ENSURING COMPLEX SAFETY OF RESERVOIRS IN DRIP IRRIGATION SYSTEMS: MANAGEMENT OF WATER, STRUCTURAL AND ELECTRICAL HAZARDS

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Abstract: As drip irrigation technologies expand, so does the use of reservoirs designed to collect and settle water and to deliver it to the irrigation network by pump. During the operation of such structures, a set of interrelated hazards may arise: uncontrolled rise of the water level, damage to bank and lining elements, persons falling into the reservoir, and electric shock resulting from faults in electric pumping equipment. This paper examines, in a complex manner, the safety of a two-reservoir system — a large water storage reservoir and a small settling reservoir. The principal novelty lies in assessing water, structural and electrical safety as a single system, and in establishing preventive cooperation with the Ministry of Emergency Situations (MES) as a permanent element of that system.

Key words:drip irrigation, settling reservoir, geomembrane, pumping station, water safety, electrical safety, drowning prevention, MES, emergency situation, risk assessment.

Introduction

The use of water-saving technologies in agriculture, and of drip irrigation systems in particular, is one of the key directions for the efficient use of water resources. In such systems, a settling reservoir is used first to collect and clarify the water, after which a pumping station delivers the water through pipes at the required pressure. The regulatory documents in force in Uzbekistan likewise identify the settling reservoir and the pumping station as constituent parts of a drip irrigation system.

Assessing a reservoir solely as a technological facility does not fully capture its operational safety. Standing water, the smooth surface of the geomembrane, saturation of the banks, the proximity of people to the facility and the presence of an electric pump simultaneously generate several hazard factors. For this reason, a reservoir must be assessed as a complex hazardous zone in which people, water, structures and electrical energy interact.

Aim of the study

To carry out a complex study of the safety condition of a two-reservoir hydraulic facility within a drip irrigation system, and to develop an engineering and preventive model aimed at preventing uncontrolled water release, persons falling into the reservoir, and emergencies associated with electric current.

Object and approach of the study

The water-management part of a drip irrigation system consisting of two reservoirs was adopted as the object of the study. The first reservoir is the main, large-capacity water storage reservoir. The second is a small-capacity settling reservoir that serves to settle mechanical impurities before the water is passed to the next technological stage. An electric pump is used in the system to deliver water to the drip irrigation network. The use of protective structural elements and a geomembrane in the reservoirs improves water retention, but requires regular monitoring of the condition of the lining and of bank safety. The safety of the facility was studied from the standpoint of practical observation and preventive assessment carried out in cooperation with MES personnel.

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Principal hazard factors

1. Hydraulic engineering hazard

Inflow of water in excess of the design value, or inadequate performance of the discharge system, may lead to a rise in the water level, overtopping of the banks, erosion of the banks and the foundation, and flooding of the surrounding area. Accordingly, water-level monitoring, the capability to discharge excess water safely, and the condition of the bank structures must be inspected together.

2. Hazard of a person falling into the reservoir

The smoothness of the geomembrane, moisture, the slope of the bank and the depth of the reservoir may make it difficult for a person to climb out unaided after falling in. For this reason, warning signs alone are not sufficient: a protective system is required, comprising a physical barrier, access restriction, a safe walkway, rescue equipment and regular preventive inspection.

3. Electrical hazard

The electric pump located near the reservoir creates an electrical hazard additional to the risk of drowning. Damage to cable insulation, short circuits, moisture ingress or failure of a protective device may aggravate the hazard. It is therefore proposed that the combination of "person + water + electric pump" be assessed as a separate emergency scenario.

Scientific novelty of the study

The principal novelty of the work consists in the proposal to assess reservoir safety not merely in terms of water level or structural strength, but through three interrelated circuits.

Circuit 1 — water and structure	Circuit 2 — personal safety	Circuit 3 — electrical safety
Water level → excess water → bank/dam → geomembrane → leakage	Barrier → sign → access control → rescue equipment → inspection	Power supply → cable → pump → protective automation → earthing → emergency shutdown

Proposal to introduce a "Reservoir Safety Passport"

It is proposed that a "Reservoir Safety Passport" be drawn up for every reservoir. It should not be a one-off document, but a tool for dynamic monitoring of the safety of the facility. Technical, hydraulic, personal and electrical safety indicators should be recorded in it on a regular basis.

No.	Area	Monitoring item
1	Reservoir structure	banks, walls, foundation
2	Geomembrane	tears, punctures, separation
3	Water level	normal and hazardous condition
4	Excess water	discharge capability
5	Access control	barrier and protection
6	Warning	presence of signs
7	Rescue equipment	availability and serviceability
8	Electrical system	cable, connections, protection
9	Pump	technical condition
10	MES prevention	inspections and identified deficiencies

An improved model of cooperation with the MES

It is proposed that cooperation with the MES be organised not merely as post-emergency assistance, but as a prevention mechanism: identification of the facility → preliminary hazard assessment → joint

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inspection → classification of deficiencies → definition of safety measures → follow-up monitoring. The results of preventive work are entered into the "Reservoir Safety Passport" on an ongoing basis.

Discussion

Assessing drip irrigation reservoirs solely as water storage structures may leave important aspects of safety out of consideration. Because the electric pump is permanently connected to a power source, an incident involving a fall into the water may develop into a situation more complex than ordinary drowning. Accordingly, the first task of the safety system must be to prevent a person from falling into the reservoir, and the second to eliminate the electrical hazard promptly should such an event occur and to organise rescue operations safely.

In addition, in a membrane-lined reservoir, special gratings should be installed to prevent persons from falling in, and a rope secured to a firm anchor post should be left in place along one side of the reservoir.

Conclusion

The safety of reservoirs in drip irrigation systems must not be limited to preventing flooding or structural failure. The combination of water, people and electrical energy within a single facility calls for a complex approach to safety. The study proposes a three-circuit model integrating water-structural, personal and electrical safety for a large water reservoir and a small settling reservoir, together with a "Reservoir Safety Passport". This approach may serve to identify hazardous conditions in advance, to document preventive measures, and to systematise cooperation with the MES.

References

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