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THE STUDY OF THE HEAT INTO NON-HEATED CULTIVATIVE CONSTRUCTIONS OF THE CLOSED SOIL

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The issue of using thermos greenhouses as unheated cultivation facilities for growing leaf crops year-round with minimal costs to maintain the required microclimate is considered. The main advantages and disadvantages of the construction and operation of different types of pit greenhouses are analyzed using the example of greenhouse thermoses. The design diagram of the heat balance of an unheated structure is given, the main types of supply and heat costs are considered. The total solar heat flux, which penetrates to the working surface (floor) of the greenhouse through a translucent fence, is calculated, and the obtained value is compared with the average heat loss in the cold period of the year from one square meter of the greenhouse working surface. The process of receipt of biological heat to heat the soil (or zone of the root system) is considered. Presents data on the temperature values of organic substances and the timing of the support of this temperature, when we using substances to produce biological heat. Analyzed the process of condensation of moisture on the coating, the effect of excess moisture on the condition of plants and made recommendations to eliminate the excess moisture in the air of the greenhouse.

Key words: greenhouse-thermos, closed ground, lightness, convective heat, radiant flux, aeration, heat balance, biological heat, condensation.

Introduction. In the future, the problem of providing vegetables and leaf crops to the population in winter may be solved by exporting them from foreign countries. But this increases the cost of production, in addition, in some cases, the quality of such products may be conscientious. Significant costs of products occur in the process of transportation of goods over long distances, which leads to a rise in price when the goods reach the buyer. This indicates the need for the development of the domestic greenhouse economy. If calculations proceed from monthly norms of green vegetables per person and average yields of 1 m^2 greenhouses, we can calculate the required area of winter greenhouses for any economy that serves a particular city or area. It is considered expedient to use large greenhouse combines of the following structure: winter greenhouses - 17%, winter seedlings - 10% of the total area of all greenhouses, spring greenhouses - 73%. Moreover, the definition of optimal capacities and their rational placement is of great importance. But for small farms the commissioning and maintenance of the greenhouse is a challenge to be overcome, therefore, it becomes a question to develop such conditions of exploitation and maintenance of small greenhouses with minimum expenses in order to obtain maximum income with a minimum cost of production. In addition, the location of such small greenhouse farms does not require large areas, they can be located not far from settlements and cities, which, in turn, reduces the cost of delivering goods to consumers. When transporting crop production, its quality is influenced by delivery terms and terms of stay on the road. The analysis of the actual cost of growing vegetables and leaf crops shows that in December, January and February, the production cost increases dramatically due to the high costs of heating and low crop yields during this period of the year. Comparison with the estimated cost confirms the need to grow in the winter only green crops that are less demanding for light and heat and have a short vegetative period.

The problem. For good human health, green leafy vegetables that are rich in essential and potent nutrients are critical and are an important part of a healthy diet rich in vitamins, minerals and fiber, but have a low calorie content. A diet rich in dark green leafy vegetables can bring total benefits to the body, including reducing the risk of obesity, cardiovascular disease, high blood pressure and mental illness. One of the ways of even supplying fresh vegetables to the population throughout the year is the development of closed soil, which gives the opportunity to get a crop regardless of weather. But possibilities of vegetable cultivation of the closed ground are limited by insufficient natural illumination in the autumn-winter period and high cost of heating in winter. It is determined that the share of heating costs is 40 ... 50% of the total cost of production. Therefore, it is necessary to pay attention to the growing of leaf crops in non-heating cultivating structures, which will significantly reduce the cost of the resulting products. The simplest construction of protected soil is the greenhouse, which receives both solar heat and heat from the transfer of manure. From the top of the manure there is a small layer of soil. The advantage of such structures is the low cost of fencing structures. As a rule, their height does not exceed one meter, and they are covered with wooden panels with glass filling. The designs of the greenhouses, taking into account their height and the presence of doors, allow the care of crops more convenient, in addition, the coating is made of polyethylene or polycarbonate.

