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Integral Regulation of Sedimentational Processes in Technoparks Waste Waters at Global Warming Conditions

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Abstract **-** *Local interest in the accumulation of water precipitation is based on the need to collect raw materials for construction. Raw materials can be primary or secondary. The task of restoring secondary material to recovery the quality of primary. This is the motivation for industrial enterprises to recycle. Updating production processes to reduce production costs is a very promising way of technology parks. Data collection on changes in water level and quality of hydrological resources at characteristic cross-sections of Kapustyane Reservoir data was collected using bathymetric sensors. The geometrical parameters of the recreational reservoir depending on the lithological characteristics of the wastewater sediments, that were calculated and confirmed during the field research. The use of mechanical and adhesive water treatment can accelerate the process of water recovery to supply the river basin. A methodological basis for regulating the flow of effluents depending on the quality of the re-resource for the creation of turbulence zones in the reservoir has been developed. The study obtained more than 87 kg / 1 area for 1 month. Thus the technical sizes of recreational reservoirs of technoparks depending on volume and quality of wastes are calculated. By restoring the resource of the river basin, biodiversity is renewed and fauna is restored - the simplest conditions for sustainable development of the metallurgical region. Additional methodological tools for productive regulation of regional water regulators have been developed. Productive joint work of the regulator and scientific experts for revealing of perspective directions of work of hydrological experts is offered.*
Keywords**:** *sensors, sediment, salt supersaturation, reservoir length, wastewater, hydrological regime, chemical balance, hydrological potential*

1. Introduction

The accumulation of river sediments is required for the economic activities of recreational units of the municipality, the technological process of creating conditions for the accumulation of sedimentary material and the instrumental control mechanism. The Kapustyana river basin, equipped with level gauges, a salt meter and a surface meter, for calculating the frequency of sewage flow, is taken as a prototype of a recreational reservoir. The flow rate of the effluent in the channel was measured with a Zhestovsky turntable. The density and weight of the precipitate were measured in the factory laboratory using a penetrometer and sediment chromatography. The thickness of the sludge film was measured by gravimetric methods in the laboratory of National University. In the spring-summer-autumn period, the specialists of the research group in the reservoir basin calculated and adjusted the frequency of industrial effluents for the formation of turbulent flow regime. The duration of the measurement ranged from 3 to 45 minutes depending by the sediment density. Bathimetric sensors were located at a distance of 0,5-10-20-30-40-50 m from the beginning of the reservoir. Sediment weight and their lithological characteristics were measured by sampling the suspended solids from the bottom of the lake on a boat at a distance of 10-25-50-75 meters from the bank. The maximum depth was 8 m (echo sounder data). Measurement of indicators of hardness, alkalinity, pH and salt content was performed by appropriate rapid tests of chemical quality water indicators.

Recent research and measurement.

It is necessary to determine the morphological changes in urban wastewater, the results of the water impact and changed chemical balance of the reservoir, development of the reservoir as a whole, outside the city. In cities where industrial enterprises are located, forced mixing occurs naturally, but regulation for sustainable community development is not shown. To develop new technological schemes for re-water recovery, it is useful to know the multicomponent composition of effluents and its risks. The calculation of waste dilution and the required technological flow to restore the resource is relevant for the sustainable development of the technology park. Occurrence of anthropogenic phenomena in risk areas has a circulating effect on the chemical composition of salt components of the reservoir balance. Suspension of anthropogenic phenomena will stabilize the chemical and morphological regime of the reservoir. The formation of relief-resistant materials suspends landslides and channel runoff. The use of digital modeling helps in the operational regulation and strategic planning of reservoir development. Waste organic morphology helps to accelerate the process of gasification of fuel. Such devices should be implemented to determine the desired morphology.

2.Experimental Methods And Aparatus

The operational needs of society and the greening of enterprises have influenced the introduction of on-line monitoring of bathymetric sensors in the characteristic crossings in Kapustyana river: TDS meter, ovp meter, express tests of water rigidity, alkalinity, oxidation. Implementation the results of developed bathymetry programs, water mode, mixture, helps in operational and strategic planning of regional reservoir modes.

