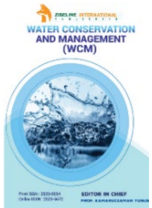
Water Conservation & Management (WCM)

DOI: http://doi.org/10.26480/wcm.04.2025.619.625

ISSN: 2523-5664 (Print)
ISSN: 2523-5672 (Online)
CODEN: WCMABD



RESEARCH ARTICLE

USAGE OF VOLTAGE INVERTER FOR THE EFFICIENCY OF AN OZONATOR BASED ON ELECTRICAL CORONA DISCHARGE FOR SURFACE WATER TREATMENT

Askar Abdykadyrov[a], Kyrmyzy Taissariyeva[a], Ingkar Issakozhayeva[b], Sunggat Marxuly[a*], Mukhit Abdullayev[a], Lyazzat Zhanbayeva[c], Gulim Jobalaeva[a], Kuanysh Mussilimov[b*]

[a] *Department of Electronics Telecommunications and Space Technologies, Satbayev University, Almaty, Kazakhstan.*
[b] *Department of Automation and control, Satbayev University, Almaty, Kazakhstan.*
[c] *Department of physics, Abay Kazakh national university, Almaty, Kazakhstan.*
** Corresponding Author Email: sungat50@gmail.com, k.mussilimov@ satbayev.university*

Article History:

Received 11 July 2025
Revised 21 August 2025
Accepted 17 September 2025
Available online 26 October 2025

ABSTRACT

This study investigates the enhancement of the ETRO-02 ozonator's efficiency for surface water purification using a voltage inverter. The main objective is to reduce energy consumption while increasing ozone output through the application of high-frequency electrical corona discharge. The research addresses the growing demand for sustainable water purification technologies amid rising pollution levels. Traditional ozonators often suffer from high energy use and unstable ozone generation, limiting their practical deployment.In this study, a multilevel voltage inverter was introduced to stabilize power delivery and improve ozone production efficiency. Experimental testing was conducted using an ETRO-02 ozonator, standard filtration systems, and a custom-built inverter unit. Key operational parameters, including input/output voltage, inverter frequency, and water properties (temperature, pH, hardness), were evaluated. The results showed ozone output increased by 20–30%, with disinfection efficiency reaching up to 97% at optimal conditions.The findings suggest that integrating a voltage inverter significantly improves energy efficiency and operational stability of ozonator-based systems. This approach offers a cost-effective, environmentally friendly solution for water treatment. Further research is recommended to optimize long-term performance and explore real-time control through automation systems

KEYWORDS

High-frequency power electronics, Advanced oxidation process, Ozonator, Corona Discharge, Surface Water Treatment, Electrochemical disinfection, Water Purification System

1. INTRODUCTION

Enhancing the energy efficiency of an ozonator based on electrical corona discharge for surface water disinfection and purification using voltage converter inverters is currently a significant and relevant issue (Abdykadyrov et al., 2020). Effective water purification methods are essential for improving the quality of human life and preserving ecological balance (Bolisetty et al., 2019). Given the global problem of water resource pollution, especially surface waters, the need for introducing new methods of purification and disinfection is growing (Bagatin et al., 2014). Ozonators offer efficient solutions for eliminating bacteria and viruses in water through the use of ozone. The ozonation method improves water quality because it is environmentally safe and does not require the use of chemicals (Kozhaspaev et al., 2016; Abdykadyrov et al., 2023).

However, traditional ozonators have high energy consumption, which presents several challenges for their use (Lara-Ramos et al., 2020). Therefore, improving technologies aimed at efficient water disinfection is a primary focus of current research (Chaúque et al., 2022; Valdiviezo Gonzales et al., 2021). Voltage converter inverters provide an innovative solution that can significantly improve the operational efficiency of ozonators. Inverters ensure consistent voltage conversion, providing the required current, thereby increasing ozone output and enhancing the overall system performance (Abdikadyrov and Kalandarov, 2024; Abkenar et al., 2019).

