Innovative design solutions to ensure the environmental safety in the existing water intake technological complexes of water systems for urban farms

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Abstract. The main design flaws in terms of protection against young fish entering the water intake bucket, sediment inflows, sludge and floating objects, which largely do not provide the current regulatory environmental requirements for ensuring environmental safety (ES) of water intake technological complexes (WITC) directly interacting with the natural water environment (WE) of the water body (MPWS) as a part of the natural technical system (NTS) “WE-WITC-MPWS” were identified during the comprehensive studies to assess the functional effectiveness of existing water intake structures (about 44) of multi-purpose water supply systems (“MPWS.”) of urban farms and settlements in the Lower course of the river Don from the Tsimlyansky reservoir to the mouth (Azov).

In order to ensure the operating “WITC” operating systems based on the results of constructive studies using domestic experience in the use of high-strength synthetic fabric materials, an innovative design of a water intake structure in the form of a soft floating structure (SFS) has been developed providing the regulatory requirements on the main indicators of ES by 85% - 95%.

Introduction

In a water resources formation and use processes systematic review within the basin geosystem of the Don River occurs on the waterways of the river hydrographic network located in the territory of 15 constituent entities of the Russian Federation and the territory of the Rostov region water flow (surface, underground) additionally comes from the territory of Kharkov, Donetsk and Lugansk regions of Ukraine. Medium-long-term water flow of the basin geosystem the Don river is 26.2 km³, the maximum is 50.9 km³ and the minimum is 10.9 km³, of which 2.24 km³ is used in the Rostov Region, including the housing and utilities sector of cities and settlements about 0.25 km³ (11%).

The study is based on the analysis of the functional work of the existing (44) water intake technological complexes (WITC) of the multi-purpose water supply systems (MPWS) of urban farms in the lower reaches of the Don river from Tsimlyansk reservoir to the mouth (Azov). The existing water-intake technological complexes (WITC) include replaceable filter cartridges, which ensure the...
selection of the estimated water flow rates in the MPWS, protection of the bucket from the juvenile fish ingress, bottom sediment and suspended sediment (Figure 1).

![Constructive scheme of existing water intake structures](image)

**Figure 1.** Constructive scheme of existing water intake structures (A-E gauging points for measuring the speed of water flow at the entrance to the site)

To protect the water intake bucket from sludge, the side barriers made of metal pipes (700mm) floating objects are installed and the metal boards are attached to the pipes. The research has established that the functional effectiveness of existing WITC as a part of the WE-WITC-MPWS does not meet the environmental requirements for ensuring environmental safety (ES) in many respects, which determined the need for constructive improvement of "WITC" with the use of new building materials and domestic design inventive achievements.

Based on the results of a comprehensive study of the relationship, interaction and relationship (IAR), as a technogenic component, with natural (biotic, abiotic) complexes of WE and man-made components of MPWS, a systemic need to evaluate the functional significance of indicators of EB on individual structural elements “WITC” [5,7].

**Research methods**

To substantiate the design indicators of the electronic control system “WITC” as part of the existing and newly created NTS “WE-WITC-MPWS” as an important factor in the formed ecological state (ES) of the influence zones “WITC”. The results of the full-scale laboratory studies of individual structural elements in the form of water intake structures, structural and technological measures for the protection of MPWS from toxic blue-green algae and clam were used. In the system examination of the specialized type of NTS “WE-WITC-MPWS”. Orderliness in the system under consideration determines the processes of self-organization between its components, which is used by WITC.

The process control of the IAR between the structural elements of the WITC and the surrounding WE water body in the system sense, as established, is carried out in accordance with the main principle of system integrity, which defines the dominant role of the whole over the parts - the system in question, as WITC separately, as well as NTS “WE-WITC-MPWS” as a whole [1]. At the influence zones level “WITC” the main principle of system integrity and, accordingly, functional efficiency in ensuring electronic safety, is determined by the preservation of biological diversity in the WE water body, protection of the water intake bucket from bottom and suspended sediments, floating objects, sludge.