3. Results of analytic experiments

3.1 Results of bathymetric data

The approach explores the localized dynamics of the tidal amplitude of the water level. The synchronous assumption makes it possible to raise the determined gradients directly from the amplitude of the tidal heights. Solutions obtained for the triangular shape of the lake c = (g × D)0,5. Equivalent results for a rectangular cross-section implies velocity change c = (0,55 g × D)0,63. Dynamic solutions are reduced to the functions ξ*, D and the friction coefficient of the reservoir bed f.

3.2 Results of salt intrusion study and reservoir depth

Interest in mixed or partially mixed reservoirs assume that the temporarily vertical, constant relative gradient of axial density, Sx = (l /ρ) (∂ρ/∂x) is linearly proportional to salinity. In previous studies, the length of penetration of man-made solution, LI, in mixed reservoirs, for sedimentation:

$$L_I = \frac{0{,}007 \times D^2}{f \times U^* \times \frac{1}{3} U_o} \qquad (1)$$

The results associated with the subsequent expression determine the point of invasion of impurities along the reservoir to display the main indicators of the mixing zone (risk zone).

By lowering the convective term from the momentum equation, one can describe the tidal distributions in a recreational lake:

$$\frac{\partial U}{\partial t} + g\frac{\partial \zeta}{\partial x} + v\frac{\partial \xi}{\partial x} + f\frac{U|U|}{H} = 0 \qquad (2)$$

$$B\frac{\partial \xi}{\partial t} + \frac{\partial}{\partial x}AU = 0 \qquad (3)$$

where U – liquid flow velocity;

ς - water level;

D - water depth;
H - total water depth (H = D + ξ);
f - layer friction coefficient (~ 0,0025);
B - channel width;
A - cross-sectional area;
g - gravitational acceleration;
t - time.

The assumption of a synchronous lake shows small axial variations ξ*. The solutions obtained for U* (Fig. 1) indicate an additional assumption, exceptionally for shallow rivers. The following triangular section with constant lateral slopes, (2) reduces to:

$$\frac{\partial \xi}{\partial t} + U\left(\frac{\partial \zeta}{\partial x} + v\frac{\partial \xi}{\partial x}\right) + \frac{1}{2} f \frac{\partial U}{\partial x}(\xi + D) = 0 \qquad (4)$$

The study was conducted in the Kapustyana river of Zaporizhzhya region. The sensors are located in characteristic sections, near drainage collectors of the enterprises. The research data of the flow modes in reservoir is shown in Fig. 1.

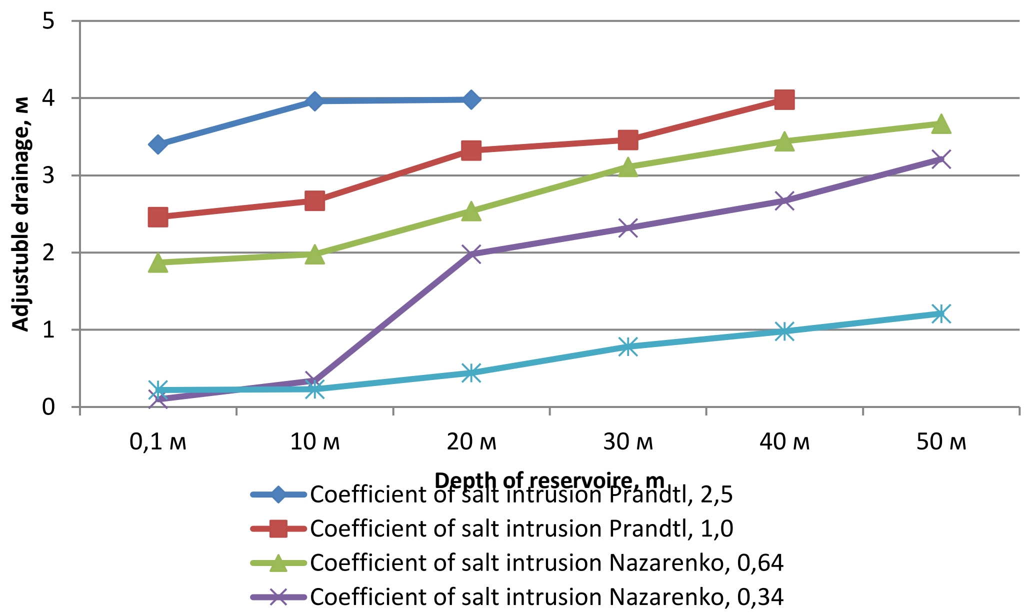

Fig. 1: - Coefficients of salt intrusion along the length of the lake, Ex / L.

