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DESIGN OF THE HEAT PIPE HELIUM GREENHOUSE

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This scientific work presents the results of scientific research on the use and accumulation of solar energy for heat supply of a solar greenhouse.

For a real assessment of the problem, the following information can be cited as an example: in a greenhouse with a total area of 234 m^2 covered with polyethylene film must be installed, on the average, with 6–8 furnaces to provide a certain amount of warm air. One furnace consumes about 2448 m^3/h of natural gas for four months, and during this time 8.6 kg of carbon dioxide (CO_2) is emitted from one furnace. As a result, taking into account the payment for the consumption of natural gas, the problem of the cost of the obtained products, energy conservation, and also environmental protection is very urgent.

To solve this problem, a solar greenhouse with an additional heating chamber was constructed at the research site of the State Energy Institute of Turkmenistan. In this structure, excess of solar and heat energy of the soil was accumulated in mountain stones, and carbon dioxide that emits soil (horse manure was used as a soil) was used to feed the Chlorella vulgaris suspension grown in the photobioreactor, which in its turn had a beneficial effect on its cultivation. To transfer heated air from the additional heating chamber to the solar greenhouse and the accumulated thermal energy of the soil, polyethylene pipes with holes were used.

Due to the use of the heat capacity of the materials (rock stones), a two-layer coating of the structure, compaction of the northern side with wool and accumulated heat energy, it was possible to achieve a positive temperature in the solar greenhouse in the minus environmental values.

The technologies and processes considered in this research are mainly renewable energies and technical (chemical reactions) solutions such as photovoltaic (PV) modules, phase exchange material (PCM), underground heat storage technologies, energy efficient heat pumps and facade materials for the better heat insulation.

In order to investigate the possibility of heating the greenhouse through heat pipelines, a helium greenhouse with an area of 24 m^2, and a volume of 54,4 m^3 and an additional heat source with an inclination angle of 36° degrees covered with glass cover with an area of 7.5 m^2, with a volume of 7.5 m^3 were installed in the State Energy Institute of Turkmenistan. The drawing of the helium greenhouse is shown in Figure 1 below.

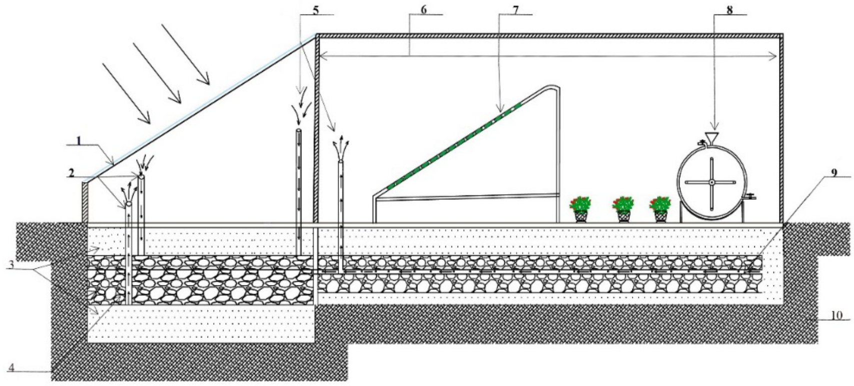

Fig. 1. General drawing of the helium greenhouse:
1 – outer glass cover of the heating chamber; *2* – inlet and outlet of the heat pipe at the bottom of the heating chamber; *3* – course layer; *4* – stone layer; *5* – entrance and exit of heat pipe at the bottom of the greenhouse; *6* – woolly wall; *7* – photobioreactor; *8* – biogas plant; *9* – heat pipes; *10* – soil layer

The amount of heat supplied through the ventilation air, which is calculated by the following expression:

$$Q_{air} = GC_p(T_1 - T_2),$$

where G – mass consumption of air from the fan; kg/hour; C_p – specific heat capacity of air at different temperatures, 0,241 *J*/kg · К; T_1 – the temperature at the output of the heat pipe °C*;* T_2 – the temperature at the inlet of the heat pipe, °C.

Mass air consumption from the fan is determined by the following expression:

$$G = V\rho,$$

where V – fan performance, Tidar RQA 12038HSL 220VAC series 170 m^3/h [18]; ρ – air density at different temperatures, kg/m^3.

The amount of heat transmitted to the greenhouse by solar radiation is calculated by the following expression:

$$Q_{rad} = \eta I_c F_{rad} \tau,$$

where η – the efficiency of the heat conversion of the beam equal to $\eta = 0,7$; I_c – solar radiation intensity, W/m^2; τ – the heat transfer coefficient, for a polyethylene film, the coefficient value is assumed to be 0,35. It is estimated that solar radiation reaches half of the roof area:

$$F_{rad} = bL_k,$$

where L_k – typical roof dimensions, 6 m; b – the length of the roof, 4,8 m.

Execution of heat in the soil of the heating chamber for heating the greenhouse. In this method the soil heat of the heating chamber installed in front of the greenhouse was used to heat the greenhouse through the heat pumps.

The measurement and calculation results for the case when Execution of heat in the soil of the heating chamber for heating the greenhouse are shown in table.

