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CALCULATE THE VOLUME OF TURBIDITY IN THE RESERVOIR

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Abstract

In the article, the change in the size of the water reservoir in the process of silting, the dependence of the water level in the water reservoir is evaluated. On the basis of research conducted in natural field conditions, the recommended calculation method was analyzed and compared. Under natural field conditions, research was conducted in Tashkent reservoir. As a result of the analysis of the collected data based on mathematical statistics methods, a relationship was obtained that expresses the relative turbidity volume in the reservoir and the relative water depth in the reservoir (the correlation coefficient is 0.96.).

Key words: Water reservoir, water balance, reservoir usable volume, method, muddy, sediment, water flow, water level, kinetic energy, ground power, Archimedes power, relative depth, project amount.

1. Introduction

In our country, special attention is paid to the development of economic sectors, including the agricultural sector, the cultivation of abundant crops from agricultural crops, and the provision of food to the population. considered as In the conditions of our country, built in recent years to provide guaranteed water to cultivated areas [1,2,3,6].

Calculation of the useful volume of reservoirs, their filling with turbidity, and the theoretical foundations of the problems of water loss in reservoirs were developed by a number of scientists A.B.Avakyan, A.V.Karaushev, V.S.Lapshenkov, V.A.Skrylnikov, K.Sh. Latipov, A. M. Mukhamedov, A.M.Arifjanov, V.I.Shtefan, K.K.Edelstein, V.F.Brekhovskikh, D.W.Baker, B.P.Bledsoe, C.M.Albano, N.L.Poff, G.Williams, S.Heaven, T.Tanton, D.Rycroft, A.M.Patil, D.Patil and others' work reflected and certain positive results were achieved [3,4,5,8,9].

Today, despite the large-scale research conducted in this direction in our republic, issues such as the assessment of the change in the useful volume of water reservoirs, the calculation of the volumes of siltation in water reservoirs, and the development of scientifically based measures based on them, remain relevant.

It is necessary to have accurate information about the volume of water stored in the reservoir during the development of the working regime of reliable and efficient use of water reservoirs, during the safe operation of facilities. This volume is constantly decreasing due to sediment deposition as a result of the annual operation of the reservoir. In a year, millions of cubic meters of muddy sediments can accumulate in reservoirs, as a result of which the useful volume of reservoirs is not determined with many errors [4.5.6].

To calculate the volume of water reservoirs, the water balance elements during their operation over the years, i.e. the sum of the inflow and outflow water amounts and the change of water levels in the last months of these years are used. The dependence of water levels on the estimation of changes in reservoir volume due to turbidity in individual reservoirs has been shown in many years of research [4.5.6.8]. In this article, the reduction of the useful volume of water reservoirs due to siltation is estimated depending on the change of the water level.

In this article, the amount of turbidity in the reservoir during the years of operation was determined to be 2 times higher than in the project. The decrease in the useful volume of reservoirs due to turbidity is estimated due to changes in water quality. Data from natural field-produced materials is used, water sources including rivers are useful.

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2. Materials and Methods

When the volume of the reservoir is filled with sediments, the technical characteristics of the reservoir deteriorate, irrigation canals and water access works receive large sedimentary deposits, and the water level can be controlled. This makes it necessary to predict turbidity.

Conservation of the situation under natural field conditions carried out in reservoirs, sudden movement from measured siltation during planned siltation.

Desilting of water reservoirs helps to improve the system of using the water reservoir on the one hand, and on the other hand, it helps to co-move river sediments into channels and to use small sediment particles rich in minerals as fertilizers.

Based on the researches of A. V. Karaushev, K. Sh. Latipov, V. S. Skrilnikov, Lapshenkov, A. M. Arifzhanov, etc., which were allocated to the place of siltation of water reservoirs, we will consider the order of siltation wounds. Through turbidity, water is distributed. We write the variable of the kinetic energy of the particles as follows:

$$\frac{dE}{dl} = F_i - R_x \quad (1)$$

here: l-length F_i- gravity and Archimedes forces:

$$F_i = -g(\rho_т - \rho)V_т n\, sin\alpha \quad (2)$$

R_x −resistance force:

$$R_x = -\frac{1}{2}\rho V_т n \frac{d\vartheta^2}{dl} \quad (3)$$

Then put (2) and (3) into (1):

$$\frac{dE}{dl} = -g(\rho_т - \rho)V_т n \cdot sin\alpha + \frac{1}{2}\rho V_т n \frac{d\vartheta^2}{dl} \quad (4)$$

here: n- solid particles per unit volume; $sin\alpha$- the slope angle of the stream; $\rho_т$; ρ − solid particle and fluid density, respectively; $V_т$- volume of solid particles; g - free fall acceleration; ϑ– average flow speed.

