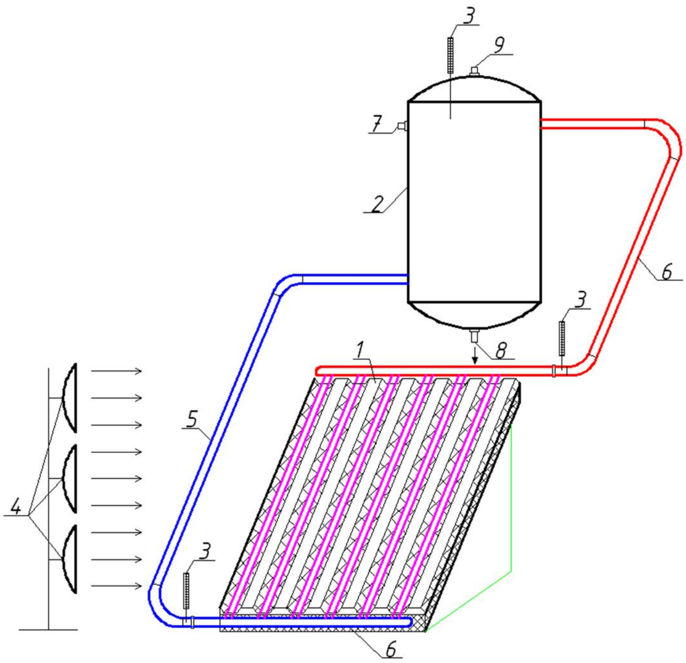

Fig.1. Chart of the experimental unit: 1 – combined solar collector; 2 – accumulator box; 3 – mercury thermometer; 4 – source of radiation; 5 – reverse pipeline; 6 – supply pipeline; 7 – output pipe; 8 – pipe drain coolant; 9 – air exit valve; 10 – insulating layer.

Sunlight falls on the solar energy absorber and tube for coolant. The result of this is heating. Due to the temperature difference and density difference, the circulation of the coolant is created in the area of input and output sockets created by. The heated coolant through the supply pipeline 6 is supplied into accumulator box of hot water 2. The heated water through the pipe 7 is supplied to the consumer. The cooled coolant return by pipe 5 returns to the combined solar collector 1 and heated. Descent of water from the accumulator box occurs by a tube 8. Air outlet – occurs by air exit valve 9. The insulating layer 6 which is placed under the bottom cover reduces the heat loss. Placing a mirroring ray layer under solar energy absorber makes possible to increase the efficiency of solar radiation, part of which was held by solar energy absorber. Mirroring ray material reflects sunlight back to solar energy absorber. Resulting of this is that solar energy absorber absorbed almost all solar radiation that reaches the solar collector.

The intensity of the flow of the energy emanated by the source was measured by an actinometer. The temperature of the heat carrier was measured at three points of the system (at the outlet of the combined solar collector, at the combined solar collector inlet and in the accumulator box) by the mercury thermometer. Environment air temperature and its speed was measured by the thermoelectric generator anemometer TESTO 405 - V1.

We made up the three-factor planning matrix with the factors interaction. As the factors we chose:

- azimuthal angle of turning of the combined solar collector, α^o, [30; 90];
- the angle of slope of the combined solar collector, β^o, [30; 90];
- the heat flow intencity, W/m^2, [300; 900].

The optimization parameter was the efficiency coefficient of solar system $K_{еф}$. It is defined by the formula:

$$К_{еф} = Q/(Q_{пад} \cdot F) \quad (1)$$

where, Q – нeat energy which was accumulated in the accumulator box, W; $Q_{пад}$ – amount of radiant heat, source radiated per unit surface solar energy absorber of solar collector at the same time, W; F – area of solar collector, m^2.

Heat energy which was accumulated in the accumulator box, was determined by the formula:

$$Q = m \cdot c \cdot (t_{box} - t_{vh}), \quad (2)$$

where, m – mass of coolant in the accumulator box , kg; c – specific heat offluid, J/(kg·K); t_{box}, t_{vh}– coolant temperatures in the accumulator box and inlet of the solar collector, K.

Table 1

Matrix of experimental design

№	x_0	x_1	x_2	x_3	x_1x_2	x_1x_3	x_2x_3	$x_1x_2x_3$	$K_{еф}$
1	+	–	–	–	+	+	+	–	0,53
2	+	+	–	–	–	–	+	+	0,64
3	+	–	+	–	–	+	–	+	0,75
4	+	+	+	–	+	–	–	–	0,96
5	+	–	–	+	+	–	–	+	0,25
6	+	+	–	+	–	+	–	–	0,32
7	+	–	+	+	–	–	+	–	0,36
8	+	+	+	+	+	+	+	+	0,43

We get the following equation of regression on the basis of the data in table 1:

$$К_{еф} = 0{,}53 + 0{,}058x_1 + 0{,}095x_2 - 0{,}19x_3 + 0{,}040x_2x_3 \quad (3)$$

After analyzing the coefficients of regression equations, we can conclude that the greatest impact on the efficiency of the combined solar collector is the intensity of heat flow $I_в$, and angle of solar collector β and the azimuthal angle of the collector α not significantly affected.