The hydrology characteristics of the recreational lake is:

$$\tan\theta = -\frac{F}{\omega} = \frac{SL}{0{,}7Dk} \qquad (5)$$

where SL = ∂D / ∂x

$$U^* = \xi^* \frac{gK}{(\omega^3 + I^2)^{0,5}} \qquad (6)$$

$$k = \frac{\omega}{(0{,}5D \times 0{,}78g)^{0,5}} \qquad (7)$$

The program obtain for each diameter of the sediment fraction own recommended length of lake, for sedimentation. Regulators with region specific features shall recommend efficient hydraulic modes for enterprises service manager. Assuming F ≫ ω, the value of amplitude can be determined:

$$D = \left(\frac{5}{7} \times \frac{(1{,}33 x_0 \xi^* f\omega)^{0{,}5}}{2g^{1{,}76}}\right) x^{f \times 3/7} \tag{8}$$

where $x_0 = L - X$.

Substituting X = 0 and $D = D_0$ as the basis, the lengths of lakes:

$$L = \frac{D_0^{5/7}}{\xi_0^{*2/3}} \frac{(2g^{1/4})}{(1{,}33 f\omega)^{1/3}} = 2460 \frac{D_0^{4/5}}{\xi_0^{2/3}} \tag{9}$$

Dependence on $D_0^{4/5}/\varsigma^{*1/2}$ in (9) and Fig. 1 indicates that the lakes length is much more sensitive to D. Former studies shows the expression for estuarine length is broadly consistent with lakes located around the Azov coast. For lakes, which sludge content estimates (450… 490 mg/l), allowing some discrepancies between the observed and estimated values.

3.3 Studies of water sedimentation.

The dynamic results described in the study are integrated with the data on the amount of sediment to form networks of trajectories. The practical application of the system in man-made space is proposed by reintegrating man-made factors into a new mathematical system. Erosion, assumed to be proportional to the rate squared, is modulated by the exponential subsidence rate, which gives the average and practical nature of changes in sediment concentration. The approach assumes the continuity of the cycle of erosion and sediments that coexist without peak values. The results of the components of the derivatives are determined from the product of flow control and residual velocities (modified for the components of the vertical structure) of the components of the sediment concentration:

$$\frac{\partial}{\partial x}(u^2) + \frac{\partial}{\partial z}(uw) = -\frac{1}{\rho}\frac{\partial \rho}{\partial x} - g\frac{\partial z_0}{\partial x} + \frac{1}{\rho}\left(\frac{\partial \tau_{xx}}{\partial x} + \frac{\partial \tau_{2x}}{\partial z}\right) \tag{10}$$

$$\frac{\partial}{\partial x}(uw) + \frac{\partial}{\partial z}(w^2) = -\frac{1}{\rho}\frac{\partial \rho}{\partial z} - g\frac{\partial z_0}{\partial z} + \frac{1}{\rho}\left(\frac{\partial \tau_{x2}}{\partial x} + \frac{\partial \tau_{x2}}{\partial z}\right) \tag{11}$$

$$\frac{\partial}{\partial x}(u^2) + \frac{\partial}{\partial z}(uw) = -\frac{1}{\rho}\frac{\partial \rho}{\partial x} - g\frac{\partial z_0}{\partial x} + \frac{1}{\rho}\frac{\partial \tau_{2x}}{\rho \partial z} \tag{12}$$

3.4 Investigation erosion components of velocity

The range of values of the settling velocity, 1 <Ws <2,5 mm/sec, is close to the value adopted for the Kapustyana River (2020). Moreover, recently results have been obtained from a number of regional reservoirs, due to flocculation, at values of Ws = 1 mm / s. The average depth and the average concentration, 50 <C <200 mg / l, are in the lower range of the observed maximum concentrations, 10–10000 mg / l. However, these estimates can be significantly increased.

On the variation of the effective coefficient of friction, as f = 0,0032. An interesting feature of these results is the close constancy of the parameter Kz / WsD = 1, over the entire range (D, ξ *). It was previously noted that the maximum half-lives correspond to Kz / Ws D = 2.5, which coincides with Ws ~ 1 mm / s. It indicates the coexistence of maximum concentrations with the conditions of morphological stability.