Turbid flow kinetic energy:

$$E = \frac{2\rho_т V_т \vartheta^2 \cdot n}{3} \quad (5)$$

Substituting the 5th expression into the expression (4), the change in the kinetic energy of the turbulent flow is written as:

$$\frac{dE}{dl} = -g(\rho_т - \rho)V_т \frac{3}{2}\frac{E}{\rho_т V_т \vartheta^2} \cdot sin\alpha + \frac{3}{4}\rho V_т \frac{E}{\rho_т V_т \vartheta^2}\frac{d\vartheta^2}{dl} \quad (6)$$

Expressing the flow speed by discharge of flow,

$$\vartheta = \frac{Q}{\omega},$$

(6) the equation is written as:

$$\frac{dE}{dl} = -\frac{3}{2}g\frac{(\rho_т - \rho)}{\rho_т}\frac{E\,\omega^2}{Q^2} \cdot sin\alpha + \frac{3}{4}\frac{\rho}{\rho_т}\frac{Ed(ln\vartheta^2)}{dl} \quad (7)$$

Integrating the 7 th equation

$$E = C \cdot exp\left\{-\frac{3g(\rho_т - \rho)}{2\rho_т Q^2}\int_0^l \omega^2 sin\alpha\, dl\right\} exp\left\{\frac{3}{4}\frac{\rho}{\rho_т}\ln\vartheta^2\right\} \quad (8)$$

constant of integration of C , determined from initial conditions.

When

$$l = 0\,; \qquad E = E_0\,;$$

and the equation is written as:

$$E = E_0\left(\frac{\omega_0}{\omega}\right)^{n_1} exp\left\{-\frac{3g(\rho_т - \rho)}{2\rho_т Q^2}\int_0^z \omega^2 \sin\alpha\, dl\right\} \quad (9)$$

Based on the research conducted in this direction, [5,6] passing from the quantity of turbidity particles to the concentration of turbidity, the expression (9) is written as:

$$\frac{s_i}{s_o} = \left(\frac{\omega_i}{\omega_o}\right)^{n_1} \cdot exp\left\{-\frac{3g(\rho_i - \rho)}{\rho_т\, Q^2}\int_0^l sin\alpha\,\omega^2 dl\right\} \quad (10)$$

Turbidity discharge:

$$P_i = s_i\, Q \quad (11)$$

Turbidity volume:

$$V_i = s_i\, Q \cdot t \quad (12)$$

By looking at the surface of the flow in the section under consideration as a function of depth;

$$\omega_i = f(H_i) \quad (13)$$

Putting (13) and (12) into (10), the following expression is obtained:

$$\frac{V_i}{V_{МДС}} = \kappa\left(\frac{H_i}{H_{МДС}}\right)^{n_1} \quad (14)$$

here: $H_{мдс}$ – the depth corresponding to the standard damped level, $V_{мдс}$ – the volume of the reservoir corresponding to the water level, κ and n_1- coefficients, determined on the basis of research in natural field conditions.

Derived formula (14) expresses the relative turbidity volume in the reservoir as a function of the relative water depth in the reservoir.

3. Results

Effective use of the above formula (14) requires quantification of n1 and k. Analytical determination of the amount of these coefficients is complicated by the variability of the reservoir volume. Therefore, the values of n1 and k are determined on the basis of data

obtained in natural field conditions, for which data collected in several reservoirs were used. In particular, observation data in natural field conditions in the basins of Tashkent and Southern Surkhan reservoirs were used (tables 1). From the analysis of the collected data on the research conducted in natural field conditions, it became known that the amount of turbidity in the observed water reservoirs is 2 times higher than the design amount (Table 1). In particular, according to the design calculation of the South Surkhan Reservoir, it was noted that the annual volume of sedimentation will be equal to 6.8 million m3. But the conducted studies show that this amount is variable and has been increasing in recent years. In the Southern Surkhan reservoir, it was observed that the amount of turbidity was 1.3 times higher than in the project as determined by measurements during the years of operation (Table 1).

The analysis of the conducted studies showed that the same situation was observed in the Tashkent reservoir, that is, the amount of silt-sediment sedimentation was 2 times more than in the project.

Based on the analysis of the research carried out in the Tashkent reservoir under natural field conditions, the dependence of turbidity in the reservoir on the water level was analyzed, the results of the analysis are presented in Table 1[3,4].

