Journal of Positive School Psychology http://journalppw.com
2022, Vol. 6, No. 5, 2921-2925

# Development Of A High-Performance Technology For Mixing Ozone With Water For The Preparation Of Drinking Water From The Reservoir

**Makhmudov Ilkhom Ernazarovich[1]. , Aliev Makhmud Kuvatovich[2]. , Makhmudova Dildora Ernazarovna[3]. , Musayev Sharof Mamarajabovich[3]. , Rustamova Mukhlisa Muhtaralievna[4]. , Nematov Davlat Berdiyor ugli[5]. , Boboyorov Bekhruz Ixtiyor ugli[6]**

[1]*Professor, Scientific Research Institute of Irrigation and Water Problems, Doctor of technical sciences, Uzbekistan.*
[2]*Tashkent institute of architecture and civil engineering, Uzbekistan.*
[3]*Jizzakh Polytechnic Institute, Uzbekistan.*
[4]*Phd student, Tashkent institute of architecture and civil engineering, Uzbekistan.*
[5]*Phd student, Scientific Research Institute of Irrigation and Water Problems, Uzbekistan.*
[6]*Master degree student, Bialystok University of Technology, Poland.*

## Abstract

The article represents the features of mixing ozone with treated water, directly in the process pipeline. Due to the significant volumes of water consumption in the interests of ensuring economic activity, the issue of disinfection of drinking water is substantial. Along with traditional methods of disinfection, considerable attention of modern researchers is focused on the development of innovative technologies for this process. These include the technology of mixing the ozone-air mixture with the treated water directly in the process pipeline. The features of the formation and the qualitative composition of the water of the Charvak reservoir were investigated with the analysis of the reliability of the existing technology for the preparation of drinking water. The effect of ozone on the physicochemical parameters of water taken from the reservoir was investigated.

The article discusses the process of disinfection of drinking water with ozone directly in the process pipeline. The description of a prototype installation for disinfection of drinking water with ozone directly in the process pipeline is given. The results of experimental studies to identify the dependence of the degree of liquid disinfection using ozone are presented.

Consideration of the intensification of the process of dissolution of ozone in water due to a swirling flow as the most economical and promising way to achieve 95-99% of ozone utilization has been established.

As a result of the study, a treatment mode was determined that provides the smallest amount of ozone with the maximum disinfection efficiency.

**Keywords:** ozonation, mixing, reservoir, treatment mode, disinfection efficiency, process pipeline, swirling flow.

## Introduction

In recent years, in our country and abroad, research has been carried out on the study and implementation of the dispersion of the ozone-air mixture directly in the process pipeline using static mixers / 1-3 /. Static mixers are characterized by their compactness and high mass transfer coefficients. Gas-liquid mixing is carried out by creating an intensive swirling of the liquid and gas flow by using the kinetic energy of the liquid. Intense swirling of the flow in static mixers is associated with the creation of a rotational motion of the liquid in certain sections of the pipeline located behind the mixer. The operation of such devices is based on the use of the energy of the flow of mixed media to create high local shear stresses.

Intensification of the process of dissolution of ozone in water by means of a swirling flow is considered as the most economical and promising way to achieve 95-99 percent of ozone utilization.

The preference for this or that method of mixing ozone with water is justified in each specific case by economic calculations, and also depends on the purpose of ozonation. For example, to facilitate the process of coagulation or disinfection, it is known that different doses of ozone and the duration of contact of the ozone-air mixture with water are required, which determines the choice of a particular mixing method.

Currently, in the overwhelming majority of cases, purification and disinfection of drinking water is carried out using coagulation, chlorination at the initial and final stages of purification. However, wastewater discharges from cities and industrial enterprises have led to serious changes in the qualitative composition of water in water supply sources. The emergence of products as surface active substances (surfactants), oil products, phenols, ions, heavy metals, etc. in its composition does not allow the existing treatment facilities to perform a barrier role for their removal. In addition, as a result of the treatment of water from surface sources with chlorine, as a rule, volatile halogen-containing compounds (VHCs) and trihalomethanes (THMs) are formed in their composition, which are toxic and carcinogenic substances.

In this regard, the scientific and technical task of developing a technology for obtaining high quality drinking water is of great national economic importance.

In recent years, many research institutes working in the field of water purification have developed new technological processes and methods for treating drinking water, ensuring the production of water with a high degree of sanitary reliability. One of the methods to improve the quality of water purification at waterworks is water ozonation.

The first experimental plant for ozonation of water was built at the end of the last century in Paris. In Russia, in 1911, the world's largest industrial ozone plant was put into operation at a filter station in St. Petersburg with a capacity of 44.5 thousand m3 / day. Subsequently, water ozonation became widespread in France, the USA and a number of other countries.