Figure 6.5 (a) and (b) show the net fluxes and mean suspended concentrations calculated by (6.31) and (6.26) for Ws = 1 mm / s and 2 mm / sec, consistent with stable morphology. Moreover, these upstream flows increase approximately in proportion to 3.1 and vice versa.

The xi values include hydraulic compensation for reducing the inflow velocity as the depth decreases, and ignore axial flow changes. Tidal expansion of saline solutions:

$$E_x = \left(\frac{2{,}41}{\pi}\right) U^* \frac{2}{3} P \qquad (13)$$

The area shown in Fig. 5, fully corresponds to the imposed distribution of values (D, ξ*) in Zaporizhzhia lakes.

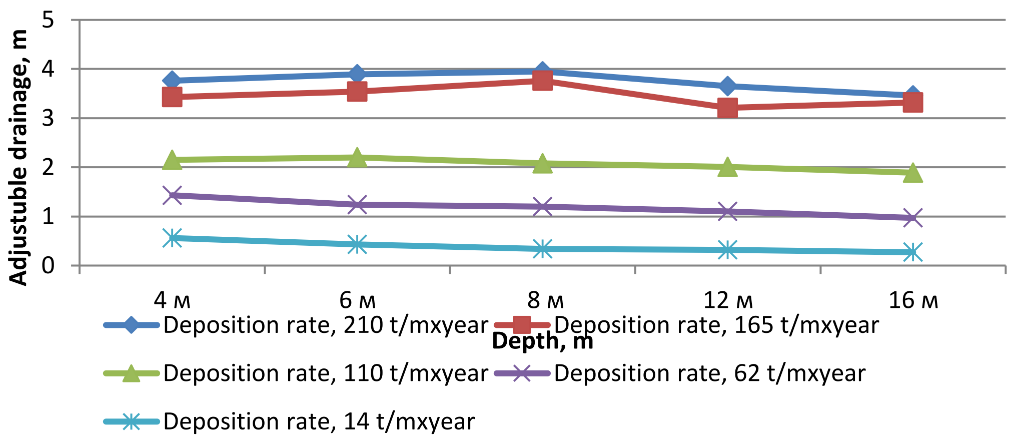

Fig.2: Sediment flows (peak) in t / year and concentration (bottom) in mg / l as f (D, ξ *). (b) WS = 0.002m / s.

3.5 Study of scenario indicators

Estimates of precautionary changes in JSC “Hydroenergo” to 2100 include technical data on water levels, which will decrease by 0,5m in the south region. Relevant operational estimates of river flows confirm a reduction to 25%.

Making these changes to the river stream, Q, (9) and the resulting changes in depth, D(5) can be estimated by changes in the length of the lakes, ΔL. Representative values of D, L and B over the ranges of geomorphological estuarine changes are calculated using a mathematical model. Adequacy and reproducibility of the model were evaluated according to the statistical criteria of Kohren, Fisher.

Table 1: Experiment factors and variation intervals

	Lower level (-1)	Common level (0)	Upper level (+1)	Variation interval	Factor name
x_1:	0,4	2,2	4	1,8	Amplitude of tidal currents, m

x_2:	2	79	156	77	Concentration of $CaSO_4$, mg/l
x_3:	30	4340	8650	4310	Mode, hours

Research equation of mathematical model taking into account constant factor:

$$Y = 51{,}355-0{,}614x_1-3{,}25x_3-0{,}528x_1^2 + 0{,}936x_3^2 + 0{,}823x_1x_3 \quad (14)$$

Discussion.

The convenience of numerical simulation planing different scales of man-made load for short and long project periods. Fig. 8 presents the simulation of the development of the basin according to the operational scenario (95%) and strategic planning (5%) in the presence of appropriate hydrological GPS sensors. Operational use in real time sends out warnings about the danger of storms, electric surges, movement of oil or chemical spills, search and rescue, eutrophication of toxic algae.

Conclusions.