The purpose of research. The purpose of the following research was to study the requirements for creating the necessary microclimate in growing leaf crops in non-heated cultivating structures of closed soil. In the course of the research, the types of heat entering the protected soil were analyzed. The analysis of influence of sunlight (insolation) on temperature change in the greenhouse, taking into account the correct location of the external fence relative to the sides of the world, was carried out. The objective is to determine the main objectives of the study: - study of the processes of receiving heat from the insolation and biological heat for heating the soil (or zone of the root system) in the structures of protected soil; - studying the conditions for calculating the flow of heat into a non-heating plant.

The results of the research. An analysis of existing non-heated greenhouses has led to the conclusion that the most economical in operation are underground greenhouses-thermoses [2]. Such a greenhouse can be used all year round. However, it is believed that the main negative side in the construction of such a greenhouse is digging the pit, because this process is quite labor-intensive and requires additional costs. When calculating the cost of a greenhouse-thermos building, the cost of digging the pile is overwhelmed by savings on building materials when erecting walls. As a material for a wall of such a greenhouse, you can use shells, bricks and wood, which was in use. It is not necessary to decorate such walls. That is, the economic benefits of the construction of such a greenhouse-thermos are obvious, regardless of the cost of the cover sheet for the roof. As a cover sheet, you can use a film, glass or cellular polycarbonate in a thickness of 6 mm.

a) the deepened pitting tunnel greenhouse b) an underground pit of two-leaf greenhouse

c) the arched or tunnel greenhouse-thermos d) a single-deck greenhouse-thermos

Fig. 1. Varieties of greenhouse-thermoses.

Pit greenhouses, depending on the depth of immersion in the soil and the height of the walls are divided into underground and deepened. For underground greenhouses, the outside only finds coverage, but there are problems with lighting. When deepened hothouses to a depth of 50 to 80 cm cover and part of the walls is found above the ground. The height of the above-ground part of the walls is taken at a minimum of 110 cm, but due to the aboveground wall, the heat is consumed extra. It is recommended for areas with even relief horizontal greenhouses, that is, greenhouses in which the opposite walls of the same height. At different heights of opposite walls, oblique models are used, they are mainly used on slopes. The main condition of such a greenhouse is the choice of the sunshine and the optimal angle of the roof. The question of the orientation of greenhouses relative to the world's sides is solved depending on the location of the greenhouse, there is a zone, where there is practically no direct solar radiation in the winter, and the zone where the radiation is sufficiently abundant. In the summer, overheating of greenhouses takes place in the southern regions, therefore, their proper orientation is important to reduce overheating. It is determined that for the orientation of the grasshopper greenhouses should take into account assortment and methods of growing plants during the critical period. At low solstice (in the morning and at the end of the day), in order to improve the spacing between the rows, the rows of plants should be placed from east to west. In addition, to create a uniform illumination of all neighborhoods of greenhouses should anticipate the deviation of the axis of the greenhouse at 5 ... 22°. In suburban areas, the arrival of solar radiation in cultivating facilities is 7 ... 12% more than 12 hours a day (after astronomical time) than after 12 hours - this is due to a decrease in the transparency of the atmosphere after 10 ... 11 o'clock in the morning. According to the Danish and British experts, increasing the greenhouse's 1% education gives 1% of the increase in the yield. To provide better airflow, greenhouses with a height of 2.5 m or 3 m, but not higher, are taken in order to provide better airflow, as increasing the height leads to an increase in wind load, heat and blow ups. The basis of the climate research of the greenhouse was laid the method of thermal balance, which allows to consider the construction as a single energy unit in the study of the relationship of all flows of heat and mass in the building with the help of a system of balance equations [5]. The method of thermal balance allows to determine the thermal properties of the structure. When calculating the thermal balance of a non-heating greenhouse, the following components are taken into account: radiant fluxes emitted by the soil and the external surface of the enclosure; radiant flux, which is perceived by the inner surface of the fence; convective heat supplied by the soil and the external surface of the fence; the heat that is spent on the evaporation of moisture from the soil, and the heat that is released when condensing on the inner surface of the enclosure. An analysis of air temperature changes was carried out in height, width and length of the greenhouse, as well as on the soil surface. The location of the aeration tanks in the lower part of the enclosure, directly near the ground, with a small width of the greenhouse negatively affects the plants due to the sharp cold air that intrudes. It can not be considered rational location of tidal air vents directly in the working area of the building, so this question is still in the study stage [3, 4].