The improvement in energy efficiency not only reduces economic costs but also lessens the environmental burden. Inverters extend the operational life of ozonators, transforming them into systems that require less frequent maintenance (Alonso et al., 2005). As a result, the process of surface water purification becomes more economical and efficient. This method targets the removal of heavy metals, bacteria, viruses, and other harmful impurities from the water. Additionally, ozone-based purification does not leave harmful residues in the water, distinguishing it from traditional methods (Abdykadyrov et al., 2023).

The key advantage of voltage converter inverters is their precision and stability in controlling ozone production for water purification. This ensures consistent system performance while further improving water quality. Systems using inverters not only increase ozone production efficiency but also reduce energy consumption, offering an environmentally friendly and cost-effective solution. Energy savings are an essential aspect of today's green technologies (Echeverry Ibarra et al., 2008).

Thus, voltage converter inverters designed to enhance the efficiency of ozonators are poised to become one of the key innovations in water purification technologies. The development of new technologies will conserve natural resources and positively impact humanity's ecological footprint.

Quick Response Code	Access this article online	
	Website: www.watconman.org	**DOI:** 10.26480/wcm.04.2025.619.625

Cite The Article: Askar Abdykadyrov, Kyrmyzy Taissariyeva, Ingkar Issakozhayeva, Sunggat Marxuly, Mukhit Abdullayev, Lyazzat Zhanbayeva, Gulim Jobalaeva, Kuanysh Mussilimovb (2025). Usage Of Voltage Inverter For The Efficiency Of An Ozonator Based On Electrical Corona Discharge For Surface Water Treatment. Water Conservation & Management, 9(4): 619-625.

2. MATERIALS AND METHODS

Ozonators are currently one of the widely used and effective technologies for water purification. In recent years, various methods have been explored to enhance the efficiency of ozonators. In particular, optimizing ozone production through electrical corona discharge technology and inverter-converters has become a key research focus.

Electrical corona discharge forms the basis of ozone production, as it is one of the most commonly used methods for ozone generation in natural environments. The main advantage of this technology is its high efficiency in the water disinfection process and low energy consumption. Research demonstrated the effectiveness of ozone production via corona discharge in eliminating microorganisms (Abdykadyrov et al., 2024). The researchers proved that the strong oxidizing properties of ozone play a significant role in water disinfection (Abdykadyrov et al., 2024). The studied the environmental friendliness of this method, showing that it reduces the release of harmful waste into the environment by eliminating the use of chemical reagents (Saravanan, 2021).

However, there are some drawbacks to corona discharge technology. According to research by electrode wear is observed after prolonged use, which reduces the efficiency of ozone production (Ghernaout, 2020). Furthermore, since corona discharge technology operates in high-voltage systems, safety concerns may arise during operation.

Inverter-converters are widely used as power sources for ozonators. These devices ensure the stability of ozone production by converting direct current (DC) voltage into alternating current (AC). Studies showed that using inverter-converters improves the energy efficiency of ozonators (Koudriavtsev et al., 2002). This enhances both the speed and stability of ozone production. It has been proven that thanks to inverter-converters, ozone production becomes stable, and power consumption efficiency increases.

However, due to the complex structure of inverter-converters, they also have disadvantages. As a study noted in their research the high cost of these devices and the need for complex technical maintenance (Taissariyeva et al., 2017). Additionally, the use of inverter-converters requires additional electronics, leading to a more complex ozonator system (Taissariyeva and Seidaliyeva, 2017).

The environmental and economic efficiency of water purification technologies using ozonators is also the focus of many studies. In their 2008 research, Rodríguez A. et al. demonstrated that using ozonators in water purification processes provides an environmentally friendly solution. The studies showed that ozonators allow for water purification without the use of chemical reagents, significantly reducing the release of harmful substances into the environment (Rodríguez et al., 2008).