The current study allows to visualize the water, environmental and biological risks of a technogenic metallurgical region when interacting with the flora and fauna of the region: testing the mathematical model of productivity of cavitation sedimentation; during the flow study, more than 1350,000 m^3 / year of restored water and about 250,000 sludge in one metallurgical region were calculated; - for the first time the equation of expansion of salt solutions of recreational reservoirs is received; the methodology of increase of concentration of bottom deposits depending on coefficient of friction from 0,0025… 0,125 is offered; the optimal length of the reservoir to maximize sediments was identified; a software shell has been developed to calculate the directions of hydrological development of the reservoir.

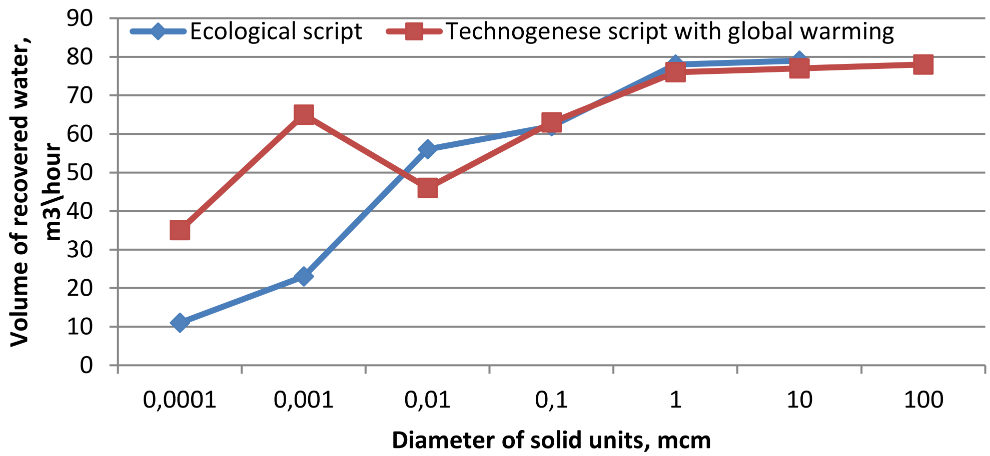

Fig.3: Influence of volume of recovered water to diameter solid units.

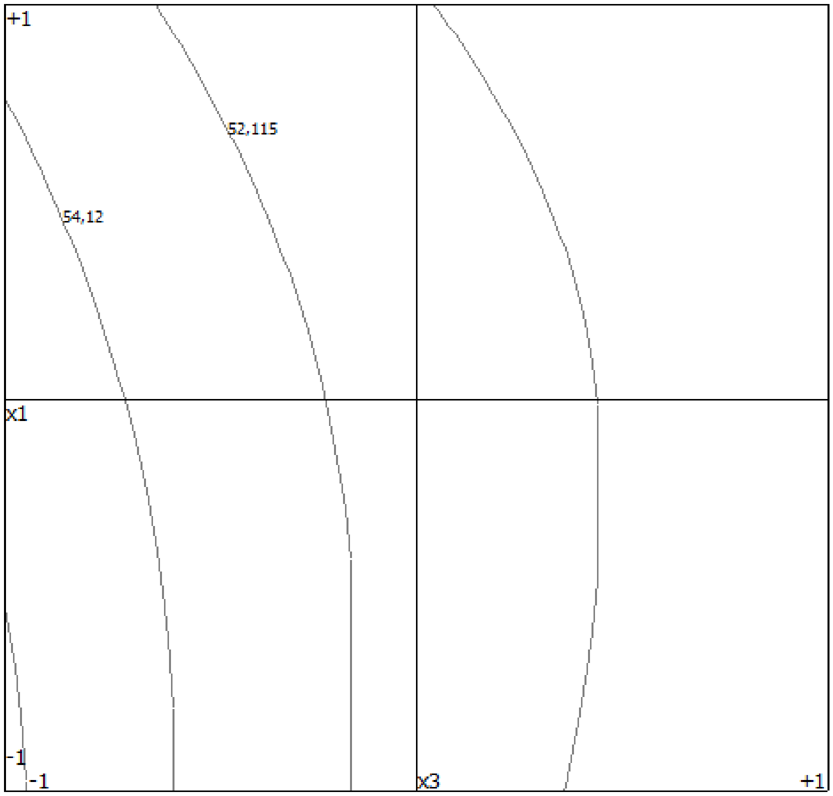

Fig.4: Determination diagram of sediment productivity of lake.

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