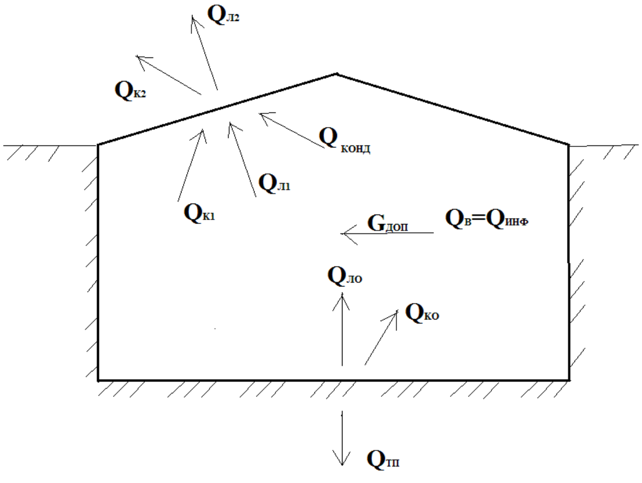

Fig. 2. Calculation scheme of thermal balance of non-heating plant.

$Q_{\text{Л0}}$, $Q_{\text{Л1}}$, $Q_{\text{Л2}}$ - radiant heat flux according to the soil, to the rock, from the slope, J/h.; $Q_{\text{К0}}$, $Q_{\text{К1}}$, $Q_{\text{К2}}$ - heat transfer by convection from ground to rock, from rock, J/h.; $Q_{\text{К0НД}}$ - heat release during condensation of steam on a ramp, J/h.; $Q_{\text{ТП}}$ - heat loss through soil, J/h.; $G_{\text{ДОП}}$ - additional humidification of internal air, kg/h.

One of the main tasks of the study was to study the processes of heat flow from insolation. A calculation was made of the amount of solar energy that penetrates the greenhouse through the roof of the greenhouse-thermos. Determine the total solar flux of the Φ_{Π} that penetrates the working surface of the hangar greenhouse at $13^{\underline{00}}$ hours in December. The greenhouse is located at latitude $\varphi \approx 47^{o}$ (north of the Odessa region).

Output data:

1) the area of the greenhouse $S_{\Pi} = 100$ m^2 (width 5 m, length 200 m);
2) angles of slope $\alpha_1 = \alpha_2 = 30°$;
3) orientation - a grasshopper in the E-W (latitudinal);
4) the design of the greenhouse - a metal frame, glazing in a span with a step of 610 mm.

Glass pollution is insignificant $\tau_3 = 0,9$.

The total solar radiation for the north of the Odessa region in December is Q_C = 207 W/m^2; - height of the sun on December 22 $h_{\Theta} = 66,5$ °; - azimuth of the sun at noon $a_{\Theta} = 0^{o}$, thus $h'_{\Theta} = h_{\Theta}$ = 66,5^{o}. According to the graphs [1, p.124] we find the coefficient of use of beam streams $U^{H} = 1$ (at $h'_{\Theta} > \alpha$).

According to the graphs [1, p.120] we find the angle of incidence of direct sunlight for December $i_1 = 2^{o}$ and $i_2 = 65^{o}$. We accept the value of the coefficient $\tau_K = 0,9$.

Based on the design of the frame of the greenhouse, we determine the following dimensions of the structural elements of the enclosure: h'= h''= 0.036 m; l'= 0.61 m; l'' = 1.7 m; b'= b''= 0.036 m.

From the orientation of the greenhouse A = 0.

