Investigation of the influence of radiation on the optical biomaterials characteristics of the storage lake Sorbulak

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Abstract. The authors carried out the study on the effects of radiation on the optical characteristics of water solutions of Lake Sorbulak during the passage of laser radiation through them. The experimental data are well consistent with the theoretical calculations of the exponential model.

1. Introduction
In recent decades, much attention has been paid to studying the conditions of accumulation of precipitation in lakes and sources of irrigation water [1 – 5]. The process of cleaning bottom sediments (BS) and biomaterials is largely determined by the rate of sedimentation and is described by the silt index, since microorganisms participate in the natural cleaning of water bodies [6, 7]. The increased silt index indicates a malfunction of the cleaning system [8 – 11].

Contaminated organic substances of storage materials lead to negative consequences for water bodies [12 – 15]. The study of the natural environment of water resources is relevant to this day. For example, the concentrations of trace elements and heavy metals in irradiated and unirradiated lake plants (basil, reed, sedge, elm, etc.) were studied in [16 – 18]. In [19] evaluated the toxicity and fertilizing ability anaerobic sludge as fertilizer after treatment with gamma radiation.

This work is devoted to the study of the effect of radiation on the transmittance of water solutions of the storage lake Sorbulak.

2. Methods of the experiment
A device was developed (Scheme 1) for the study of unirradiated and previously irradiated storage materials. It includes a laser source, a water solution, photodiode sensor, monitor, stand with barbell, interface, time sensor, fixing elements and data analysis block.

A water solution of the storage lake was immersed in a liquid measuring tank and placed between the light source and the recorder. The dependence of the intensity (illumination) of light (laser radiation) on time is fixed. The material was irradiated on a linear electron accelerator, where the particle energy was 4 times greater than the rest energy. Absorbed doses were 500 kGy and 3 X-rays.
Figure 1. Picture of the experiment on the transmission of light through samples

3. Discussion of results
Figure 2 shows the dependence of the intensity of laser radiation on time.

Figure 2. Data on the time dependences of the intensity for unirradiated (1) and irradiated by electrons (2a, c) and photons (2b, d) bottom sediments in different periods

white figures – experience 2016; black figures – experiences 2018; curves – calculation data
The intensity increases over time, after which it reaches saturation. Experiments conducted on electron-irradiated deposits show that particle beams have a direct effect on the dependence I (τ). The nature of this dependence after electronic exposure is practically unchanged. The degree of natural and artificial filtration is related to the deposition rate of the accumulated material. For curves 2b, d, samples exposed to x-rays with a dose of 3P, the deposition rate decreases, which indicates the activation of microorganisms in solution.

The results obtained are satisfactorily described within the framework of the cascade-probabilistic model proposed by the authors of [20] (Fig. 2a, b, c, d):

\[ I = I_0 \left(1 - \exp\left(-\frac{\tau}{\tau_0}\right)\right), \]

here \( I_0 \) – max the illumination of the laser radiation, and \( \tau_0 \) – the time during which the illumination of the material decreases by \( e \) times.

Further, the study was carried out on the microstructure of bottom sediments and silt with numerous living organisms of the Lake Sorbulak (Diagrams 3, 4). As can be seen from figure 3 bottom sediments have sizes of 300 – 1000 nm, and particles of silt – 200 – 600 nm.

![Figure 3. Storage materials of the Lake Sorbulak](image)

![Figure 4. Silt particles of the Lake Sorbulak](image)

4. Conclusions
1. The study was conducted on the effect of radiation on the optical characteristics of water solutions of Lake Sorbulak. The intensity of laser radiation when passing through a solution first increases sharply, and then reaches a constant.
2. At low doses of photon irradiation, a decrease in the intensity of optical radiation occurs, and at high electronic doses, an increase occurs, which is associated with an increase in the activity of microorganisms and their death, respectively.
3. The curves of the dependence of I on τ are satisfactorily described in the framework of the exponential model.
4. Microscopic studies of bottom sediments and silt with numerous living organisms of the Lake Sorbulak were carried out. As follows from the analysis of the results, bottom sediments are 300 – 1000 nm in size, and silt particles are 200 – 600 nm in size.

Acknowledgment
The study was carried out with the financial support of the grant of the Ministry of Education and Science of the Republic of Kazakhstan. IRN Grant: AP05132221.

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