In the energy entropy IAR processes consideration of the technogenic component “WITC” with “WE” of the water body and “MPWS” as a part of the specialized type NTS “WE-WITC-MPWS the natural component of the principle role of the whole manifests itself under the influence of continuous energy flows emanating from the original source - the Sun relatively to the Earth’s biosphere within the spatial limits of which the global moisture cycle takes place (577 thousand km³) and at the level of the
local basin geosystems under consideration, quantitative and performance-quality water resources used in the sectors of economic activity, including in the "MPWS" urban farms [1]. The technogenic component with the natural component principle whole predominant role of the is determined by the level of functional efficiency and the constructive perfection of the technogenic component "WITC" as part of the subject NTS “WE-WITC-MPWS”.

The study of the relationship between the technogenic component and the natural component, the principles of the whole dominant role in the special type of NTS “WE-WITC-MPWS” under consideration allows to create environmentally acceptable (EA) constructive-technological WITC providing the necessary ES related to the preservation of bioresources in the water body and other technological requirements.

Research results
WITC is a complex of various types of hydraulic structures (HS), technological devices (Figure 1), which should ensure the selection of estimated water flow Q m³ / s from a water body under different channel hydraulic modes in the location of the water intake structure, preserving biodiversity of various species of ichthyofauna and aquatic vegetation, protection of the water intake bucket from bottom and suspended sediments, protection of the water intake structure from freezing and floating objects, protection of MPWS from toxic water and the effects of blue-green algae and clam. Important design and technological elements of the WITC is a water intake structure, which should be multifunctional and maximally meet the environmental requirements for the provision of electronic facilities. Investigations of the constructive dependence of both individual structural-technological elements and WITC as a whole as part of the considered NTS “WE-WITC-MPWS” on the dominant role of the whole were developed multifunctional water intake structure construction, which uses high-strength synthetic fabric materials of domestic production. The construction of fabric materials, hereinafter referred to as a soft floating structure (SFS), in which the main functional element is a vertically positioned textile fabric of a given shape, the upper and lower edges of which are attached to the system of movable and fixed floats held by anchors with flexible connections. (Figure 2). The dominant role of the whole in the SFS of the water intake structure is conditioned in its multifunctionality - in a sustainable selection of the estimated water flow from the water body; protection against the entry of young and adult individuals of various species (surface, bottom) fish (up to 90%) by diverting them from the water intake window due to the created hydraulic structure of the water flow; protection of the water intake bucket from bottom (by 95%) and partially from suspended sediment; protection of the intake bucket from floating objects (up to 98%) and freeze-up. In the water area of the water intake bucket, the MPWS is protected from toxic blue-green algae by placing special technological devices for the selection of these algae from the aquatic environment (up to 98%).

For protection from clam (up to 90%) of the piping system at the technological site of drinking water treatment "MPWS". The use of innovative design solutions to improve the WITC as a part of the NTS “WE-WITC-MPWS” should be concluded that the use of modern structural materials and innovative technological methods of protection causes their electronic signature which is expressed in the form of a kind of “copies” of natural processes in which the maximum possible preservation of natural biodiversity on water bodies is ensured, the rational use of blue-green algae in the biological productivity of fish farming and the reduction of energy costs on the technological site of water treatment MPWS. The functional WITC effectiveness as a part of the NTS “WE-WITC-MPWS” systemically determines the predominant role of integrity in the anthropogenic component.

In the technogenic component concept development in the creation of innovative design solutions in the reconstruction of the existing WITC, as established by the results of many years research, it is recommended to use the principle of ES, which makes it possible to apply new modern structural materials, expand functionality, for example, water intake structure, reduce resource consumption and improve energy efficiency, which ultimately contributes to the provision of an electronic library in the zone of the WITC influence.
Figure 2. Scheme of the plan of the Alexander water intake “S.M.V.” city farms of Rostov-on-Don, Aksai, Bataysk

Summary
1. Based on the results of comprehensive studies of operating WITC in the lower reaches of the Don river as a part of the considered NTS “WE-WITC-MPWS” their functional efficiency was determined, which to a large extent does not meet modern environmental requirements in terms of ensuring the ES.
2. Based on the results of innovative constructive research to ensure regulatory electronic systems in the WITC zone of influence, a multifunctional water intake structure has been developed, which is a floating movable structure made of high-strength fabric materials.
3. According to the main current environmental indicators ES, the designed water intake structure SFS ensures 85-95%.

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