According to the schedule [1, p.122] we find at $\tau_3 = 0,9$: $(\tau_C)_1 = 0,80$ and $(\tau_C)_2 = 0,60$. The transmission coefficient of direct solar radiation by the greenhouse enclosures τ_i is calculated according to the formula, which takes into account the relaxation of the light flux by the binding of the cell with a transparent translucent fence material under different conditions of its contamination:

$$\tau_i = \left(1 - \frac{2b' + h' \cdot tgi \cdot \sin A}{l'}\right)\left(1 - \frac{2b'' + h'' \cdot tgi \cdot \cos A}{l''}\right) \cdot \tau_c \cdot \tau_з \,, \qquad (1)$$

where b', h', l', b'', h'', l''- the dimensions of the structural elements of the enclosure are given, m [1, p.118];

A - azimuth of the binding of the cell (the angle between the longitudinal axis of the cell and the direction of the solar beam a_{Θ}); τ_C, τ_3 - components of the total transmittance, which characterize the transmission of translucent material (index "C") and the layer of pollution on it (index "3").

The dimensions of the structural elements of the cells are determined by the design of the frame of the greenhouse. Characteristic cells of glazed greenhouses are made of metal and have dimensions of 610*x*1700 mm (for film greenhouses, the dimensions are 1500*x*1500 mm and executed from wooden bars of a cross section 40*x*70 mm). Then, according to formula (1), determine the transmission coefficient of direct solar radiation by the cells of the greenhouse enclosure:

$$(\tau_i)_1 = \left(1 - \frac{2 \cdot 0.036 + 0.036 \cdot tg2^0 \cdot \sin 0^0}{0.61}\right)\left(1 - \frac{2 \cdot 0.036 + 0.036 \cdot tg2^0 \cdot \cos 0^0}{1.7}\right) x$$

$$x 0.80 \cdot 0.90 = 0.608$$

$$(\tau_i)_2 = \left(1 - \frac{2\cdot 0.036 + 0.036\cdot tg65^0 \cdot \sin 0^0}{0.61}\right)\left(1 - \frac{2\cdot 0.036 + 0.036\cdot tg65^0 \cdot \cos 0^0}{1.7}\right)x$$
$$x0.60\cdot 0.90 = 0.434$$

The irradiation factor of the working surface by direct radiation is determined by the formula:

$$K_{\Pi}^{\Theta} = \tau_i \cdot \tau_k \cdot m \cdot U^{\Theta} \cos i\,, \qquad (2)$$

where τ_i - coefficient of transmission of direct solar radiation by separate cells of greenhouse enclosure for a given angle i falling of sun rays to the surface of the fence; i - the angle of incidence of direct sunlight on the surface of translucent fencing, which is calculated from the normal to the fence, grad .; τ_k - coefficient, which takes into account shading from the structure of the structure of the structure (without taking into account the design of the frames);m - coefficient characterizing the relation between the surface of the fence and the working surface in the characteristic section of the greenhouse (Fig. 3); U^{Θ} - the coefficient of use of radiation streams.

$$m = \frac{S_0}{S_n} = \frac{1}{2\cdot\cos\alpha}, \qquad (3)$$

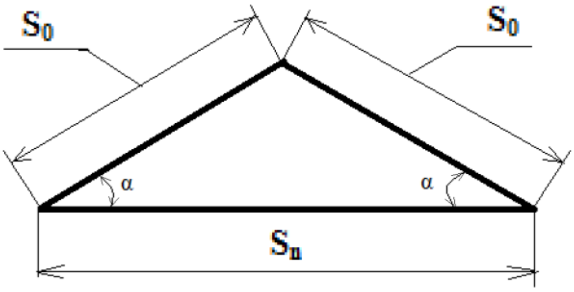

Fig. 3. Definition of the coefficient *m*.

We calculate the coefficient *m*, which characterizes the relation between the surface of the fence and the working surface in the characteristic section of the greenhouse:

$$m = \frac{1}{2\cdot\cos 30^0} = \frac{1}{2\cdot 0.865} = 0.578$$

By formula (2) we determine the irradiation factor of the working surface by direct radiation K_{Π}^{Θ}:

$$K_{\Pi}^{\Theta} = \left(0.608\cdot\cos 2^0 + 0.434\cdot\cos 65^0\right)\cdot 0.9\cdot 0.578 = 0.412$$

To determine the irradiation factor for scattered irradiation in rice. 4 and by the formula (1) at A = 45 ° we find:

- for $i = 20^o$; $\tau_C = 0.80$; $\tau_{20^o} = 0{,}593$;
- for $i = 45°$; $\tau_C = 0.75$; $\tau_{20^o} = 0{,}535$;
- for $i = 70°$; $\tau_C = 0.51$; $\tau_{20^o} = 0{,}322$.