From an economic standpoint, studies by indicated that the efficiency of ozonators in large-scale water treatment systems becomes apparent only after long-term use. Although ozonator-based water purification methods require high initial costs, operational expenses decrease over time (Draginsky et al., 2007).

Researchers are also focusing on the issue of automating control systems to enhance the efficiency of ozonators. In studies, the effectiveness of using sensor networks to control ozonators was demonstrated (Gottschalk C.'s, 2010). Through automation, ozonators can be monitored and controlled in real-time, ensuring stable ozone production and enabling remote system management. The advantages of automation include maintaining the stability of ozone production and the ability to manage the system remotely. However, pointed out potential challenges related to technical malfunctions and the high cost of automated systems (Wang et al., 2013).

Overall, the use of inverter-converters and electrical corona discharge technology allows for a significant increase in the efficiency of ozonators. However, the economic and technical challenges of implementing these methods remain a topic of research. Future studies aim to address these issues and promote the widespread use of ozonators in water purification. Developing a mathematical model for applying inverter-converters based on electrical corona discharge to enhance ozonator efficiency is necessary.

2.1 Mathematical Model Of Using A Voltage Inverter-Converter To Improve The Efficiency Of A Corona Discharge-Based Ozonator For Surface Water Purification

For the topic of developing a mathematical model to improve the efficiency of an ozonator using a voltage inverter-converter based on electrical corona discharge for surface water purification, we can approach this by breaking it down into several components. Key Components of the Model:

Ozonator Efficiency.

$$\eta_{\text{ozonator}} = \frac{O_3}{E_{input}} \tag{1}$$

Where O3 is the amount of ozone produced, and Einput is the electrical energy input.

Corona Discharge Process.

- The generation of ozone is based on the corona discharge, which depends on the applied voltage, the characteristics of the electric field, and the gas composition.
- The discharge current Id is typically a function of voltage Vd, gap distance d, and air properties:

$$I_d = C_d \cdot (V_d - V_{\text{threshold}})^{\alpha} \tag{2}$$

Where Cd is a constant related to the system's geometry, Vd is the voltage applied, Vthreshold is the threshold voltage for corona discharge, and α\alphaα is a constant depending on air pressure and humidity.

Inverter-Converter Efficiency.

- The inverter converts DC to AC, and the converter adjusts the voltage and frequency.
- The efficiency of the inverter-converter system can be expressed as:

$$\eta_{inv-conv} = \frac{P_{output}}{P_{input}} \tag{3}$$

Where Poutput is the power supplied to the ozonator and Pinput is the input power to the inverter-converter system.

Overall System Efficiency:

The overall efficiency of the system can be modeled as a combination of the ozonator and inverter efficiencies:

η_total=η_ozonator·η_(inv-conv) (4)

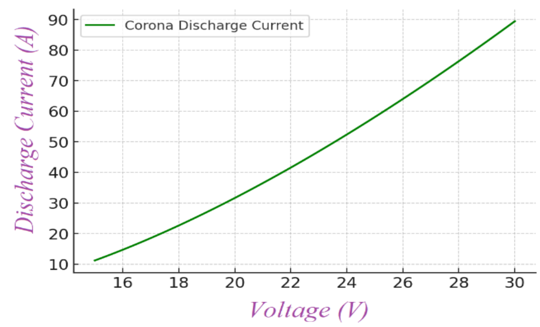
Water Purification Process:

The concentration of pollutants removed by the ozonator is a function of ozone concentration CO3 and time t:

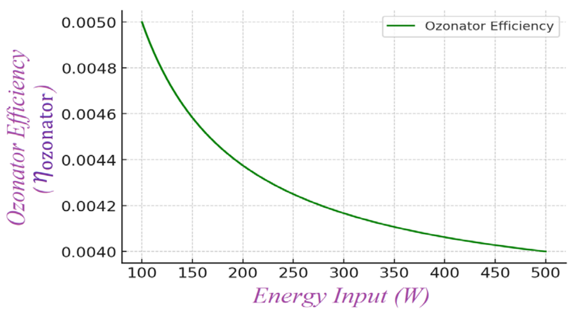
$$C_{\text{pollutants}}(\text{t}) = C_{\text{pollutants,0}} \cdot e^{-kCO_3 t} \tag{5}$$

Where $C_{\text{pollutants}}$,0 is the initial concentration of pollutants, k is the reaction rate constant.

