IRRIGATION STATION EQUIPMENT FOR PREVENTING THE USE OF LOW WATER QUALITY

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Abstract
In Romania the economically efficient irrigated area is estimated at 3.5 million hectares. On national scale there is no integrated approach for monitoring the quantity and quality of the irrigation water, using adequate equipment at the pumping station. On international scale, in many countries the pumping stations are provided with equipment for monitoring, on real time, the quality or the pumped water and for warning about critical situations (emergencies).
This paper describes a technical solution consisting of equipment which monitors the following parameters of water pumped in irrigation systems: turbidity, pH, CE at 25 ^{o} C, Na^{+}, Cl^{-}. The lapse of time for monitoring is of 10 to 60 min. The main components are the following: the sampling pump (submersible) the monitoring board, the repression pipe of the analyzed water. Warnings are made about values exceeding the programmed level for each monitored parameter, about the fact that the pump and agitator do not work or about any other source of damage.
The technical solution and equipment were tested at a pumping station which uses water from Danube, in most cases mixed with water originating from drainage. Results showed a reduction of the total content of soluble salts from soil and of their negative impact upon the crops, a reduction of the degree of river alluvial deposits within the irrigation system and reduction of the energetic consumption required for pumping.

Keywords: irrigation, pumping station, monitoring, water quality, equipment

1. INTRODUCTION

Although a significant progress has been recorded, the agricultural processes still remain exposed to the unfavourable action of the natural agents whose apparition, duration and extent in space cannot be prevented or completely eliminated.
For harmonizing with requirements for a sustainable development and as a result of the predicted climatic changes, agriculture will be increasingly demanding new technologies and equipment for a more efficient use of the irrigation water, will very probably strive to a better use to the unconventional water resources and will have to obey the requirements of the quality management [1, 2, 3, 6, 8].
The problem of a qualitative and quantitative water monitoring became more acute after 2000, when by the Framework Directive 2000/60/EC the transition to a new stage of development in the field of a sustainable water management, involving the qualitative and quantitative control of the resources was enforced by law.

2. MATERIALS AND METHODS

Any field of activity - especially the technical ones, in which the hydro ameliorations as a hydrotechnical system can be included - can be easily modernized (solutions, materials, equipment, technologies etc), according to the new requirements, generated mainly by the technological progress. The following four things can be done for modernization of the irrigation systems: rehabilitatation of the infrastructure, providing modern equipment, and knowing the interrelation water - soil - phenophases – environment and professional training.

For realization of the equipment the starting point was the necessity of obtaining a non-expensive measurement system based on a modular structure, which can be easily configured for using it in various work environments and for various applications. The demands of potential beneficiaries and the compatibility with the financial power of being active in the Romanian market had also been taken into account.

The technical solution consists of equipment which seizes the critical situations at the pumped water by realizing the monitoring of the irrigation water quality [4, 5, 7]. When a critical situation is reached, the pumping of water is stopped till the situation gets back to normal.

By using only water which corresponds physically and chemically, the protection of the components of the equipment, of the soil, of the underground water and of the crops, is realized, contributing to the quantitative and qualitative increase of production.

The monitoring equipment includes 3 functional blocks: the water sampling system, the hydraulic circuit of measurements and the automatic board.

The sampling system brings the samples to the measurement circuit. This is composed of a submersible centrifugal pump EasyPump, type Sub 700/Sub 700A (with a maximum flow of 15,000 $l \cdot h^{-1}$ and the discharge diameter of 1 ¼ inch) and pipes of adduction and discharge.

The hydraulic circuit of measurement is placed on a board which integrates the sensors, the devices for connecting to the circuit, water catchment basin with discharge tube, filtration system, bleeder, fittings and valve gates.

The producers of the sensors and monitored parameters are: the German company Endress & Hauser for turbidity and the American company Innovative Sensors Inc. for pH, CE at 25^{o} (range 0.1-5000 $\mu S \cdot cm^{-1}$, range 0.01-5 $mS \cdot cm^{-1}$), Na^{+} and Cl^{-}.