The coefficient is defined as the average of the coefficients τ_i at i = 20, 45 and 70° for A = 45°:

$$\tau_{\text{д}} = \frac{1}{3}\left(\tau_{20^0} + \tau_{45^0} + \tau_{70^0}\right), \qquad (4)$$

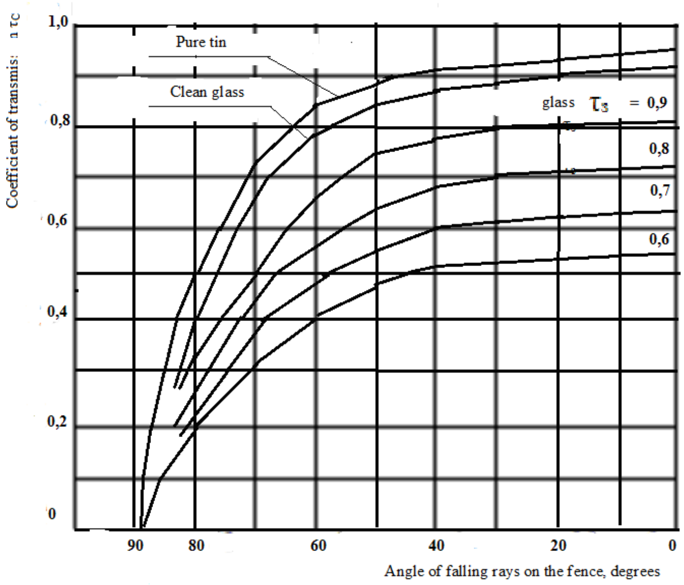

Fig. 4. Pass-through coefficient of translucent material τ_C.

By formula (4) we determine the total transmittance of scattered rays (diffuse radiation) by separate cells of the greenhouse enclosure:

$$\tau_{\text{д}} = \frac{1}{3}(0.593 + 0.535 + 0.322) = 0.483$$

For new greenhouse designs, the coefficient $K_{\text{П}}^{H}$ is calculated according to the formula:

$$K_{\text{П}}^{H} = \tau_{\text{д}} \cdot \tau_{K} \cdot U^{H}, \qquad (5)$$

where $\tau_{\text{д}}$ - the total transmission factor of diffused rays (diffuse radiation) by separate cells of the greenhouse enclosure; U^{H} - coefficient, taking into account the mutual shading of slopes (for block greenhouses is taken equal to 0,95, for individually located is equal to 1).

By formula (5) we determine the irradiation factor with diffused irradiation $K_{\text{П}}^{H}$:

$$K_{\text{П}}^{H} = 0.483 \cdot 0.9 \cdot 1$$

By nomograms [1, p.129] we define: $\sinh^{ср}_{\Theta} = 0.65$ and N = 2,8.

Based on the found coefficients $K_{\text{П}}^{\Theta}$ and $K_{\text{П}}^{H}$ determine the required total irradiation coefficient of the working surface $K_{\text{П}} = 0.70$. The total flux of solar radiation penetrating the working surface (floor) of the greenhouse through the translucent fencing $\Phi_{\text{п}}$, W, is determined by the formula:

$$\Phi_{\text{п}} = Q_C \cdot K_{\text{п}} \cdot S_{\text{п}}, \qquad (6)$$

where Q_C - total solar radiation flux on the horizontal surface of the greenhouse, W/m^2; $K_{\text{п}}$ - coefficient of irradiation of the working surface (floor) of the greenhouse by the total heat flux of solar radiation; $S_{\text{п}}$ - floor area, м^2.