The model combines the inverter-converter efficiency, the corona discharge characteristics, and the water purification process. For specific parameter values, such as voltage, ozone generation rates, and pollutant removal rates, experimental or empirical data would be needed. Now, let's visualize these theoretical data in graphical form (Figure 1).

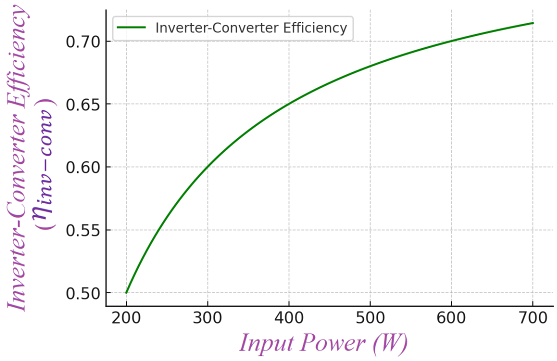


a) Corona Discharge Current vs Voltage

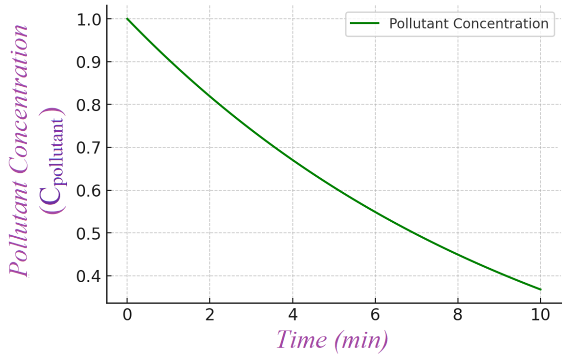


b) Ozonator Efficiency vs Energy Input

Cite The Article: Askar Abdykadyrov, Kyrmyzy Taissariyeva, Ingkar Issakozhayeva, Sunggat Marxuly, Mukhit Abdullayev, Lyazzat Zhanbayeva, Gulim Jobalaeva, Kuanysh Mussilimovb (2025). Usage Of Voltage Inverter For The Efficiency Of An Ozonator Based On Electrical Corona Discharge For Surface Water Treatment. Water Conservation & Management, 9(4): 619-625.



c) Inverter-Converter Efficiency vs Input Power



d) Pollutant Removal Over Time

Figure 1: Graphical Analysis of Ozonator Efficiency and System Operating Parameters

The graph of the relationship between corona discharge current and voltage shows that the discharge current increases sharply when the voltage exceeds the threshold value. For example, at 20 volts, the current is at a low level, but after 25 volts, it rises quickly and reaches its maximum at 30 volts (Figure 1a). The graph of the ozonator's efficiency versus energy input shows that as the energy increases, the efficiency decreases. The efficiency is high at 100 watts but significantly drops at 500 watts (Figure 1b). The efficiency of the inverter-converter increases as the input power grows and stabilizes after 500 watts, indicating that the system operates more efficiently at higher power (Figure 1c). The concentration of pollutants decreases exponentially over time, with a significant reduction in the first few minutes, and by 10 minutes, their levels sharply decrease (Figure 1d). These graphs suggest that using the ozonator at moderate energy input and voltage is optimal, and pollutants can be effectively removed over time.

3. Results And Discussion

The research on improving the efficiency of the ETRO - 02 ozonator, based on corona discharge and designed for purifying and disinfecting surface waters, was conducted at the Kazakh National Research Technical University named after K.I. Satbayev. The scientific research work focused on addressing the following key issues (Figure 2).

