Improvement of water regulation on drainage-humidification systems

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Abstract. The analysis of the operation of the drainage and humidification system, equipped with an automated control system for water regulation processes with the help of hydro-automatic devices, in order to promptly regulate the reclamation regime of cultivated crops, guaranteeing the rational use of water resources, has been carried out. Such a system allows maintaining groundwater levels within normal limits throughout the growing season, which ensures an increase in agricultural production. It was found that additional costs for the construction of a humidification network and automated facilities on a drainage and humidification system amount to 12500 rubles per hectare, and the operating costs for maintenance are 10500 rubles per hectare.

Keywords: drainage-humidification systems, two-way humidity control, hydro-automatic devices

Introduction. Most of the territory of Russia is located in the temperate zone and is characterized by excessive moisture. To obtain stable high yields in such areas, drainage systems were built. But during the growing season, periods of drought occur, leading to the drying out of the soil profile and the death of the cultivated crops. To solve the problem, it is necessary to build a system of two-way regulation of the moisture content of the root layer of the soil [3], equipped with an automated control system for water regulation processes, providing the required reclamation regime. In such systems, the control of the water content in the soil in

periods of different moisture content is automated according to the set values at the characteristic points of data sampling, depending on the heat and moisture supply of the period of the year and the requirements of agricultural crops.

Studies have established that when soil moisture deviates from the optimal value by 10% during the growing season, a decrease in crop productivity from 30% to 50%, a temperature change by 1°C reduces productivity by 5-10% [4]. Thus, the operational and effective management of the reclamation regime is a complex optimization problem, the solution of which is carried out using modern automated systems, which ensures the operational regulation of the energy and material balance of plant growth and development factors with constant monitoring of their condition, which guarantees a decrease in operating costs and an increase in the profitability of grown crops. when obtaining economically justified and environmentally sound crop yields.

Purpose of the work: to evaluate the operation of the drainage and humidification system, equipped with an automated control system for water regulation processes using hydraulic machines.

Materials and research methods.

The efficiency of the reclaimed land use largely depends on the design perfection of the drainage and humidification systems, the level of their technical equipment, the adopted structure for the management of the reclamation regime and the organization of operational services.

In the design and construction of drainage and humidification systems, depending on soil and climatic conditions, double-acting systems with a closed regulating network and subsurface humidification are used by creating a backwater in drainage collectors and subsequent infiltration of water into the ground. Subsoil moistening is most effective on drained massifs with terrain slopes $i \leq 0.005$ and soils with a filtration coefficient of at least 0.5 m/day. The control of the water-air regime in such systems is carried out according to the level of groundwater controlled in the wells of the regime observation network.

Depending on the relief and hydro-geological features of a particular drained massif, as well as the adopted methods of subsurface moistening, the planned location of the control network on the drainage and humidification systems can be represented by four typical schemes: water supply to the mouths of drainage collectors by creating a backwater in the channels of the conducting network (type I); water supply to the sources of drainage collectors from humidifying channels (type II); water supply to the sources of drains from humidifying collectors (type III); water supply from humidifying canals to the sources of non-sloping or low-slope drains (type IV) [2].

For the technical improvement of drainage and humidification systems, increasing the efficiency of control of the processes of regulating the water-air regime and ensuring the rational use of water supplied for humidification, hydraulic structures have been introduced on a number of systems, ensuring the use of technological schemes for automatic water regulation.

A typical example of a system with automated control of water regulation processes using hydro-automatic devices is a drainage and humidification system with an area of 946 hectares. This system was chosen as the object of automation due to the technical perfection of its conducting network, a reliable source of humidification and technological uniformity of the operating modes of network facilities. A network of collecting drainage canals with a total length of 69.2 km is designed on the system, through which water coming from a closed drainage network (length 638.9 km) is diverted into the main canal and into three humidification tracts with a length of 28.3 km to supply water from the reservoir into a closed regulatory network.