The Dzerzhinsky branch of LenNIIkhimmash and PO Kurganarmkhimmash are engaged in the improvement and modernization of existing ozonizers in order to increase the reliability of their operation, as well as the development of high-performance ozonization equipment.

In recent years, the Dzerzhinsk branch of LenNIIkhimmash has upgraded the following equipment: since 1989, the OP I2I ozonizer has been replaced with a monoblock sample V24-25-IL-0I. Indicators of technical characteristics have been significantly improved, including - specific energy consumption has been reduced from 22.5 kW to 15.6 kW per 1 kg of ozone; water consumption is reduced by 2 m3 / h; the pressure of the ozone-air mixture was increased to I, 6 kgf / cm2. The PT 510 ozonator is supposed to be replaced with the B-175-165-O1L-O1 type since 1991. The Ozon-2M ozonator has been replaced since 1989 with a new sample B-085- 08-1L-01. The indicated types of ozonizers operate at industrial frequency.

The development of ozone modules for 15 and 30 kg of ozone per hour, operating at higher frequencies (up to 1000 Hz), are at the completion stage.

At present, in Russia, ozone is used in the technology of natural water purification at large water treatment plants in Moscow, St. Petersburg, Nizhny Novgorod, Novosibirsk and other cities.

A large number of ozonation units are available abroad, for example in France, Russia, USA, Japan, Switzerland, Germany, England, etc. According to literatures \ 1-3 \ ozonization of water is often considered only as one of the methods of disinfection that do not have the disadvantages inherent in other methods of water disinfection. In accordance with this point of view, the purpose of ozonation is limited only by its abiotic effect. Meanwhile, ozone, due to its oxidizing ability, guarantees not only fast and reliable sterilization, but also provides effective oxidation of organic substances, improving the organoleptic properties of water. As known, ozone is one of the strongest oxidants \ 3 \. In terms of its oxidizing ability, ozone is second only to fluorine \ 2 \. From an economic point of view, the introduction of ozone as a reagent for water treatment is also cost-effective \ 7-12 \. So, with ozone doses of 4-6 mg / l, ozonation is advisable not only from the point of obtaining a high effect of water treatment, but also from a technical and economic point of view.

The analysis of the available materials shows that currently there are no clearly developed recommendations for the use of ozone in water purification processes. However, the enormous potential of ozone in water purification processes and its great impact on the aquatic environment are increasingly attracting specialists to conduct new research and searches for reliable methods of natural water treatment.

It is known that phyto- and zooplankton contained in natural water significantly affect the operation of water treatment facilities.

Literature data show that fouling biocenoses can be used as an additional structure for preliminary water purification \ 6-8 \. On the active surfaces of this structure, finer dispersed particles, substances dissolved in water and microorganisms are captured. The latter, which began to develop in fouling, will, in turn, retain substances dissolved in water, using them for their exchange.

Mixing the ozone-air mixture with water plays an important role in the ozonation process \ 9-11 \. In the practice of ozonation, there is a wide variety of methods for mixing ozone with water \ 9-28 \. At large water supply and sewerage stations, the bubbling and emulsifier mixing method \ 11-13 \ is widespread. As a result of considering the existing methods for introducing ozone into the treated water, the designs of devices for mixing ozone with water, a direction was identified that turned out to be promising, especially for a station of low and medium productivity. This direction is the treatment of water with ozone in the technological pipeline \ 23,24,26 \.

This article discusses a new technology for water purification using the accumulating ability of natural biocenosis, microfiltration and ozonation.

The purpose of the work is to create a highly efficient technology for mixing ozone with water for the preparation of drinking water from the reservoir.

To achieve this goal, the following tasks were solved:

- the features of the formation and the qualitative composition of the water of the Charvak reservoir were investigated with the analysis of the reliability of the existing technology for the preparation of drinking water;
-the effect of ozone on the physicochemical indicators of water taken from the reservoir has been studied;
-determined the mode of water treatment and the minimum dose of ozone coagulant to achieve the standard level of parameters of drinking water;
- a new design of an apparatus for mixing ozone with water has been created and investigated, with the development of a method for its calculation;
-developed and tested in laboratory conditions various methods of preparation of drinking water from the reservoir.

**Scientific novelty of the work:**

-developed a highly efficient technology for the treatment of medium-turbid, low-color natural waters by natural biocenosis, microfiltration, ozonation and filtration, which ensures the production of drinking water with parameters corresponding to GOST UzDST 950-2011 “Drinking water”;

-developed a new design of the device for mixing ozone and treated water in the process pipeline / 3 /;

-developed theoretical foundations for calculating gas-liquid apparatuses built into the process pipeline. The optimal parameters of the process of mixing ozone with water — the twist angle and the length of the mixing path — have been experimentally determined.