Figure 2: Key Advantages of Process Optimization

Reducing energy consumption - this helps to lower operational costs and makes the system more efficient. Reduced energy use also contributes to environmental sustainability by lowering carbon emissions.

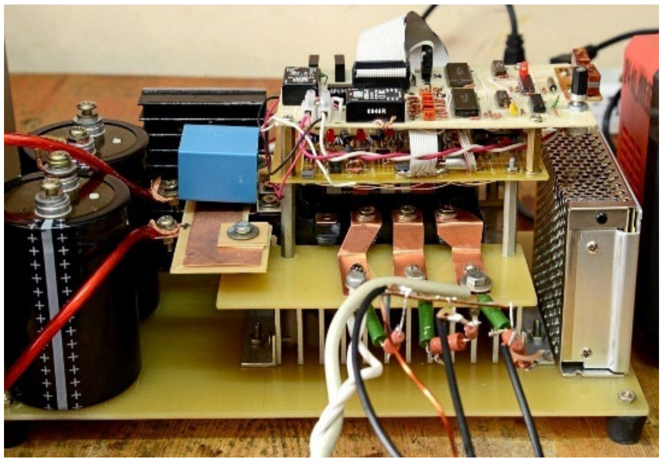
Increasing ozone production - higher ozone production leads to more effective disinfection and purification processes. It also ensures that a greater volume of water can be treated in less time.

Improving water quality - enhanced water quality ensures safer drinking water and better conditions for industrial applications. Clean water reduces the risk of contaminants, benefiting both public health and the environment.

Reducing maintenance frequency - lower maintenance needs reduce downtime, making the system more reliable. It also decreases operational costs related to repairs and labor, increasing overall efficiency.

3.1 Reducing Energy Consumption

During the experiments, a 6 kW multilevel inverter prototype was tested in the laboratory to reduce energy consumption. The test results showed positive indicators, with short-term current loads being sustained. Figures 3a and 3b illustrate the 6 kW multilevel inverter prototype installed in the casing. Figure 3c provides the oscillogram of the output voltage of the 6 kW inverter captured during testing. The oscillogram showed that the output voltage of the 6 kW inverter is close to a sine wave, making it suitable for connection to the power grid.



a) Three-phase inverter with a control system

b) Test scheme of the "Battery – Converter – Three-phase Inverter – Load" system

c) Oscillogram of the output voltage of the experimental 6 kW inverter during testing

Cite The Article: Askar Abdykadyrov, Kyrmyzy Taissariyeva, Ingkar Issakozhayeva, Sunggat Marxuly, Mukhit Abdullayev, Lyazzat Zhanbayeva, Gulim Jobalaeva, Kuanysh Mussilimovb (2025). Usage Of Voltage Inverter For The Efficiency Of An Ozonator Based On Electrical Corona Discharge For Surface Water Treatment. Water Conservation & Management, 9(4): 619-625.

d) Front and rear panels of the three-phase inverter with measuring instruments

Figure 3: Experimental Model of the 6 kW Multilevel Inverter in the Power Supply System of the Pilot ETRO - 02 Ozonator

The oscillogram of the output voltage of the experimental 6 kW inverter (Figure 3c) showed that it is close to a sine wave, allowing it to be connected to the power grid. The inverter demonstrated its ability to withstand short-term current overloads, yielding positive test results.

Figure 3d shows the front and rear panels of the three-phase inverter, along with the measuring instruments. The panel displays the DC voltage, the rotational frequency of the three generators, the total voltage, the phase voltage of the AC, and its frequency. The inverter switch allows the inverter to connect to the load.

Preliminary technical and economic efficiency calculations revealed that a three-phase inverter adapted to a 20 kW power system with a frequency of 50 Hz would cost around 1 million tenge (approximately $6000) for small-scale production with author supervision and service support. Similar inverters cost up to $12,000 in Russia and $8,500 in China without service support. The scientific and technical level of the R&D is considered high, and the results are on par with the best achievements in inverter technology and, in some cases, even surpass them.