The coefficient of irradiation of the working surface of the greenhouse $K_{\text{п}}$ is determined by the irradiation coefficient of the working surface of direct radiation $K_{\text{П}}^{\Theta}$ and the irradiation factor with diffused radiation $K_{\text{П}}^{H}$. By formula (6) we find the total flow of solar radiation that penetrates to the working surface (floor) of the greenhouse through a transparent window fence:

$$\Phi_{\text{п}} = 565 \cdot 0{,}70 \cdot 100 = 395500 \text{ W} = 396 \text{ kW}.$$

Average heat losses during the cold period of the year from one square meter of working surface area of the greenhouse are 200 W/m^2. According to the calculations, the amount of heat from the total solar radiation flux is 396 W/m^2. That is, on sunny days, the amount of heat generated by solar radiation by the working surface of the greenhouse thermos exceeds the heat loss from the same surface. Consider the process of heat loss through the soil after calculating the heat balance equations. Specified heat loss through the soil $Q_{\text{ТП}}$, J is determined by the formula:

$$Q_{\text{ТП}} = \frac{t_{\text{об}} - t_H}{R_0^{CP}}, \qquad (7)$$

where $t_{\text{об}}$ - the total temperature of the internal air, which takes into account the heat transfer conditions in the greenhouse, ºC; t_H - temperature of external air, ºC; R_0^{CP} - resistance to heat transfer through the soil, which is determined by the formula:

$$R_0^{CP} = \frac{\pi \cdot l}{2\lambda \cdot n \cdot \ln \frac{\alpha_{\text{об}} \cdot l}{\lambda \cdot n}}, \qquad (8)$$

Formula (8) is used for hothouses, where the length is considerably greater than width, and for greenhouses of a large area (F >16 m^2). The heating of greenhouses with the help of solar energy is best combined with the heating of biological. This will significantly reduce the cost of heating greenhouses and improve the conditions for growing plants. To create optimal conditions for growing different crops in greenhouses use three main methods of heating the soil and heating greenhouses: natural, technical and biological. It is believed that the optimum daytime temperature is 16 ... 25ºC, and the night can decrease by 4 ... 8ºC. Consider the flow of biological heat for the heating of the soil (or root zone system). Increasingly, generating biofuels based on manure or straw is used to create warm rundles on warming mixtures. Often, as biofuels for greenhouses, manure is used for domestic animals, wood fillet, straw, leaves, plant residues, household garbage of organic origin. After use, biofuels are used as fertilizers. That is, using biofuels can significantly improve the efficiency of greenhouses and improve the environment of the surrounding space. The heating process begins from the moment of decay and decomposition of organic substances, during which heat is released, and the air is saturated with carbon dioxide, which is necessary for plants to ensure normal livelihoods. The mass of biofuels depends on the amount of heat released: the more manure layer, the higher the temperature. The classic version of the substrate can provide a temperature level of up to 65 ... 75°C. Isolation of heat occurs due to chemical processes of decay. The manure of different origin allocates heat in different amounts. Table 1 presents the data on the temperature values of organic substances and the timing of maintaining this temperature when using substances for the production of biological heat.

Table 1. **The temperature of heating of organic substances during decomposition and terms of maintaining temperature**

Name of raw material (source)	Heating temperature during the decomposition of organic matter deg.	Term of temperature support
Horse manure	33...38	up to 90 days
Cow's waste	12...20	100 days
Pork manure	14...16	up to 70 days
Crumbled bark	20...25	4 months
Sawdust	up to 20	up to two weeks
Straw of winter wheat	40...45	short-term effect

\To accelerate the processes of heat release, in the waste poured hot water or quicklime. An important condition for the success of heating in this way is the presence of nitrogen fertilizers in the ground, good aeration and a normal level of humidity in the greenhouse. The method of preparing biofuel for placement in the greenhouse is simple enough: one week before laying a lot of garbage, straw or manure should be loosened loosely. In the greenhouse, on the beds, remove the top layer of soil and deposit biofuel with a layer of thickness of 15 cm. Then it is level with rake, watered with hot water or liquid manure to restore the process of decay. Biofuels will begin to heat in three to four days. Then they fall asleep with a layer of fertile land on which the beds are broken. Particular attention should be paid to the process of condensation of moisture on the coating. To grow healthy crops and get a good harvest, it is necessary to fight with condensation, which creates an excellent environment for the development of bacteria and fungi. In a non-heated greenhouse with closed ventilation, a decrease in moisture can only be achieved by condensing the residual moisture on the roof of the greenhouse. In this case, the temperature of the coating should be below the dew point, then when moisture is condensed enough heat is released. In order to prevent the re-evaporation of this moisture, it should be anticipated that it should be taken out of the greenhouse, there are the ventilation openings - fragmentation. However, during the winter period, it is necessary to be very careful, as there is a replacement of warm air inside the greenhouse on the cold air from the outside. The main cause of condensation formation is improper ventilation or its absence. Open the greenhouse in the morning until it has heated up under the influence of sun rays. The difference in temperature inside and outside will not be very high, then the moisture remains outside. Watering the plants should be done in the morning with warm water to evaporate the moisture remains throughout the day. To reduce the humidity at constant temperature in the greenhouse and the temperature difference at 20ºC it is necessary to replace 40% of the air without taking into account the evaporation of moisture inside the greenhouse, for this the frauds are opened for 2 ... 3%. It is estimated that when the relative humidity in the greenhouse is 90% and the temperature is 20°C, then when the temperature decreases at 2°C, the moisture falls very abundantly.