The sensors are integrated within a hydraulic circuit through which the water which must be monitored is pushed by the submersible sampling pump. At the exit from the coupling of the turbidity transducer, the water passes through a mechanical filter. The cleaning process can be started automatically or manually.

The automatic board is the functional block which monitors the selected parameters for describing the quality of the irrigation water, being provided with the facility to be interconnected to specialized systems for a remote control of the measured parameters.

On the door of the automation case the following component parts are placed:

- display and warning module for pH, electrical conductivity, Cl^{-}, Na^{+}, turbidity;
- condition parameters for the sampling pump, the stirrer of the thermostatic bath, bleeder;
- buttons for selecting the drive type (manual, automatic) set off the sound warning alarm;
- thermal printer which prints at time intervals fixed by the operator;
- key boards for introducing the data by the user;
- the general display for showing the menus of the equipment for visualization, calibration or programming operations.

The measured parameters can be listed at the printer.

3. RESULTS AND DISCUSSION

The system has the possibility of setting the upper limit of the field which generates the signals for sight and sound warning. The washing of the sensors is made manually, at certain fixed intervals, or anytime the systems of automatic testing of the transmitters of the sensors require their recalibration.

Technical - constructive characteristics of the equipment:

- monitoring board: dimensions 760 x 600 x 210 mm; weight 35 kg;
- gauge sizes of the transducers board: 1000 x 600 mm (without thermostatic bath and sampling pump);
- sensors board weight: 30 kg**;**
- the supply voltage of the monitoring board : 220V ± 15 %- 20 %, 50 Hz.

Functional characteristics of the equipment:

- the measurement field for turbidity : 0 - 3 $g \cdot dm^{-3}$;

- the measurement resolution for turbidity : 0.1 $g \cdot dm^{-3}$;
- the measurement error for turbidity : ± 2 % from the measured value ± 1 digit ;
- the pH measurement field : 0 - 14 pH ;
- pH measurement resolution : 0.1 pH ;
- pH the measurement error : ± 0.2 pH ± 1 digit ;
- the measurement field for conductivity : gama 1: 0,01- 5 mS; gama 2: 0,1-5000 µS;
- the measurement resolution for conductivity : 0.01 mS for gama 1 ; 0.1 µS for gama 2;
- measurement error for electrical conductivity: ± 5 %;
- the measurement field of the Na^+: ions concentration 0-1000 ppm ;
- the measurement resolution of the Na^+: ions concentration Na^+: 1ppm ;
-the measurement error of the Na^+ ions concentration ± 10 %;
- the measurement field of the Cl^- ions concentration : 0-1000 ppm ;
- the measurement resolution of the Cl^- ions concentration : 1 ppm ;
-the measurement error of the Cl^- iones concentration ± 10 %;
- print the measurement bulletins on the thermal printer.

The software for evaluating the water quality takes into account the mineral residue expressed indirectly, depending on electrical conductivity, for the conditions existent in Romania.

In accordance with the stipulations of the specialized standard from Romania (STAS 9450-88) the maximum value for the residue is of 3500 $mg \cdot dm^{-3}$.

The testing of the proposed technical solution was made at the pumping station Manta at the local irrigation system from Giurgiu County, belonging to the National Land Improvement Administration Bucharest. The water supply is from the Danube River.

4. CONCLUSIONS

The economic and ecologic effects registered by using the equipment are the following:

- reduction of the total content of soluble salts from soil, with a positive effect of 100 - 1000 $€ \cdot ha^{-1}$, which represents the cost for the amelioration of one hectare of salinized soil ;
- elimination of the negative impact upon the crops, estimated at a production decrease with 10 - 25 %;
- reduction of the degree of river alluvial deposits within the irrigation system with 600 - 1200 $kg \cdot ha^{-1}$ and reduction with 1 - 2 % of the energetic consumption required for pumping;
- increase of the economic efficiency of the irrigation, by including the water quality in the delivery price.

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