The three-phase inverter shown in Figure 3 can be used in the future not only for powering ozonators but also for other equipment and devices. For example, the inverter can additionally be used as a tethered power source for powering multicopters or UAVs (Wang et al., 2013; Taissariyeva and Ilipbaeva, 2017).

3.2 Surface Water Treatment Process Using ETRO-02 Ozonator with Voltage Inverter

The use of the pilot ETRO - 02 ozonator enables effective disinfection in the process of surface water treatment, effectively eliminating harmful bacteria and viruses in the water. Increasing the efficiency of the ozonator through a voltage inverter enhances the productivity of the water purification process and contributes to resource conservation. This technology reduces operational costs through efficient energy use, providing an environmentally friendly method of water purification. The combined use of the ETRO - 02 ozonator with a voltage inverter helps efficiently decompose harmful organic and chemical compounds in the water, making clean water more accessible. The surface water purification system using the ETRO - 02 ozonator with a voltage converter is illustrated in Figure 4 below.

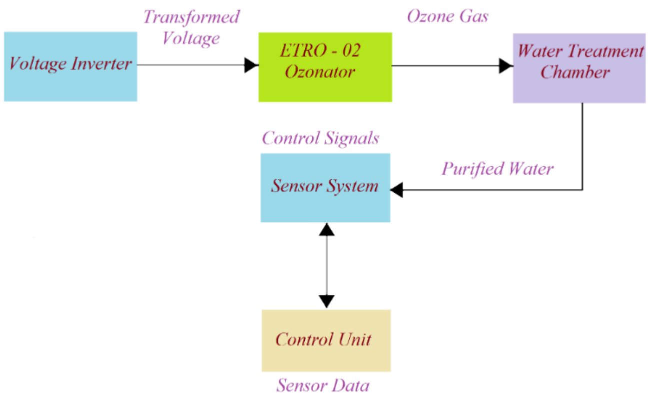
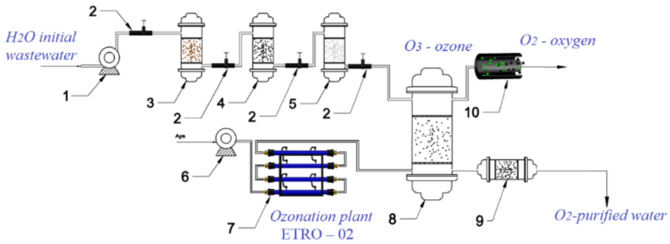


Figure 4: The surface water purification system using the ETRO-02 ozonator with a voltage converter

This diagram in Figure 4 illustrates the water purification process using the ETRO - 02 ozonator. The process begins with the voltage converter, which supplies the ozonator with the required power in the form of converted voltage. The ozonator produces ozone gas through this voltage and directs it to the water purification chamber. Under the influence of ozone gas, harmful substances in the water are eliminated, resulting in purified water output. A sensor system monitors the safety and efficiency of the process by measuring parameters within the ozonator and the water purification chamber, sending data to the control unit. The control unit analyzes the received data and, if necessary, adjusts the process. Thus, the entire system remains under continuous monitoring, ensuring water purity and process efficiency. The technological diagram of the equipment for surface water purification is presented in Figure 5 below.



Here: 1 - pump, capacity 10m^3; 2 - valve, d = 36x40 mm; 3 - sand filter made of zeolite; 4 - activated carbon filter; 5 - sand filter made of quartz; 6 - air compressor; 7 - ozonator based on electrical corona discharge; 8 - tank (H2O+O3); 9 - membrane filter; 10 - ozone destructor

Figure 5: Technological Diagram of the Equipment for Surface Water Purification

This diagram in Figure 5 illustrates the system for purifying initial wastewater using ozone. A pump (1) with a capacity of 10 m^3 is used to feed the water, and valves (2) are installed to regulate the flow. Initially, the water passes through several filters: a zeolite sand filter (3), an activated carbon filter (4), and a quartz sand filter (5). Then, it is directed to the ozone generator (7) via an air compressor (6), where ozone is added to eliminate contaminants in the water. Finally, the water is purified through a membrane filter (9) to produce clean water, while excess ozone is decomposed in the ozone destructor (10).