Conclusions. A calculation scheme of the heat balance of a non-heating plant for analysis of the main types of heat supply is prepared. The calculation of the total solar radiation flowing to the working surface (floor) of the greenhouse through the

transparent translucent enclosure in December showed that during the sunny days of the cold period of the year, the amount of heat generated by solar radiation by the working surface of the greenhouse thermos exceeds the heat loss from this the same surface. The process of receiving biological heat for soil heating (or zone of root system) is analyzed. On the basis of the analysis of the effect of moisture residues in the air in the greenhouses on the formation of condensate the recommendations are for the formation of favorable thermal characteristics.

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ИССЛЕДОВАНИЕ ПОСТУПЛЕНИЯ ТЕПЛА В НЕОТАПЛИВАЕМЫЕ КУЛЬТИВАЦИОННЫЕ СООРУЖЕНИЯ ЗАКРЫТОГО ГРУНТА

Мартынова Е.Б., Студзинский А.О.

Ключевые слова: теплица-термос, закрытый грунт, освещённость, конвективное тепло, лучистый поток, аэрация, тепловой баланс, биологическое тепло, конденсация.

Резюме

Рассмотрен вопрос использования теплиц-термосов в качестве неотапливаемых культивационных сооружений для выращивания листовых культур круглогодично с минимальными затратами на поддерживание требуемого микроклимата. Проанализированы основные преимущества и недостатки строительства и эксплуатации разных видов ямных теплиц на примере теплиц-термосов. Приведена расчётная схема теплового баланса неотапливаемого сооружения, рассмотрены основные виды поставки и затрат тепла. Проведён расчёт суммарного потока солнечного тепла, которое проникает к рабочей поверхности (полу) теплицы через светопрозрачное ограждение, и сравнение полученной величины со средними теплопотерями в холодный период года с одного квадратного метра площади рабочей поверхности теплицы. Рассмотрен процесс поступления биологического тепла для подогрева грунта (или зоны корневой системы). Представлены данные по температурным значениям органических веществ *и сроки поддержки данной температуры при использовании веществ для получения биологического тепла. Проанализирован процесс конденсации влаги на покрытии, влияние излишков влаги на состояние растений и даны рекомендации по устранению излишков влаги в воздухе теплицы.*

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Summary

The issue of using thermos greenhouses as unheated cultivation facilities for growing leaf crops year-round with minimal costs to maintain the required microclimate is considered. The main advantages and disadvantages of the construction and operation of different types of pit greenhouses are analyzed using the example of greenhouse thermoses. The design diagram of the heat balance of an unheated structure is given, the main types of supply and heat costs are considered. The total solar heat flux, which penetrates to the working surface (floor) of the greenhouse through a translucent fence, is calculated, and the obtained value is compared with the average heat loss in the cold period of the year from one square meter of the greenhouse working surface. The process of receipt of biological heat to heat the soil (or zone of the root system) is considered. Presents data on the temperature values of organic substances and the timing of the support of this temperature, when we using substances to produce biological heat. Analyzed the process of condensation of moisture on the coating, the effect of excess moisture on the condition of plants and made recommendations to eliminate the excess moisture in the air of the greenhouse.