The reservoir is located in the eastern part of the drained massif at command elevations and is filled with water from the Ubort River using a pumping station (flow rate 210 l/s). On the drainage channels of the conductive network and drainage collectors, regulation is applied along the upper pool, on the humidification channels and collectors - along the lower one.

To maintain a given level of groundwater on drainage and humidifying collectors, regulating wells are arranged, which are equipped with manual shut-off devices. The same technology is used to maintain the level regime on polder systems with machine drainage.

To implement the selected automatic control schemes, a complex of automated structures was used, equipped with hydraulic automatic devices designed by different authors, including those from Ukrgiprovodkhoz.

Head water outlets from the reservoir to the humidification canals are equipped with diaphragm-type hydro-automatic devices that stabilize the water levels in the downstream of the structures with an accuracy of +2...3 cm [1.5] (figure 1).

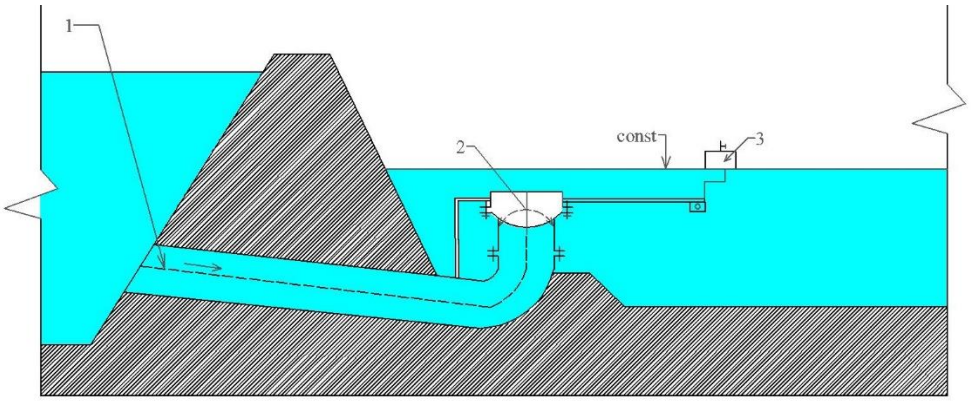

Figure 1. – Water outlet with diaphragm type hydroautomat:

1 - water outlet pipe; 2 - diaphragm hydraulic automatic device; 3 - downstream level sensor

Retaining structures on the humidification canals are equipped with sector-type hydro-automatic devices that stabilize the water levels in the downstream of the structures while protecting the canals from overflow [1,5] (figure 2). At the wellhead tubular structures on the drainage network canals, box-shaped gates are provided, which ensure the stabilization of water levels in the upper pool due to the automatic discharge of excess water coming from the drainage network (figure 3).

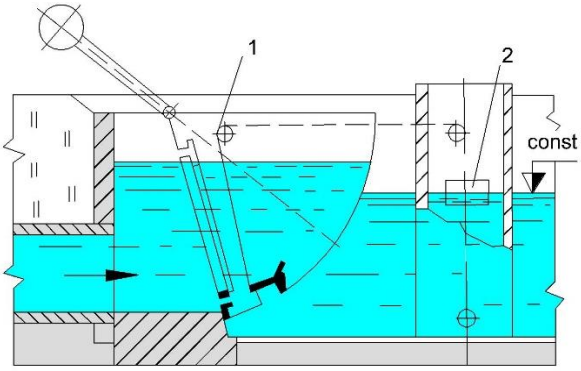

Figure 2. – Retaining structure with a sector-type hydro-automatic: 1 - sector-type hydro-automatic; 2 - level sensor

