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BASIC PRINCIPLES OF AUTOMATION CONTROL OF HEATING OF PROTECTED GROUND STRUCTURES

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ABSTRACT

This article describes how to control the operating modes of greenhouse heating systems, how to control the heating process in the daytime and in the evening, the temperature of heating furnaces using automatic regulators and relays. The effectiveness of manual and automatic control is also noted.

АННОТАЦИЯ

В данной статье рассказывается, как управлять режимами работы систем отопления теплицы, как контролировать процесс отопления днем и вечером, температуру отопительных печей с помощью автоматических регуляторов и реле. Также отмечается эффективность ручного и автоматического управления.

Keywords: Key words: control principle, temperature, regulator, valve, photosynthesis, ventilation.

Automation of heating of greenhouses as rather simple structures of the protected ground is reduced to automatic control of temperature of the soil and air depending on weather conditions, a type and age of plants.

The control of the thermal regime can be manual: switching the heating elements to different voltages, switching on separate groups of heaters, etc. However, automatic control of the temperature in greenhouses is preferable: only electricity costs are reduced by 15...20% compared to manual control.

Greenhouses, as objects of temperature control, are among the most complex objects of automation, and the determination of their characteristics is associated with certain difficulties arising from their features.

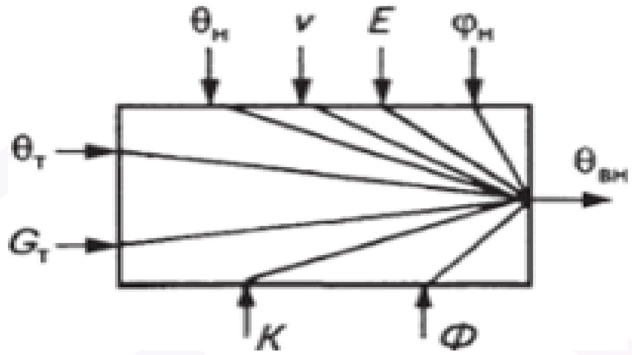

Fig 1. Block diagram of the greenhouse as an object of temperature control

The time constant of the greenhouse through the channels of control actions is determined by the heat capacities of the pipe heating system and the greenhouse itself. The first of the components depends on the heat load of the heating system and decreases exponentially with increasing water consumption, and the second can generally be assumed to be constant, independent of its consumption.

The delay in changing the air temperature in the greenhouse when changing the power of the pipe heating system depends on the design of the greenhouse itself and its heating system, the direction of movement of the coolant in the pipes and the location of the measuring transducers. The delay time varies for different control channels. Its lower values characterize the channel G_T - " O_{VN}, since when the flow rate changes the temperature of the outer walls of the pipe registers changes simultaneously along the entire length, and when controlling the water temperature (channel O_T- " O_{VN}), the delay value also includes a component determined by the speed of the temperature front along the length of the pipes. That is why the G_T —> O_{VN} channel is characterized by less inertia

The presence of a green mass of plants largely determines the unsteadiness of the greenhouse, as well as the temperature regime. During the time from the planting of seedlings to the beginning of harvesting, due to the increase in the green mass, the time constant of the object increases by 1.1... 1.3 times, the transmission coefficient decreases by 1.5 times, and the delay, depending on the speed of distribution of air flows, increases by 300...400 p.

Self-propelled guns with temperature in block and hangar greenhouses have their own characteristics and are therefore considered separately.

The temperature control systems in block greenhouses are not the same for the cold and warm seasons. In the cold season, temperature control can be provided by changing the temperature From (quality) or the flow rate from (quantity)of the coolant. Typical for block greenhouses is the qualitative management principle.

The temperature of the coolant is changed using a three-way mixing valve (TSK), designed in such a way that when moving h (Fig. 2) of the plunger, the flow rates G are hot and (?$_z$ of the chilled water changes in equal parts, but with a different sign. Therefore, the total flow rate of water G_j through the valve does not depend on the position of the plunger, its temperature changes O_T.

