RESULTS OF PRACTICAL EXPERIENCE OF HEATING A GREENHOUSE VIA SOLAR WATER HEATING COLLECTORS WITH VACUUM TUBES (IN KARSHI CITY CONDITIONS)

Toshboev Abdimalik
https://orcid.org/0009-0005-2139-2861
Assistant, Karshi State Technical University
Sultanov Samandar
https://orcid.org/0009-0009-6593-6671
PhD student at Karshi State Technical University.
Sohibov Medxun
https://orcid.org/0009-0007-6557-9948
Master's student at Karshi State Technical University.

Annotation

This article calculates the heat load required to maintain the internal temperature of the greenhouse and analyzes the possibilities of heating a greenhouse using solar water heating collectors with vacuum tubes under conditions of external temperature fluctuations. The article uses as a basis the model of a greenhouse with an area of 50 m², covered with glass.

Keywords: greenhouse heating, solar energy, evacuated tube collector, solar water heater, alternative energy sources, practical experience results, thermal efficiency, environmentally friendly heating method, solar collector system, energy-saving technology.

In Uzbekistan, year-round cultivation of vegetables and other products in greenhouses uses artificial heat sources. Compared to traditional fuels, the use of solar energy can reap environmental and economic benefits, especially through the use of vacuum tube solar collectors.

In winter, there is a need for an efficient source of heat to maintain a greenhouse microclimate. Solar energy is important as a renewable and cost-effective source. In order to determine the efficiency of vacuum tube solar water heating collectors under real conditions, an experiment was carried out in Karshi.

Experience Conditions

Date: February 22, 2025- Location: Karshi city, Kashkadarya region- System: vacuum collector with 20 pipes, capacity 200 liters- Time: from 09:00 to 15:30- Outside temperature: 6 °C → 23 °C- Water temperature: 20 °C → 51 °C- Solar radiation: 342 → 970 W/m² (mixed cloudy and sunny conditions)

Table of experiments (main observations)

Time	External temperature (°C)	Water temperature (°C)	Solar radiation (W/m²)
9:00	6	20	342
9:30	7	22	480
10:00	8	25	627
10:30	9	28	729
11:00	10	30	645
11:30	13	33	860
12:00	17	35	820
12:30	18	38	650
13:00	18	39	400
13:30	18	42	650
14:00	20	44	845
14:30	23	49	970
15:00	22	50	560
15:30	21	51	710

Calculation of energy harvest

Thermal energy collected through water (during the whole experiment):

Formula:Q = m · c · ΔTm = 200 kgc = 4186 J/kg·°CΔT = 51 - 20 = 31 °CQ = 200 × 4186 ×31 = 25,951,200 J ≈ 7210 Wh = 7.21 kWh

Result: During the experiment, 7.21 kWh thermal energy was collected.

Correlation with expected energy

Average solar radiation: 745 W/m²
Collector area: 2 m²Working time: 6.5 hours

Q = 2 × 745 × 6.5 ≈ 9.67 kWh

Actual: 7.21 kWhTheoretical maximum: 9.67 kWh
Efficiency: (7.21 / 9.67) × 100 ≈ 74.6%

Figure 1 Solar Water Heating Collectors with Vacuum Tube

Calculation of greenhouse heat load

Heat loss of a greenhouse is calculated by the following formula:

$Q=U \cdot A \cdot \Delta T$

here:

- Q is heat loss (W),
- U is the total coefficient of thermal conductivity ($W/m^2 \cdot K$),
- A— heat-conducting level of the greenhouse (m^2),
- ΔT is the temperature difference (K) between the inside and outside.

Information:

- Greenhouse area: 50 m^2
- Average height: 2.5 m → Volume ≈ 125 m^3
- Surface area (wall + roof): approx. 130 m^2
- Glass (window) surface: 100% → U=5.7U = 5.7U=5.7 W/cu· K (U-value of a normal window)
- Internal temperature: +20 °C
- External temperature: from +5 °C to −5 °C

Calculations:

External temperature (°C)	**ΔT (K)**	**Q(W)**
+5	15	5.7×130×15=111155.7 × 130 × 15 = 111155.7×130×15=11115 W
0	20	5.7×130×20=148205.7 × 130 × 20 = 148205.7×130×20=14820 W
−5	25	5.7×130×25=185255.7 × 130 × 25 = 185255.7×130×25=18525 W

Thus, when the outside temperature drops to −5 °C, the greenhouse heat load reaches 18.5 kW.


FIGURE 2: **Solar Greenhouse Heat**

Conclusion

This experiment from Karshi showed that 200 liters of water was heated to 31°C in 6.5h and 7.21kWh of energy was collected. Even in partially cloudy weather, the collector was able to generate enough heat. These results provide a practical justification for the use of such collectors for heating greenhouses

It is evident from calculations that a greenhouse with an area of 50 m² can be heated using solar water heater collectors with vacuum tubes. The main advantage of the system is environmental friendliness and low operation costs. The initial investment, while high, has long-term cost-effectiveness.

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