Protective Measures When Cleaning Bed of Shershnevsky Reservoir of Ground Deposits in Operating Conditions of Water Intaking Constructions

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Abstract. The article sets the objective to develop protective measures when cleaning the bed of the Shershnevsky reservoir of ground deposits using a dredger in the operating conditions of water intaking constructions. As protective measures the authors considered the application of polymer screens made of Dornit geofabric to clean ground deposits using a dredger which allows one not to violate the existing process conditions of the water intaking constructions at the reservoir. The authors developed a structure of a protective polymer screen and the scheme to apply the screen for the conditions of cleaning the bed of the Shershnevsky reservoir of ground deposits using a dredger. The installation of the polymer screens prevents the distribution of turbid suspended solids along the water area of the water body in the course of cleaning. The protective screen to prevent turbid substances in the course of bed cleaning allows blocking the enclosed space from the water surface to the bottom of the water body. It ensures the excavation of ground deposits in a cycle closed from the external water environment with the exclusion of sediment spreading and damage to the water body’s ichthyofauna. Keywords: ground deposits, cleaning of deposits, reservoir sedimentation, Shershnevsky reservoir

1. Introduction
The problem of clean water is very pressing in Russia. Over the last years, the sanitary condition of water bodies has improved slightly due to the reduction of discharge by industrial companies, but it is still concerning. The problem of clean drinking water sources is one of the most topical universal problems of the XXI century.

Today, when, according to the recent data, the polluted water is the main reason for oncological diseases, and the content of harmful substances has reached such an unprecedented concentration that the nature of influence on the human organism has become threatening (threats of mutagenic, teratogenic and pathogenic degeneration, human injury with incurable fatal diseases), only cleaning of drinking water bodies will allow to improve its quality and to solve the problem of the human health maintenance.

Based on the aforesaid, it should be noted that the main and the only source of drinking water in Chelyabinsk is the Shershnevsky reservoir, which belongs, according to the hygienic classification, to
water bodies of an average level of pollution with domestic and industrial waste and is subject to cleaning from the ground deposits accumulated over the years (1969-2017). [1-2]

The objective of the work is to offer protective measures – polymer screens made of Dornit geofabric for cleaning of ground deposits using a dredger, which allow not to violate the existing process conditions of the water intaking constructions.

To decrease the sedimentation of reservoirs and channels, it is recommended to: [3-6]

- maintain such conditions and operations, which enable a maximum transit of the incoming solid discharge; over the period of incoming water with an increased turbidity, channels must operate in the conditions close to the constant ones with the maximum possible water flow;
- wash the reservoirs and riffles of intake channels, clarify the water in settling basins, apply coast-protecting and sediment-retaining devices or remove sediments by mechanical means;
- daily activate pools to the minimum possible level (for daily controllable reservoirs).

Cost-protecting activities must be carried out at coastal sections subject to an intensive destruction under an economically justified project.

Cost-protecting and reclamation works provide for:

- preservation of the forest cover on mountain slopes, within the reservoir, planting of forest on the slopes and strengthening the slope with other vegetation;
- strengthening the existing ravines and mountain slopes decreasing the erosivity of water flows: slope terracing, ploughing along the slope with a horizontal furrowing;
- protection from torrent deposits by the arrangement of dams and fixing of slopes;
- mechanical sediment removal;
- washout of the reservoir.

