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Automated Technology Controlled Irrigation Water Treatment Acceptable Salinization

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Abstract

The paper presents materials for the development and construction of an automated water treatment technology using ground water from wells. In an object consisting of a vertical drainage well, a mixing tray and a source, ground water is mixed with non-saline water, and on this basis an automated mixing process is formed with its control and management. In this case, the salinity parameter of the prepared water is characterized as a control one, and is controlled by its maximum permissible salinity

Keywords: automation, sensor control, irrigation vertical drainage mixing, primer water concentration electronic circuit hydraulic chute.

Development and improvement automated technology use of wells for mixing water for irrigation crops based on vertical drainage wells, requires the implementation of certain requirements for soil water, source water, water prepared and in general equipment and technology for the formation of the process. The specified mixing process, in this case, can have portioned and continuous character. Moreover, in the structure automated system management as technical automation and mixing control equipment involved: well with submersible pump, saline channel water, microHS (Hydraulic structures) with electrified flat shutter equipped with a gate measurements, construction of a mixer trough, station of automatic controls, automation level control in the measurement line, water salinity control devices, means of automatic level control in the sprinkler. Composition of devices and technical means function from the saline side water and from the side of "clean water". Both streams move to a hydraulic structure called a mixing trough where a control sensor is installed salinity. The above conditions allowed to develop a block diagram technological process Figure 1. Water, for example, from well 1 enters the collecting channel (tray), i.e. a tray-mixer 2. Here, from the water source 3, through the channel (tray), ordinary "clean" water enters. Here, in the mixing pan, the water is normal and mineralized is mixed in a natural way and the mixed product flows through the gate 4 into the irrigation sprinkler and then can be used for irrigation, including on the basis of various water-saving technologies.

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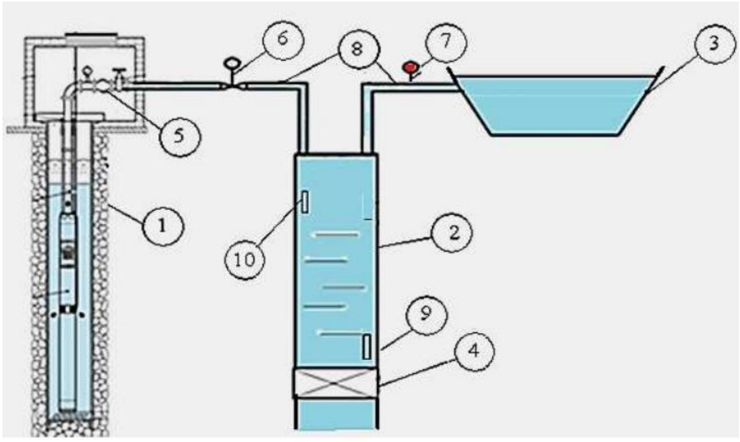

Fig-1. Mixing flow chart

1-vertical drainage well; 2-hydraulic pan mixer; 3-on-farm irrigation canal with "clean water"; 4-gate; 5, 6,7-automated gate valves; 8-supply channels (pipes); 9-conductometric sensor, 10- level sensor.

The block diagram of the mixing section of the thus presented technological object looks like for the section movement of, for example, water salted figure 2.

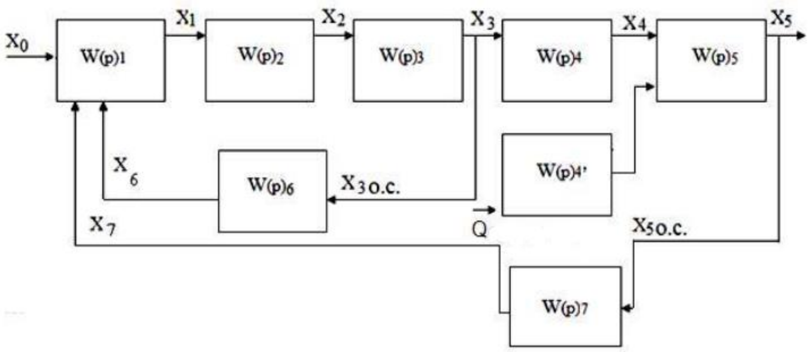

Fig-2. Block diagram of the ACS mixing process.

Where:

x_0-setting information signal of salinity;

$W_{(p)}1$ - the transfer function of the computerized control body;

$W_{(p)}2$ - transfer function of the borehole pump supplying water to the channel to the salt water pipe.

$W_{(p)}3$ - the transfer function of the salt water channel;

$W_{(p)}4$ -gate valve transfer function;

$W_{(p)}4$ -transmission function sprinkler.