**Substantiation of the object, subject, tasks and research methods.** This article discusses the design of the apparatus for mixing liquid and gas / 3 /. The principle of operation of the apparatus is based on the creation of swirling liquid flow in order to mix water and gas media during the treatment of natural waters with ozone.

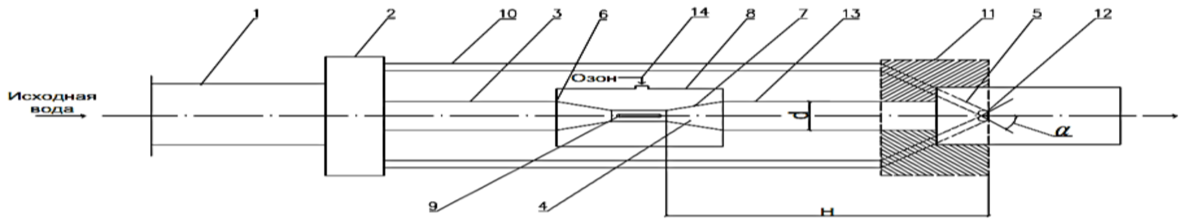


**Fig. 1. Apparatus for mixing liquids and gases.**

1 - pipe Ø50 mm; 2 - liquid distributor; 3 - pipe Ø32 mm; 4 - mixing chamber of the I-stage; 5 - mixing chamber of the II-stage; 6 - confuser; 7 - diffuser; 8 - gas injection chamber; 9 - slit Ø2

mm; 10 - supply pipe Ø5 mm; 11 - channel Ø5 mm; 12 - holes Ø5 mm; 13 - pipe Ø32 mm; 14 - branch pipe.

The device in Fig. 1, contains a liquid supply pipeline 1, a liquid distributor 2, a pipeline 3, installed in series on one axis of the mixing chambers 4,5, of the first and second stages, respectively. The chamber 4 of the first stage includes a confuser 6 with a diffuser 7, connected by a branch pipe with slots 9 and surrounded by a gas injection chamber 8.

The mixing chamber 5 of the second stage is connected by supply pipes 10 with a flow distributor 2. In the walls of the mixing chamber 5, channels 11 are made, connected to the supply pipes 10 and made along a helical line at an angle of 60-75 degrees to the chamber axis. In this case, the outlet openings 12 of the channels 11 are located from the inlet 13 of the mixing chamber of the first stage at a distance H equal to 2.5-4 diameters of the mixing chamber of the first stage. Chamber 8 is equipped with a gas inlet 14.

The device works as follows. The liquid is fed through the pipeline 1 into the distribution stream 2, from where part of it through the supply pipe 10 enters the mixing chamber 5 of the second stage. The main liquid flow is fed through the pipeline 3 to the chamber 4 of the first mixing stage. Entering the confuser 6, the liquid through the holes 6 captures the gas coming from the nozzle 14. In the diffuser 7, the mixture expands, after which the mixture enters the mixing chamber 5 of the second stage, where it is fed through the pipes 10 and channels 11 from the liquid distributor 2. Due to the screw direction channels 11, located at an angle of 60-75 degrees to the axis of the chamber, the streams of the added liquid move into the chamber 5 along a helical trajectory and are mixed with the gas-water mixture coming from the mixing chamber 4 of the first stage.

The effectiveness of the experimental study of swirling flow in pipes depends a lot on the choice of the procedure for setting up and processing the experiment itself, as well as on the design of the stand. A number of properties of swirling flows in the most different forms are manifested depending on the constructive use of the hydraulic circuit of the experimental setup. Therefore, in order to obtain reliable experimental data, such influences were excluded.

The specific features of the swirling flow of gas-liquid mixtures in pipes, the strong anisotropy of the medium under study, the complexity and variety of flow forms, the big difference in the physical properties of ozone and the water under study impose certain conditions on the design of the experimental setup.

A specific feature of swirling flows is also the emergence of flow areas with an active influence of centrifugal mass forces on the flow structure, in which the field of mass forces promotes the development of random disturbances or suppresses them.

Thus, the flow of a swirling flow is characterized by the presence of flow areas with opposite longitudinal static pressure gradients, negative in the peripheral and positive in the axial zone of the pipe. In this case, in contrast to axial flows, the signs of the gradients of velocity and pressure coincide with each other.