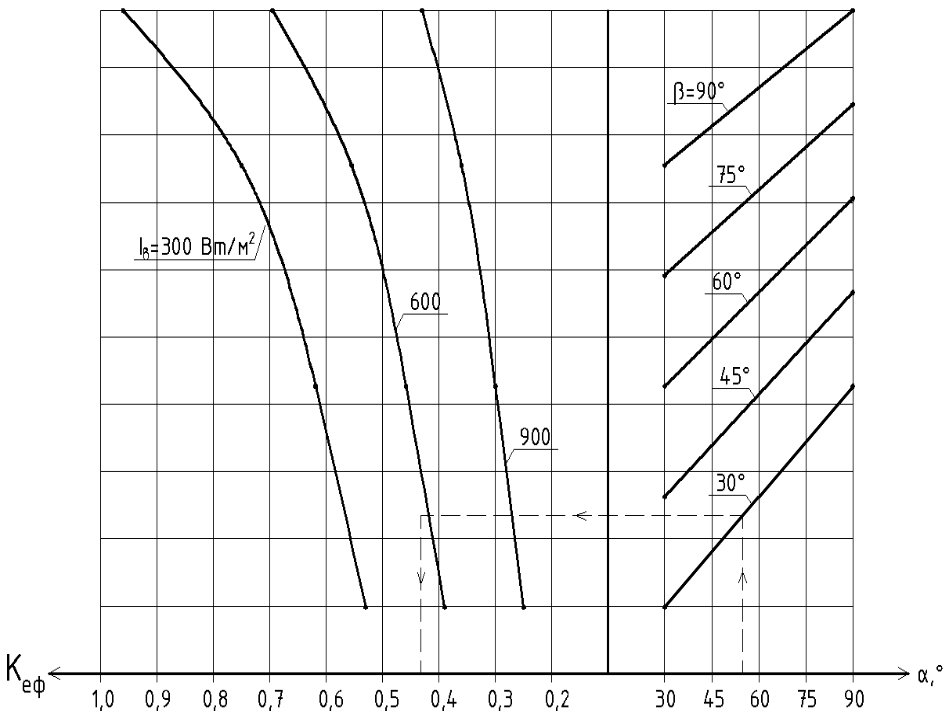

Fig.2.Results of the experimental research

On the basis of the results of experimental research we have built the nomogram (fig. 2) of dependency of azimuthal angle of turning of the solar collector α, angle of rotation of the solar collector β, the intensity of the heat flow $I_в$ and the efficiency coefficient $K_{еф}$.

From the nomogram (fig. 2) we see that the efficiency of combined solar collector at the change of the fall angle α and β from 90° to 30° falls on 43%.

An insignificant fall of the solar collector efficiency will be at the change of the fall angle of solar radiation.

Conclusion

The research showed the high efficiency of the combined solar collector, that allows to talk about its wide use in the systems of solar heat supply. The efficiency coefficient $K_{еф}$ at the intensity of the heat flow of $I_в$ = 300 W/m^2 changes from 0,96 to 0,53, which means the ability to catch radiation efficiently at different deviations of fall angles of the heat flow from 90°.

1. Wiśniewski G., Gołębiowski S., Grycik M. i in. Kolektorysłoneczne: energiasłoneczna w mieszkalnictwie, hotelarstwe i drobnymprzemyśle. – Warszawa : " Medium" , 2008. – 201 s. 2. Tvajdell D. Vozobnovljaeтые ystochnyky эnerghyy / D. Tvajdell, A. Uэjr; per. s anghl. pod red. V. A. Korobkova. − M. : Эnerghoatomyzdat, 1990. − 391 s. 3. Voznjak O.T. Efektyvnistj ploskogho sonjachnogho kolektora pry riznykh intensyvnostjakh ta kutakh padinnja teplovogho potoku/ O. T. Voznjak, S. P. Shapoval// Naukovo-tekhnichnyj zhurnal Nova tema: ghol. red. M. V. Stepanov. – №3, 2010. – s. 32-34. 4. Shapoval S. P. Efektyvnistj systemy teplopostachannja na osnovi sonjachnogho kolektora pry zmini kuta nadkhodzhennja teplovogho potoku / S. P. Shapoval, O. T. Voznjak, O. S. Dacjko // Visnyk Nacionaljnogho universytetu "Ljvivsjka politekhnika" ["Teorija i praktyka budivnyctva"]. − L. : V-vo NU "LP", 2009. − № 655. − S. 299-302.

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ENVIRONMENTAL ASPECTS OF USING SOLID FUEL IN URBAN HEATING SYSTEMS

The article presents recommendations for technical solutions and safe volumes transfer applicable boiler houses to solid fuel.

Key words: solid fuel, environmental air, pollutants.

Наведено рекомендації щодо технічних рішень та безпечних обсягів переведення діючих котелень на тверде паливо.

Ключові слова: тверде паливо, навколишнє повітря, забруднюючі речовини.

Raising the question

Recently, Ukraine puts a lot of efforts on economy natural gas. One such event is the transfer of municipal boiler houses from natural gas to solid fuel.

However, the impact of such an event on environment requires research and careful analysis. Thus the aim of the article is to outline the main issues that arise from the translation of the existing gas boiler houses for solid fuels.