$W_{(p)}5$ -mixer channel transfer function;

$W_{(p)}6$ - transfer function of the salt water conductometric sensor;

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$W_{(p)}$7- transfer function of the conductometric sensor in the mixer channel;

X_1-X7- inter-element informative actions;

$X_{O.C}$ - feedback signal to control channels X3 and X5

(1) $w_{(p)1}=\frac{W(p)_1\cdot W(p)_2\cdot W(p)_3}{1+W_{(p)1}\cdot W(p)_2\cdot W(p)_3 W(p)_6}$ $w_{(p)II}=\frac{W(p)_I\cdot W(p)_4\cdot W(p)_5}{1+W_{(p)I}\cdot W(p)_4\cdot W(p)_5 W(p)_7}$

The above block diagram of the site control systems and automatic control of the process of moving and mixing salt water allows, to have a basis for the study of the ACS from the salt water supply and, subsequently, for the whole mixing process.

Let's select from this structure, for example, the equipment of the mixer channel $w_{(p)5}$. Let's reveal the dynamic function of the process in the mixer channel in the first approximation, as a first-order aperiodic link with a pure delay, and write: (2) $w_{(p)5}=\frac{K}{T_1 p+1}\cdot e^{-p\tau}$

where the coefficients are:

T_1 - capacitive information parameter (time constant); sensor in the object mixer;

τ - pure lag of the control process in the mixer facility;

K- object transfer ratio

The indicated coefficients are essential for the characteristics of this link of the ACS - $w_{(p)5}$ in the transient process and are necessary for the project of a mixing pan. Universal reduced technological parameter, as well as control, at this stage studies can be considered an indicator of water salinity passing through the link - $w_{(p)5}$. And having the opportunity, at the stage of constructing the mixing tray and the automatic control system as a whole, varying the coefficients T_1 τ and K can to achieve stable operation of the ACS, and the required quality of water regulation in the mixing pan. Similar reasoning is acceptable and for that part of the mixing control system that quantifies the water entering the mixer. As already noted, for using drainage water for irrigation, there are recommendations for mixing saline water from vertical drainage wells with “clean” water taken from the river. These reclamation recommendations character are justified at the appropriate level [2], however, the search for automated technical and technological solutions for obtaining irrigation water on the basis of mixing according to well-known recommendations (ameliorators) revealed the absence of such, and in this regard, there were work was carried out to create the required technology with the involvement and development of methods and means of automation of the mixing process for the preparation of irrigation water from vertical drainage wells. Directions have been identified experimental laboratory research for the study of electronic means and automation schemes for controlling the water salinity boundary and controlling the mixing process. On the laboratory model, it was supposed to carry out tests of the permissible limiting concentration of the solution using an electronic circuit assembled in laboratory conditions. The conductometric method of analysis is based on measuring the electrical conductivity of the analyzed solution. As you know, electrical conductivity is called the reciprocal of electrical resistance R. The unit of measurement for electrical conductivity is Ohm-1 or Siemens. Electrolyte solutions, being conductors of the second kind, obey Ohm's law. By analogy with the resistance of type I conductors, the resistance of the solution is directly proportional to the distance between the electrodes l and inversely proportional to their surface area S.

(3) R=r(l/S), where r - resistivity (Ohm. Sm). For l = 1 cm and S=1 cm2, we have R=r, therefore, the resistivity is equal to the resistance of 1 cm 3 of a solution located between two parallel plates

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with an area of 1 cm 2 spaced 1 cm apart from each other. The reciprocal of the specific resistance is called the electrical conductivity c=1/r. Specific electrical conductivity is numerically equal to the current passing through a layer of solution with a cross section equal to

unit, under the action of a potential gradient of 1V per unit length.

(4) Specific and equivalent conductivity are related to: l = 1000 s / s

where c is the molar concentration equivalent, mol-eq / l.

In our case, the methods of direct conductometry is based on the fact that in the area of dilute and moderately concentrated solutions, the electrical conductivity increases with an increase in the concentration of the mixed components, namely, saline water from a well and non-saline water from a river (channel). Moreover, automatic control had to be directed to exclusively the salinity limit of 3g/l is defined as the maximum permissible. Thus, the aim was not to continuously measure the salinity parameter of the water prepared in the mixing tray. The experiment pursued the goal of taking readings from the salinity sensor to form a control, boundary signal for the salinity of the test solution. That is, the goal of measuring salinity was not pursued, but only to search for that salinity value that could be used to signal the established limit states of salt concentration: for our case, it is 3g/l. It was also necessary to obtain the possibility of sampling the control signal to form a control action on the actuator in the mixing ACS. In the developed model, the necessary importance was attached to the electronic concentration control circuit. Therefore, the questions of searching for a similar scheme for carrying out experimental work were studied. The construction of an electronic circuit and the further choice of an acceptable one, had in view of sufficient experience in terms of such circuits.