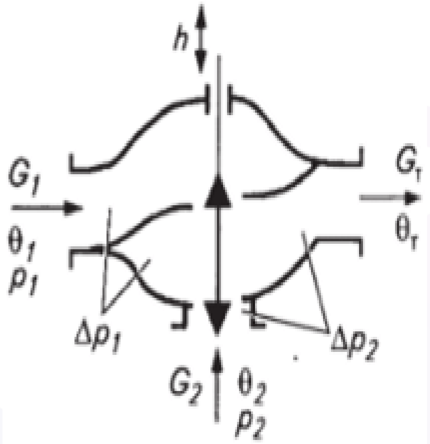

Fig. 2. Three-way mixing valve

A typical version of the ACS O_{VN} is a single-circuit control system for parameter deviation.

Hot water from the heat network enters the horizontal inlet pipe of the three-way mixing valve 2 (Fig. 3). At the same time, the pump 3 supplies a certain amount of chilled water to the vertical inlet pipe, which has passed through the pipes 1 of the greenhouse heating system. The water formed as a result of mixing the streams with a temperature of O_T enters the heating system.

The temperature at the midpoint of the greenhouse (primary converter T E 1) is maintained by the PI controller TS 2, which controls the position of the plunger TSK.

At night, when there is no photosynthesis, the temperature in the greenhouse should be lowered by 4 ... 6 °C. This is provided by the command of the time relay KT4, which is set up so that by sunrise the next day the greenhouse is warmed up.

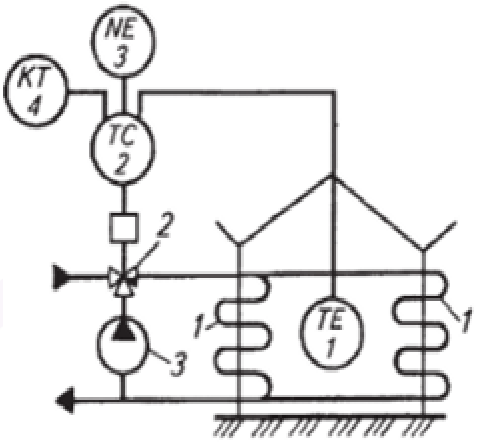

Fig. 3. Functional diagram of the ACS with temperature in a multi-layer greenhouse in the heating mode:

1- *pipe heating system; 2-three-way mixing valve; 3-pump*

During daytime hours, the greenhouse air temperature is automatically adjusted according to the natural light level measured by the NE3 transmitter. This converter is a design that combines a photodiode and an amplifier, mounted in a single housing, covered with a spherical light diffuser.

The described scheme does not provide the required quality of temperature stabilization due to the unsatisfactory characteristics of the object along the channel' of the control action (O_T —> O_{VN}), as well as the inability to take into account the parameters of the valve due to pressure changes in its inlet pipes. At the same time, simultaneously with the increase (decrease) of the water temperature in the heating system, its consumption decreases (increases).

It is also necessary to take into account the mutual influence of the ACS of individual greenhouses of the block through a common source of heat supply — a heat point. The structure of the heat point includes: collector 1 (Fig. 4) of direct water (CPV), hot water from which enters the horizontal inlet pipes of all TSK; collector 2 of return water (KOV), which receives chilled water that has passed through the heating systems of greenhouses; collector 3 of subsurface heating (KPO), used to power subsurface heating systems. At the same time, only a part of the total amount of cooled water pumped by pumps 4 into the vertical inlet pipes of the TSK is supplied to the KPA. From the KPO, water is drained into the KOV through a jumper 5 connecting these collectors. Due to the limited capacity of the heat supply source, an increase in the consumption of hot water in one of the greenhouses of the block leads to a drop in the pressure in the CPV and a decrease in the air temperature in other greenhouses fed from the same source.