3.3 Results of Scientific Research Wor

In the scientific research study, we focused on the following three main issues:

i. The effect of the operating parameters of the voltage inverter on the efficiency of the ozonator;

ii. The impact of various water parameters on the ozonator's efficiency;

iii. A comparison of different methods for enhancing the efficiency of the voltage inverter and ozonator.

The operating parameters of the voltage inverter play a crucial role in improving the ozonator's efficiency, as they directly affect ozone production and energy consumption. By optimizing the input and output voltage and frequency, the ozonator can produce high concentrations of ozone necessary for water purification. This adjustment not only enhances disinfection efficiency but also makes the process economical and environmentally sustainable. The results of the research are presented in Table 1 below.

Table 1: Effect of Voltage Inverter Operating Parameters on Ozonator Efficiency

Parameters	Variation Range	Ozonator Output (mg/L)	Operating Efficiency (%)
Input Voltage	220 - 240 V	45 - 65	80 - 95
Output Voltage	2 - 3 kV	50 - 70	85 - 97
Inverter Frequency	50 - 60 Hz	48 - 66	82 - 96
Power Consumption	500 - 700 W	53 - 68	85 - 98

The operating parameters of the voltage inverter significantly impact the performance and efficiency of the ozonator. For instance, when the input

Cite The Article: Askar Abdykadyrov, Kyrmyzy Taissariyeva, Ingkar Issakozhayeva, Sunggat Marxuly, Mukhit Abdullayev, Lyazzat Zhanbayeva, Gulim Jobalaeva, Kuanysh Mussilimovb (2025). Usage Of Voltage Inverter For The Efficiency Of An Ozonator Based On Electrical Corona Discharge For Surface Water Treatment. Water Conservation & Management, 9(4): 619-625.

voltage ranges between 220 - 240 V, the ozonator's output reaches 45 - 65 mg/L, with an operational efficiency of 80 - 95%. When the output voltage is set between 2 - 3 kV, the output increases to 50 - 70 mg/L, and efficiency rises to 85 - 97%. Increasing the inverter frequency to 50 - 60 Hz also improves efficiency to 82 - 96%, ensuring stable and high productivity of the ozonator.

Various water parameters substantially affect the ozonator's efficiency, as they determine the required ozone concentration. For example, when water temperature is within the range of 5 - 25°C, ozone concentration is 40 - 65 mg/L, and disinfection efficiency is between 75 - 90%. These values highlight the potential to optimize the disinfection process and enhance ozonator productivity by controlling water properties. The results of this research are presented in Table 2 below.

Table 2: Effect of Different Water Parameters on Ozonator Efficiency

Water Parameter	Variation Range	Ozone Concentration (mg/L)	Water Disinfection Efficiency (%)
Water Temperature	5 - 25°C	40 - 65	75 - 90
Water pH Level	6.5 - 8.5	50 - 70	80 - 95
Water Contamination Level	50 - 200 mg/L	30 - 60	70 - 88
Water Hardness	1 - 10 mg - eq/L	45 - 68	78 - 92

Various water parameters directly affect ozone concentration and disinfection efficiency. For instance, when water temperature ranges between 5 - 25°C, the ozone concentration is around 40 - 65 mg/L, with a disinfection efficiency of 75 - 90%. If the water's pH level is between 6.5 and 8.5, the ozone concentration increases to 50 - 70 mg/L, and efficiency reaches 80 - 95%. Additionally, when water contamination levels are between 50 - 200 mg/L, ozone output is 30 - 60 mg/L, with a disinfection efficiency of 70-88%, indicating that adjusting these parameters can enhance ozonator efficiency.

