WATER CONSERVATION IN CONDITIONS OF WATER WITHDRAWAL FROM SURFACE WATER SOURCES

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It is known that the problem of "clean water" is a global problem that is acute for many countries. This is a pressing problem for the Russian Federation, too. Some researchers believe that the value of water as a vital resource might soon exceed the value of oil as a major fuel resource.

Although surface water total bulk volume is less than 0.5 % of the hydrosphere volume [1], surface waters is the main source of water withdrawal coming mainly from inland water reservoirs such as rivers, lakes, artificial reservoirs.

Ichthyological watch stations have found out that every year a substantial amount of young fish dies in water intake structures [2].

Of course, there are fish protection structures (FPS) built near such installations, but they are not effective enough. For example, out of 4.000 FPS Only 400 are based on biological standards and can protect young fish properly. The situation is aggravated by the fact that existing FPS are not designed for powerful water intake structures, i.e. 10-50 m/s and more, although there are many FPS designs acceptable for successive use in small pumping systems.

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In general, development and construction of FPS in water intake structures has become a serious national-economic problem with almost every specific case requiring a study of the issue in relation to the specifics of the pond, hydrology, hydrochemistry, volume of consumption, etc. There is also a well-known problem of FPS "binding" to a particular water basin. This problem is caused by the reasons already mentioned as well as by the amount of suspended substances, the distribution of the depths in seasonal dynamics, the degree of mineralization, pH, human impact level, navigation regime and other factors [3].

In the course of water bodies and watercourses bottoms exploitation (laying of trenches, channel reaches backfilling, soil extraction and so on), bottom configuration and soil composition also change, destroying biotopes of bottom-living animals (zoobenthos). These operations lead to the formation of a zone (a plume) of elevated turbidity (suspensions departure zone). The high turbidity plume creates unfavourable living conditions for fish, and also disrupts normal living conditions for those organisms that make up fish feeding base (zooplankton and zoobenthos). These factors form a kind of "temporary" damage to fish stocks. Damage caused by temporary divestiture of water areas as well as of surface areas deterioration in washlands is also temporary [4].

Due to adverse effects of turbidity on fish and aquatic invertebrates, limits of suspended materials in water is strictly controlled by the regulations on surface water protection. In fishery water bodies of the highest and first categories, the allowed excess of solids over background concentrations is limited to 0.25 mg/l. For water objects of other categories containing more than 30 mg/l of natural suspended substances, an 5% increase is allowed.

The amount of "temporary" damage depends on the parameters of adverse impact zones, the duration of the impact and the recovery time of damaged hydro-ecosystems [5].

Restoration or formation of new planktocenosis takes place the following year after the end of all works. Zoocenosis recovery is slow, with loss of part of species and a decrease in benthos biomass.

The researchers took OOO "Orlovka" as their testing site to implement measures for the rational use of its main water body. Orlovka used to take waters from the BolshoyKinel River to irrigate agricultural lands using a single point of the water intake structure. The experiment consisted in dividing this point into three located in different parts of the water intake structure in question , thus causing minimal damage to the water basin because of the minimal washaway of the water intake area and a more equitable water withdrawal. There are also FPS installed in suction inlets.

When a single point of water intake was used, water withdrawal for irrigating agricultural land was about 1011.52 thousand m3/year.

When additional water inlets were added, the volume of water withdrawal decreased (see Table 1). The decrease in the withdrawal of water was achieved through equitable distribution of water consumption and reduction of losses and leakage along the length of the water supply line.

The first point of water intake is used for irrigating four parcels of land (Field 1 –19 hectares, Field 2 –30 hectares, Field 3 – 36 hectares, Field 4 –18 hectares, total area – 103 hectares) with sprinkling machines (DMU-B 379-75 "Fregat" – 3 units) and mobile sprinkling installations with flexible plastic pipes of a drum type (Monsoon 2700 II, Beinlich, Germany – 2 units) (See the Appendix for their characteristics).

The second point of water intake is used for irrigating a 78-hectare area (Field 5) with a sprinkling machine Monsoon 2700 II (Beinlich, Germany) (See the Appendix for its characteristics).

The third point of water intake is used for irrigating a 95-hectare area (Field 6) with a sprinkling machine DMU-A 283-45 "Fregat" (See the Appendix for its characteristics).

At the beginning of the irrigation season, sprinkling machines are installed on the fields: Field 1 –Monsoon 2700 II; Field 2 – DMU-B 379-75 "Fregat"; Field 3 – DMU-B 379-75 "Fregat" (2 units); Field 4 – "Monsoon 2700 II"; Fld 5 – "Monsoon 2700 II"; Field 6 – DMU-A 283-45 "Fregat" . Sprinkler heads, pressure pipelining and movable parts are assembled and checked.

Table 1 – Distribution after the construction of an additional water intake structure

Point of water intake	Amount of irrigated land, [thousand m^3/year]	Area of irrigation, [hectares]
1	494.008	103
2	149.572	78
3	248.716	95
Total	892.296	276

Mobile pumping units are used to supply water to sprinkling machines (Point 1 of the water intake structure – a pumping station SNP 100/100 (2 units); Point 2 of the water intake structure – a pump with a tractor drive gear BOM of Rovatti T3-110 E type; Point 3 – a pumping station SNP 75/100). The pumping units are dragged to the water withdrawal site by a tractor or other motor vehicles (SNP 75/100) or are delivered to the site by road (SNP 100/100 and the pumping unit with the tractor drive gear BOM of Rovatti T3-110 E type).

All pumping units are installed outside the coast protection line (50 metres from water line) of the BolshoyKinel River. The platforms for the pumping units are made of concrete to prevent fuel leakage into the environment. There is a culvert installed around these platforms for emergency leakage. The use of pumping units does not adversely affect the ecological state of the main water object – the BolshoyKinel River.

The experiment also proved that a self-washed fish protecting structure (SFPS), installed on the suction line of these pumping units, might be successfully used to prevent young fish, algae and weed as well as litter from entering the pressure network.

Conclusions

The relevance of water intake structures research lies in water withdrawal from surface sources reduction, fishery conservation and reducing divestiture of water areas through reducing water withdrawal. All this confirms the fact that production practices, water consumption for agricultural needs and rational water resources utilization are being improved.

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