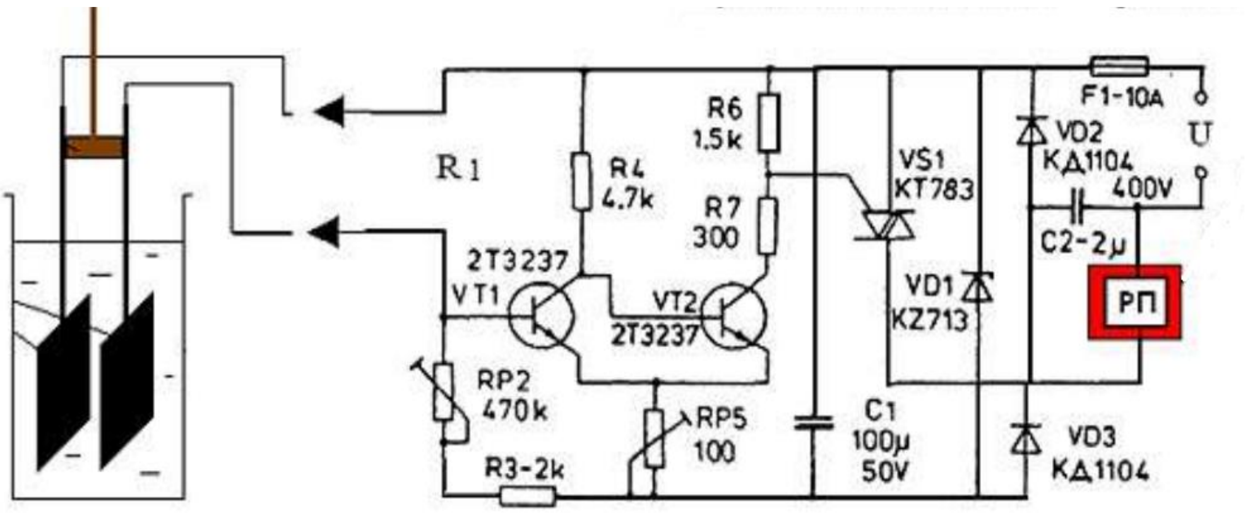

Figure-1. Experimental scheme for water salinity control.

At the same time, a review of various schemes showed that their application for the purpose of signaling concentration is quite promising. As an example, one of such schemes is considered with a possible prospect of building your own, in relation to the conditions of the work performed. A variant of the electronic circuit is shown in Fig-1.

The circuit is an electronic relay based on a Schmidt trigger (VT1,VT2). As a sensitive element (concentration sensor), flat electrodes were used, which, together with an electronic circuit, work on the principle of a conductometric sensor. The resistance R1 of the conductometric sensor together with the resistors RP2 and R3 form a voltage divider that determines base current of the transistor VT1. Resistor R3 dampens the current in the divider with a possible deviation on R1. Resistor R7 determines the current in the control electrode of the triac VS1, and R6 serves to equalize the voltage at the control electrode and at the cathode of VS1 when the transistor VT2 is closed. This ensures stable operation of the triac. The device works as follows. When the conductivity of the solution is not specified, its resistance R1 is small, VT1 is open, and VT2 is closed. The collector current VT2 and, therefore, the gate current of the triac is almost zero. In this state, VS1 is closed, and the low-current intermediate DC relay RP does not turn on. With increasing concentration, the conductivity increases. The base current VT1 begins to decrease. When a certain level is reached, VT1 closes, and VT2 opens, i.e. The trigger switches The current of the control electrode VS1, flowing through the open transistor VT2 and resistors RP5 and R7, maintains VS1 in the open state during both half-periods of the mains voltage, and the RP relay turns on, which means, there is a signal for the maximum salt concentration and a control signal. Thus, on the basis of experimental work, the fundamental possibility of practical implementation of the adopted hypothesis of controlling the boundary values of the concentration of salinity of the solution during dilution using an electronic device was established and the possibility of forming an output control signal using the selected electronic circuit of the boundary value in 3g/l NaCl. An electronic circuit for controlling the boundary value of salinity as part of the developed laboratory model has been studied and recommended; it has shown its efficiency for a concentration of 3g/l. The dependence of the forming control signal on the boundary values of salinity established for the laboratory model has been established.

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