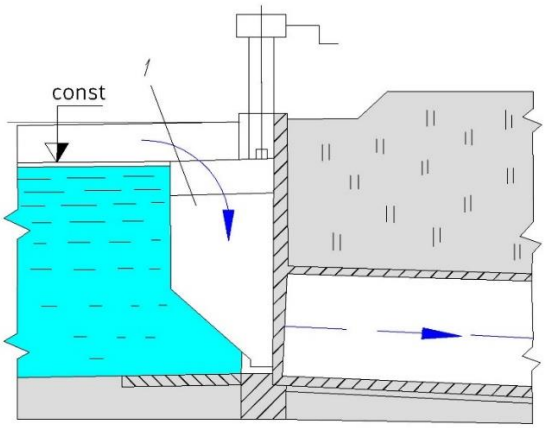

Figure 3. – Wellhead structure with box-type valve: 1- box-type valve

All wellhead wells on drainage and humidifying collectors are equipped with disc-type regulators [5], which allow creating backwater in the collectors and provide automatic discharge of excess water into the well through the top of the flexible hose when the specified groundwater level rises during the period of prolonged intense precipitation (figure 4).

For the equipment of control wells installed at the sources of the collectors [5], diaphragm-type water supply devices were used to maintain a constant water level in the well, regardless of changes in the pressure at its inlet and the collector operating mode (Figure 5).

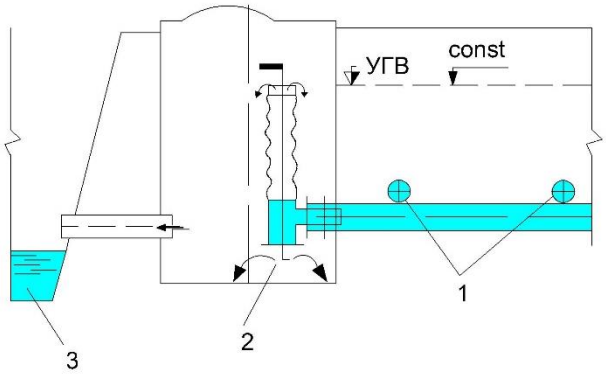

Figure 4. – Scheme of a wellhead well with a back-pressure regulator: 1 - drains, 2 - a poppet-type back-pressure regulator, 3 - collecting channel

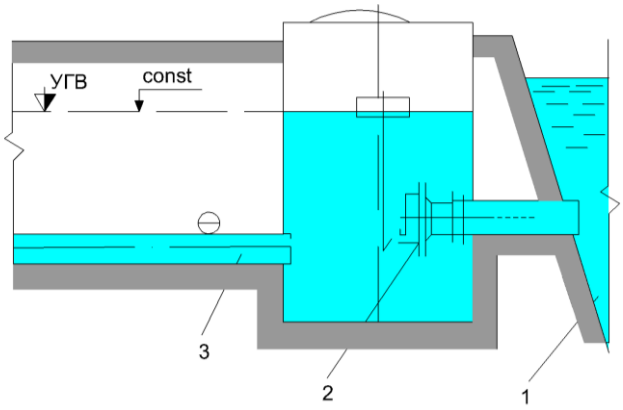

Figure 5. – Diagram of a well with a water supply hydraulic automatic device: 1 - a humidifying channel, 2 - a diaphragm-type hydraulic automatic device, 3 - a collector

Subsoil moistening with automation of water regulation allows maintaining groundwater levels within the drainage rate during the entire growing season, which ensures an increase in agricultural production.

During the operation of the drainage and humidification systems and the applied technical means of water regulation, some disadvantages were revealed. These include, first of all, a large number of structures (120-150 per 1000 hectares) on a closed network, which leads to an increase in the material consumption of systems, a decrease in the level of efficiency in managing their work due to the complexity and complexity of maintenance.

Conclusions:

1. Subsoil humidification on a drainage and humidification system with automation of water regulation allows maintaining groundwater levels within the drainage rate throughout the growing season, which ensures an increase in agricultural production.

2. Additional costs for the construction of a humidification network and automated facilities on a drainage and humidification system amount to 12500 rubles per hectare, and the operating costs for maintenance are 10500 rubles per hectare. The annual economic effect from the introduction of humidification measures with the automation of level regulation is about 125000 rubles per hectare.

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