## Conclusions

As a result of considering the existing designs of devices for mixing ozone with water, a direction was identified that turned out to be promising, especially for a treatment plant of small and medium productivity. One such direction is the treatment of water with ozone in the process pipeline. In this regard, a new highly efficient design of an apparatus for mixing ozone-air mixture with water in a process pipeline has been developed. Gas-liquid mixing in the developed apparatus is carried out by creating an intensive swirling of the liquid and gas flow due to the use of the kinetic energy of the liquid.

Intensification of the process of dissolution of ozone in water by means of a swirling flow makes it possible to achieve 95-99% of ozone utilization.

## Literature


1. Kozhinov V.F. Purification of drinking and industrial water. Examples and calculations: Textbook. A manual for universities. - 4th ed., Reprinted. - M .: LLC "BASTET", 2008. - S. 213-219.
2. Naidenko VV., Vasiliev LA, Vasiliev AL. Ozone modules. Water supply and plumbing. -1992, - No. 10. -With. 12-14.
3. Khaydar, D., Chen, X., Huang, Y. et al. Investigation of crop evapotranspiration and irrigation water requirement in the lower Amu Darya River Basin, Central Asia. J. Arid Land 13, 23–39 (2021). https://doi.org/10.1007/s40333-021-0054-9
4. Karshiev R. et al. Hydraulic calculation of reliability and safety parameters of the irrigation network and its hydraulic facilities

//E3S Web of Conferences. – EDP Sciences, 2021. – T. 264.

5. Rakhimov, S., Seytov, A., Nazarov, B., Buvabekov, B., Optimal control of unstable water movement in canals of irrigation systems under conditions of discontinuity of water delivery to consumers. IOP Conf. Series: Materials Science and Engineering 883 (2020) 012065, Dagestan, 2020, IOP Publishing DOI:10.1088/1757-899X/883/1/012065 (№5, Scopus, IF=4,652)
6. A. Kabulov, I. Normatov, A. Seytov and A. Kudaybergenov, "Optimal Management of Water Resources in Large Main Canals with Cascade Pumping Stations," 2020 IEEE International IOT, Electronics and Mechatronics Conference (IEMTRONICS), Vancouver, BC, Canada, 2020, pp. 1-4, DOI: 10.1109/IEMTRONICS51293.2020.9216402 (№ 5, Scopus, IF= 9.936).
7. Shavkat Rakhimov, Aybek Seytov, Nasiba Rakhimova, Bahrom Xonimqulov. Mathematical models of optimal distribution of water in main canals. 2020 IEEE 14th International Conference on Application of Information and Communication Technologies (AICT), INSPEC Accession Number: 20413548, IEEE Access, Tashkent, Uzbekistan, DOI:10.1109/AICT50176.2020.9368798 (AICT) pp. 1-4,(№ 5, Scopus, IF=3,557)
8. A.V. Kabulov, A.J. Seytov, A.A. Kudaybergenov, Classification of mathematical models of unsteady water movement in the main canals of irrigation systems, International Journal of Advanced Research in Science, Engineering and Technology Vol. 7, Issue 4 , April 2020, ISSN: 2350-0328, India, pp. 13392-13401.(№ 5, Web of science, IF=3,98)
9. Sh.Kh.Rakhimov, A.J. Seytov, A.A. Kudaybergenov, Optimal control of unsteady water movement in the main canals. International Journal of Advanced Research in Science, Engineering and Technology Vol. 7, Issue 4 , April 2020, India, ISSN: 2350-0328, pp. 13380-13391. (№ 6, Web of science, IF=3,98).
10. Narziev J.J., Maxmudov I.E., Paluanov D.T., Ernazarov A.I. Assessment of Probability Reliability of Hydro technical Structures during Operation Period., http://openaccessjournals.eu/index.php/ijiaet/article/view/949.
11. Jasurbek Narziev, Bhaskar Nikam, Furqat Gapparov. Infrastructure mapping and performance assessment of irrigation system using GIS and remote sensing. International Scientific Conference “Construction Mechanics, Hydraulics and Water Resources Engineering” (CONMECHYDRO - 2021). Hydraulics of Structures, Hydraulic Engineering and Land Reclamation Construction. E3S Web of Conferences 264, 03005 (2021) https://doi.org/10.1051/e3sconf/202126403005.
12. Ergash Kazakov, Uktam Jovliev, Gulomzhon Yakubov. Extension of tubular water discharge limitations with water flow extinguishers. International journal of scientific & technology research volume 8, issue 12, december 2019 ISSN 2277-8616. https://www.ijstr.org/final-print/dec2019/Extension-Of-Tubular-Water-Discharge-Limitations-With-Water-Flow-Extinguishers.pdf.