Table 1. Monitoring data in Tashkent reservoir

Water reservoir	Tashkent	Tashkent	Tashkent	Tashkent	Tashkent	Tashkent	Tashkent	Tashkent	Tashkent	Tashkent
H, м	4	4,5	5,5	6	6,5	7,5	8	8,5	9,5	10
H/H_{NDS}	0,125	0,15	0,167	0,1875	0,2	0,228	0,250	0,26	0,289	0,3125
V/V_{NDS}	0,072	0,085	0,097	0,107	0,12	0,136	0,146	0,159	0,178	0,196

Processing the collected data on the basis of mathematical statistics methods (the correlation coefficient was equal to 0.96), k and n_1- coefficients in the calculation formula (15) were determined, which represent the relative turbidity volume in the reservoir depending on the relative water depth in the reservoir. Based on the analysis, the graph of the relative turbidity volume in the reservoir and the relative water depth in the reservoir is shown in Figure 1.

Sing the obtained data in Table 1 and the above formulas, a formula for determining the decrease in the useful volume of reservoirs located in the riverbed was created (Fig. 1):

$$\frac{\Delta V_H}{\Delta V_{NDS}} = 0{,}92\left(\frac{H}{H_{NDS}}\right)^{5/4} \quad (15)$$

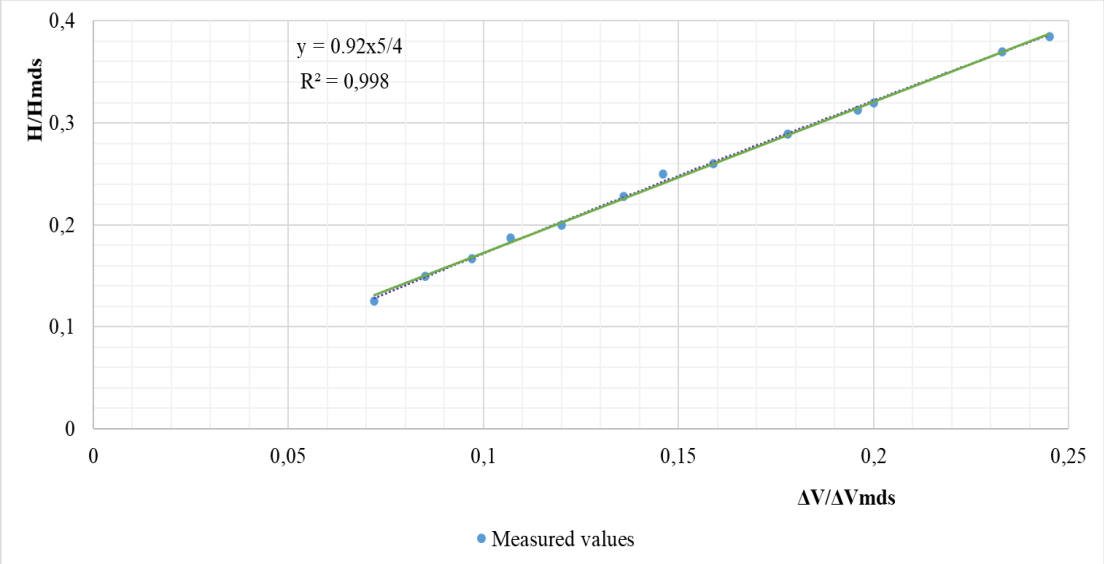


Figure 1. Graph of the relative turbidity volume in the reservoir versus the relative water depth in the reservoir

4. Discussion

The calculation of turbidity volume in reservoirs, it is essential to consider future research directions that can enhance our comprehension of this critical aspect of water quality. Potential areas for future exploration include the development of advanced monitoring technologies for real-time assessment, investigating the impacts of climate change on turbidity dynamics, and conducting in-depth studies on the ecological

resilience of aquatic ecosystems to turbidity fluctuations. Additionally, research could focus on sediment source tracking, integrating modeling approaches for more accurate predictions, and promoting community engagement through citizen science initiatives. Evaluating the economic implications of turbidity on various sectors, developing adaptive management strategies, and fostering cross-disciplinary collaboration are also crucial avenues for future research. These endeavors promise to not only refine our understanding of turbidity but also contribute to the development of innovative and sustainable reservoir management practices.

5. Conclusions

Based on the monitoring and fund data, it can be said that in the reservoirs of our republic, the amount of turbid sediments is 1.5-3 times more than the amount in the project.

In calculating the reduction of the useful volume of water reservoirs due to silting through the method recommended by us, the constituents of the water balance during the operation of the water reservoirs, that is, the sum of the amount of incoming and outgoing water and the water levels of the last months of these years, are used. A comparison of the calculated magnitude of reservoir volume reduction and the data obtained as a result of observations during the operation of reservoirs shows that we can see that the proposed method gives good results.

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