УДК 662.472:536.24

SOLAR HEATING MODE WITH FLAT REFLECTORS AND WATER HEATING ACCUMULATOR

Sh.B. Imomov[1], U.A.Hudaynazarov[2], B.Sh.Xamdamov[3].

[1]PhD in Engineering Sciences, [2] teacher, [3]student, Karshi Institute of Irrigation and Agrotechnology of the National Research University "Tashkent Institute of Irrigation and Agricultural Mechanization Engineers" Karshi, Uzbekistan

imomov-shuhrat@rambler.ru

ABSTRACT

The modes of solar and additional heating of a building with a system of solar reflectors installed on the north side are given.

Keywords: *building; northern orientation; reflectors, heating mode, insolation.*

РЕЖИМ СОЛНЕЧНОГО ОТОПЛЕНИЯ С ПЛОСКИМИ РЕФЛЕКТОРАМИ И ВОДЯНЫМ АККУМУЛЯТОРОМ ТЕПЛА

АННОТАЦИЯ

Приведены режимы солнечного и дополнительного отопления здания с системой солнечных рефлекторов, устанавливаемых с северной стороны.

Ключевые слова: *здания; северный орентация; рефлектори, режим обогрева, инсоляция.*

INTRODUCTION

Currently, there is a wide variety of solar heating systems (SHS). The choice of a constructive solution for the SHS is determined by many factors: radiation and meteorological resources of the region, thermal and hydrodynamic and economic indicators. Both water and air SHS have positive and negative sides. The determining factor in the use of air SHS, for all their disadvantages, is their simplicity and low cost.

Standard heat loss Q_{sl}^{st} indoors are determined based on average long-term data:

$$Q_{sl}^{st} = K_{br}(t_{in}^{st} - t_{ex}^{st})F_{огр} \; ; \quad (1)$$

where t_{in}^{st} and t_{ex}^{st} - standard temperature of indoor and outdoor air, ^{0}C.

As t_{in}^{st} a comfortable temperature is accepted t_{in}^{st}= 20 ^{o}C, t_{ex}^{st}- average perennial outdoor air. Actual heat loss Q_{hl}^{ac} indoors are determined by the formula [1]

$$Q_{hl}^{ac} = \varphi_{hl} Q_{sl}^{st} \; ; \quad (2)$$

where φ_{hl} – coefficient of actual heat loss:

$$\varphi_{hl} = (t_{in}^{st} - t_{ex}^{ac}) / (t_{in}^{st} - t_{ex}^{st}) ; \qquad (3)$$

where t_{ex}^{ac} - actual outdoor temperature, °C.

The heating season starts on condition

$$Q_p \leq Q_{hl}^{ac} . \qquad (4)$$

The proportion of solar radiation relative to heat loss is determined by the replacement coefficient:

$$f = Q_p / Q_{hl}^{ac} . \qquad (5)$$

Coverage of heat losses in the room is provided by the intake of solar radiation and an additional heat source. Additional heating Q_{he} is determined by the condition of covering the actual heat loss and the receipt of solar radiation:

$$Q_{he} + Q_p = Q_{hl}^{ac} \qquad (6)$$

From here

$$Q_{he} = K_{st}(Q_{hl}^{ac} - Q_p) ; \qquad (7)$$

where K_{st} = 1…1,5 – safety factor.

With solar heating, heating mode is carried out intermittently. During the period of heat shortage (at $t_{in} < 20^0 C$), heating is provided due to the accumulated heat Q_{ah} and an additional heat source Q_{he}.

Heating period τ_o consists of the battery life τ_{de} (detente) and the operating time of the additional heat source [2] τ_{ad}:

$$\tau_{he} = \tau_{de} + \tau_{ad} . \qquad (8)$$

The daily τ_{da} heating operation mode is

$$\tau_{he} + \tau_{pa} = \tau_{da} = 24h ; \qquad (9)$$

where τ_{pa} – pause when there is no heating, at $t_{in} > 20^0 C$.

Heating duration is expressed as a fraction of the daily period

$$\gamma_{dh} = \tau_{he} / \tau_{da} \qquad (10)$$

The average daily heating capacity is determined from the equation

$$Q_{he}^{av} = \tau_{hp} Q_{he} . \qquad (11)$$

From here

$$Q_{he}^{av} = \gamma_{dh} Q_{he} \qquad (12)$$

To ensure a normal temperature in the room, the condition is necessary

$$Q_{pa} - Q_{he}^{av} = Q_{hl}^{ac} \qquad (13)$$

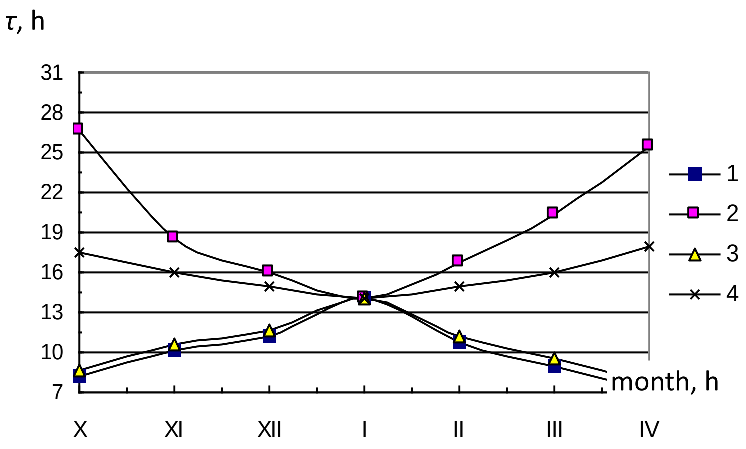
VOLUME 2 | ISSUE 3
ISSN 2181-1784
SJIF 2022: 5.947
ASI Factor = 1.7

Condition (13) can be used to determine the heating duration

$$\gamma_{dh} = \frac{Q_{he}^{av}}{Q_{he}} = \frac{Q_{hl}^{ac} - Q_p}{Q_{he}} = \frac{\varphi_{hl} Q_{hl}^{ex} - Q_p}{K_z (Q_{hl}^{ac} - Q_p)} \qquad (14)$$

Accumulation time τ_{at}, excess heat from solar radiation, coincides with the period of no heating τ_{pa}.