For each certain reservoir the sediment control methods are chosen based on the local conditions and the feasibility study, capabilities of the energy system, requirements of water users, hydrological situation and condition of water intaking and treatment facilities. [7-9]

There is a known method of cleaning water bodies with the deposit excavation in the central part of the water body using dredgers and delivery of the pulp to the shore. Based on the bottom cleaning experience and the acquaintance with the advanced technologies, it has been found out that a stepwise system procedure can enable the best choice of a dredger. The basis for choosing a dredger is engineering-geological and hydrological surveys. A careful choice of equipment is time-consuming but allows to save considerable capital investments. [10]

The volume of ground deposits to be extracted within the shortest possible period of time comprises 169215 m³. The excavation depth reaches up to 8 meters and determines the capacity of the dredger. The mobility and the availability dictates the choice of the dredger dimensions. For this case, a portable “road-mobile” dredger is needed. [11]

Whereas ground deposits of the Shershnevsky reservoir belong to grounds of category I-III, the best dredger type is a free suction dredger. To clean the Shershnevsky reservoir of ground deposits, we used the hydro-mechanized reservoir cleaning method using Uralets-400 dredger, which does not yield to foreign analogs by its capacity.

The dredger has an electric engine, which is one of the most important factors when making a choice. An electric engine as compared to a diesel engine does not endangers the reservoir in the course of cleaning by a secondary pollution with oil products, which is important, whereas the Shershnevsky reservoir is a source of drinking and utility water supply. [12-13]

The drive power of the dredge pump comprises 75 kW, which is considerably less than the power of analogous pumps, which will allow for an efficient use of the electric energy. The dredger is meant for the excavation of grounds of category I-III, such as ground deposits of the Shershnevsky reservoir.

Depending on the category of the developed ground, the dredger is able to pump the pulp with the content of up to 20% of solids, which can provide the capacity of up to 80 m³/h by the ground.

The dredger can be fitted with a miller meant for the excavation of firm, heavy grounds, as well as for the removal, milling and transportation of weeds and vegetation present in the water body to the shore.
The use of the hydro-mechanized method poses a threat of the turbid sludge distribution along the entire water body in the runoff control conditions. The water supply conditions at such method are sharply limited and require protective measures. [14-19]

To minimize the distribution of turbid suspended solids along the water body area, it was decided to install protective polymer screens.

A protective screen to prevent turbid substances in the course of the bed cleaning allows to block the enclosed space from the water surface to the bottom.

We chose Dornit (geofabric) as a material for the production of protective screens. Dornit is an environmentally safe geofabric material to be used as a filtering and a separation layer. The main advantages of Dornit geofabric include: high elasticity of the material (Dornit can withstand considerable loads at small deformations), high filtering property, conservation of filtering properties in the conditions of a strong vibration and under the soil pressure, resistance of the material to punching, resistance to the ultra-violet radiation, absolute environmental safety, durability, resistance to low temperatures.

The protective screen is a recovery net made of a piled synthetic material or rough-surfaced canvas. The upper part of the net is kept in the vertical position by buoyancies 1 and plumbs attached thereto, through which the brackets freely sliding up and down are connected with the poles 4 rammed in the bottom, which fix the net in the set direction. The lower part of the net occupies a vertical position by means of the swamp weights attached thereto.

The design of the protective polymer screen to prevent the collection of turbid substances when cleaning the bed of the Shershnevsky reservoir is shown in figure 1.

To cover the crevice between the bottom and the lower part of the net, it is necessary to use a channeled filter with small plumbs pressing its edge to the bottom.

An additional turbidity created within the permissible limits during the excavation of bottom trenches does not considerably affect the water quality and the ichthyofauna of the water body.

The cost of the device and its application must be reflected in the estimate project costs.

The scheme of using protective polymer screens is shown in figure 2.[20]
2. Conclusion

Thus, as exemplified by the Shershnevsky reservoir, we developed protective measures allowing to clean the bed of ground deposits, excluding the ecological risks of the collection of turbid substances, preserving the chemical composition and the environmental potential of the reservoir’s water ecosystem.

At the present cleaning stage, the turbidity process allows to characterize the risk level as increased, corresponding to a low environmental potential of the ecosystem, and outlines a tendency towards the destabilization of the operation of the water intaking constructions.

It is shown that the use of protective screens contributes to a decrease of the ecological risk of the collection of turbid substances for a stable functioning of the Shershnevsky reservoir and operation of the water intaking constructions.

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