Results of measurement and calculation of parameters

T, h	Δ*T*, К	ρ, kg/m^3	*G*, kg/h	Q_{air}, W	I_c, W/m^2	Q_{rad}, W	Q_{bal}, W
08.00	2	1.282	217.94	122.08	19.1	135	257.08
10.00	14.1	1.228	208.76	824	221	1560	2374
12.00	15.4	1.222	207.74	896	380	2682	3578.4
14.00	14.1	1.228	208.76	824	536	3780	4604
16.00	6.2	1.263	214.71	373	250	1764	2137
18.00	10	1.246	211.82	592.8	0	0	592.8
20.00	10	1.246	211.82	592.8	0	0	592.8
22.00	10	1.246	211.82	592.8	0	0	592.8
00.00	10.6	1.243	211.31	627.4	0	0	627.4
2.00	12	1.237	210.29	706.8	0	0	706.8
4.00	11.4	1.24	210.8	672.9	0	0	672.9
6.00	10.9	1.242	211.14	644.5	0	0	644.5
8.00	14	1.228	208.76	650.2	23	162.3	812.5

The heat under the heating chamber was pumped through a special heat pump and fed to the underground heat pipelines of the helium greenhouse. In this case, the the effect of the heat amount supplied to the greenhouse on the heat level inside it is shown in Figure 2 below.

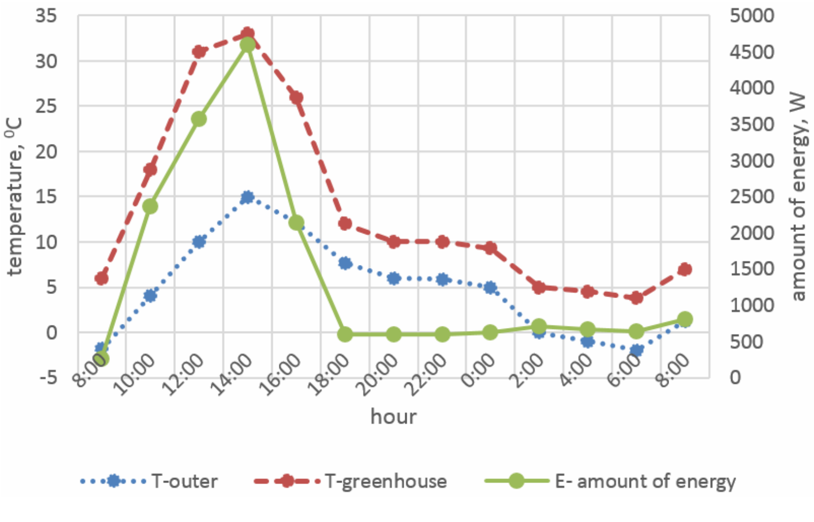

Fig. 2. Time dependence of the heat generated in the greenhouse by the use of heat in the heating chamber

Research work has been carried out in this helium greenhouse and the following results obtained: as can be seen from the dependence, the heating chamber was able to make a difference of at least +5 °C when using the soil temperature. This suggests that it is also important to use a heating chamber with an additional heat source. As also can be seen from the dependence, the temperature inside the greenhouse in the afternoon reaches a temperature that is airy for the plants, therefore it was intended to collect the accumulated heat. The excess heat in the greenhouse during the day was transferred to the underground rocks through a heat pump, thus maintaining the normal temperature during the day in the greenhouse.

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ОЦЕНКА ВНЕДРЕНИЯ РЕСУРСОСБЕРЕГАЮЩИХ И ИННОВАЦИОННЫХ ТЕХНОЛОГИЙ ПО РАЗВИТИЮ ЭНЕРГЕТИКИ В УСЛОВИЯХ ТУРКМЕНИСТАНА

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Государственная программа по энергосбережению на 2018–2024 годы была утверждена Президентом Туркменистана Указом № 14900 от 15 июля 2016 г. согласно плану выполнения намеченных мероприятий для реализации в жизнь Государственной программы повышения результатов научных исследований и инновационных технологий в Туркменистане за период с 2017 по 2021 г.

Основные цели из указанной Государственной программы:

1. Для обеспечения стабильного развития экономики Туркменистана осуществить на высоком уровние рациональное использование энергетической отрасли и природных энергетических ресурсов.

2. В топливных запасах Туркменистана увеличить количество возобновляемых источников энергии, нетрадиционных энергетических ресурсов, видов отбираемого топлива, а также вторичных источников энергии.

3. Использование средств энергетики обусловливает обеспечение охраны окружающей среды, охраны жизни и здоровья населения.

Отдельное внимание уделяется мероприятиям, связанным с разработкой инновационных и ресурсосберегающих технологий.

Развитие ресурсосберегающих технологий является одним из направлений экономического развития Туркменистана. Это технологии, обеспечивающие производство продукции с минимально возможным потреблением топлива и других источников энергии, а также сырья, материалов, воздуха, воды и прочих ресурсов, используемых для технологических целей. Они включают в себя использование вторичных ресурсов, утилизацию отходов, а также рекуперацию энергии, замкнутую систему водообеспечения и др. Позволяют экономить природные ресурсы и избегать загрязнения окружающей среды [1].

Одними из таких технологий являются электростанции с комбинированным циклом. В Туркменистане для производства электроэнергии исползуются электрические станции с газотурбинными установками разных мощностей. На газотурбинных установках с помощью копрессора всасывается воздух с атмосферы и с повышенным