In fig. 1 shows the average monthly daily room heating mode.



Drawing. 1. Average monthly room heating mode: 1 and 2 - periods of the beginning and end of heating τ_{he}; 3 and 4 - the period of the beginning and end of heat accumulation τ_{at}

DISCUSSION AND RESULTS

Heating τ_{he} is provided up to line 1 and above line 2 (heat deficit coverage). There is no heating τ_{pa} during the time between lines 1 and 2. This period is the of heat accumulation τ_{at} - the period between lines 3 and 4. The accumulation mode above line 4 is impractical, since after line 4, the accumulated heat is cooled prematurely.

1 mode. During the period of insolation, a large excess of solar radiation occurs and the air temperature in the room significantly exceeds the standard value $t_{in} >> t_{in}^{st} = 20^0 C$. Decrease of indoor air temperature to $t_{in}^{st} \approx 20$ °C provided with active aeration and ventilation of the room, as well as active accumulation of excess solar heat τ_{ah}. At night, a short period of heat occurs and the room temperature drops below the standard value $t_{in} < t_{in}^{st}$. Lack of heat at night τ_{hn} replenished only by heat Q_a, accumulated in the daytime. This regime is observed in October and April.

2 mode. During the period of insolation, there is an excess of solar radiation, the air temperature in the room exceeds the standard value $t_{in} > t_{in}^{st}$. During this period, it is necessary to actively accumulate excess solar heat τ_{ah} and ensure that the room temperature drops to t_{in}^{st}. At night, the resulting heat deficit reduces the room temperature below the standard value $t_{in} < t_{in}^{st}$. Due to the heat accumulated during the daytime Q_{ah} and additional heat source Q_{he} its deficit at night is compensated τ_o. This regime prevails in November, February and March.

3 mode. During the period of insolation, there is no excess heat of solar radiation, the air temperature does not exceed the standard value $t_{in} < t_{in}^{st}$. During the day, it is necessary to replenish the heat deficit τ_o due to additional heat source Q_{he}. This regime is observed in December and January.

Perimental studies show that after the maximum value of the air temperature at the outlet of the SC t_{oc}(after 13 h), as a result of the temperature drop t_{oc}, heat is transferred from the upper layers of the packing to the lower layers. Further, a general decrease in the heat accumulator temperature occurs, which leads to a premature cooling of the accumulated heat. On the basis of experimental data, it was found that the temperature of the air coming from solar collector in heat accumulator, falls below the maximum value t_{oc} (at 13 o'clock) by 87 ... 90% (at 14 ... 16 hours), further heat accumulation is ineffective as the mass-average temperature of the heat accumulator begins to drop. Fuel consumption for additional heating is determined by the formula

$$B_{ad} = Q_h \cdot K_{st} / Q_h^n \eta_k \;; \qquad (15)$$

where K_{st} – fuel reserve factor equal to 1,1…1,2; Q_h^n - lower heat of combustion of fuel (natural gas) [3], kJ/m^3; η_k – efficiency of the heating installation, for gas fuel 0.8. Fuel savings due to solar heating are determined by the following condition:

$$B_s = B_{hl} - B_{ad} \;; \qquad (16)$$

where B_{hl} – fuel consumption for heat losses, m^3

CONCLUSION

Fuel (gas) savings for the heating season is 58%. Electricity consumption for the operation of the fan for pumping air in the heating system is determined by the periods of accumulation τa and heating τo, in accordance with formulas (8) and (9). With air flow in the system $G = 0{,}17 m^3/s = 612 m^3/s = 612 m^3/s$; system pressure loss $\Sigma\Delta P$=110 Pa the installed power of the fan motor is $N_{ins} = 118 kWt$. We accept

VOLUME 2 | ISSUE 3
ISSN 2181-1784
SJIF 2022: 5.947
ASI Factor = 1.7

axial fan VO 4M 300-220/50: performance $G = 300...1650 m^3/h$, total pressure ΔP=110 Pa, rotation frequency $n = 1340 rev/\min$, engine power $N = 0{,}12 kWt$, with speed regulator. Electricity consumption for ventilation during the heating season is $W_v = 490 kWt \cdot h/y$. Energy consumption for ventilation accounts for 9.3% of solar and auxiliary heating energy.

REFERENCES

1. Виглин Е.С. Тепловой режим малоэтажных домов при периодичесом отоплении. //Системы вентиляции, отопления и теплоснабжения. –М.: 1985, №4, С.89-104.
2. Ш.Б. Имомов, В.Д. КИМ. Экспериментальное исследование теплового режима здания с системой рефлекторов, устанавливаемых с северной стороны. //Гелиотехника. –Ташкент: Фан, 2009, №2, С. 30-33
3. Теплотехнический справочник. Том 1. –М.: Энергия, 1975, -774 с.