In the warm season, the control of the temperature regime in the greenhouse can be provided by changing the degree of opening of the vents or by the action of the evaporative cooling system. The required degree of opening of the vents is provided by the operation of an independent single-circuit ACS, acting on the temperature deviation at the midpoint of the greenhouse (Fig. 5).

The independence of the operation of both temperature control systems is possible due to the fact that the setting of the temperature controller in the ventilation mode is set to 2...4°C higher than the controller operating in the heating mode.

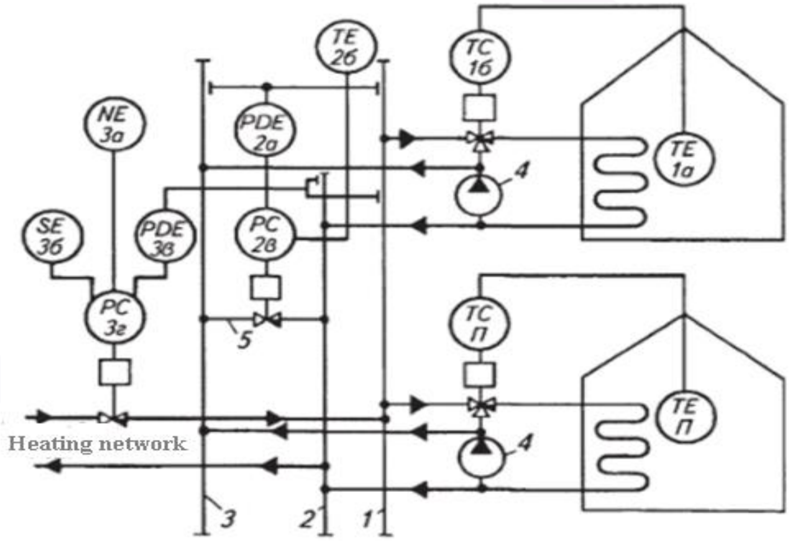

Fig. 4. Functional diagram of the automation of the thermal point of the multi-span greenhouse block:

1-direct water collector; 2-return water collector; 3— subsurface heating collector; 4-pump; 5-jumper

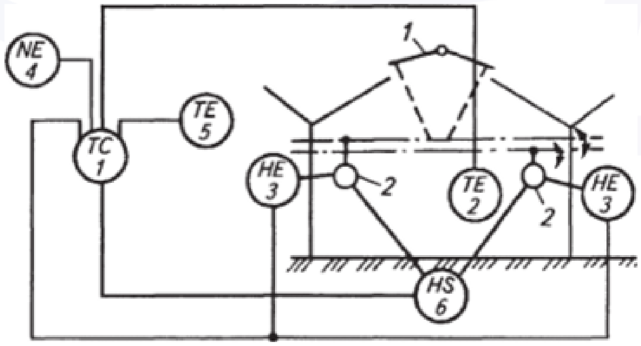

Fig. 5. Functional diagram of the ACS with temperature in a multi-span greenhouse in the ventilation mode:

1- window pane; 2-window pane actuator

The temperature controller TC1 Operates according to the P-law, maintaining a predetermined ratio between the temperature in the greenhouse (converter TE2) and the degree of opening of the vents 1 (converter I/E3). The setting of the controller is automatically adjusted depending on the level of natural light (NE4 converter), and the maximum degree of opening of the windows is set automatically depending on the current value of the outdoor temperature controlled by the TE5 transmitter.

Depending on the direction and strength of the wind, the control action with the switch S6 can be applied to one of the two rows of windows or to both at the same time. When the outside temperature drops to the set level, the command to open the windows is blocked.

In modern self-propelled guns, greenhouse ventilation provides protection that acts on closing the vents when the wind speed increases to an emergency high level. In this case, the corresponding command is issued 60 seconds after the cup anemometer has recorded an emergency. After 2500 s (the time of the course of the IM), a signal should be received confirming the closing of the vents. The ban on opening the windows is lifted only after 300 seconds after the wind speed drops to a normal level.

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