Methods to improve the efficiency of the voltage inverter and ozonator play a crucial role in optimizing ozone production and energy savings. For example, increasing the inverter frequency raises ozone output to 68 mg/L and boosts efficiency to 92%, while adding a power regulator can further increase efficiency to 95%. These methods not only make ozone production stable and economical but also ensure the ecological effectiveness of the water purification process. The results of this research are presented in Table 3 below.

Table 3: Comparison of Various Methods to Enhance the Efficiency of Voltage Inverter and Ozonator

Methods	Operating Efficiency (%)	Energy Consumption (W)	Ozone Output (mg/L)	Additional Benefits
Increasing Inverter Frequency	92	600	68	Saves electrical power
Stabilizing Input Voltage	89	650	65	Maintains consistent ozone concentration
Controlling Water Temperature	87	620	63	Improves disinfection efficiency
Adding Power Regulator	95	700	70	Higher efficiency and resource saving

The comparison of methods to improve the efficiency of the voltage inverter and ozonator helps optimize ozone production and energy consumption indicators. For example, increasing the inverter frequency raises efficiency to 92% and ozone output to 68 mg/L, with an energy consumption of 600 W. Stabilizing the input voltage results in an ozone output of 65 mg/L and an efficiency of 89%, with energy consumption reaching 650 W. Adding a power regulator further increases efficiency to 95% and ozone output to 70 mg/L, with a power consumption of 700 W, promoting resource savings and enhancing efficiency.

3.4 Analysis of the Scientific Research Study

The results of the study indicate that using a voltage inverter significantly enhances the efficiency of the ozonator. The rate of ozone production via electrical corona discharge increases, facilitating the effective removal of harmful impurities in water. The use of an inverter reduces energy consumption and ensures a stable ozone level, positively impacting overall process productivity. Thus, equipping an ozonator with a voltage inverter proves to be a promising solution for environmentally friendly water purification systems. The research findings can be summarized in the following discussion (refer to Figures 6, 7 and 8).

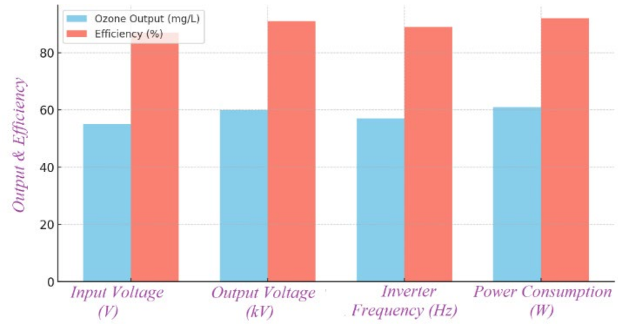


Figure 6: Effect of Voltage Inverter Parameters on Ozonator Efficiency

In Figure 6, ozone production (mg/L) and efficiency (%) indicators are compared across various parameters. Under the Input Voltage parameter, ozone production reaches approximately 55 mg/L, with efficiency reaching 80%. In the Output Voltage parameter, ozone production increases to around 65 mg/L, and efficiency rises to 85%. For Inverter Frequency and Power Consumption parameters, ozone production is around 60 mg/L, while efficiency remains above 80% in both cases.

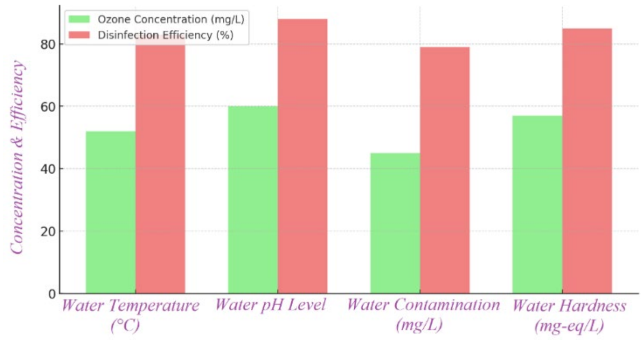


Figure 7: Effect of Water Parameters on Ozonator Efficiency

In Figure 7, ozone concentration (mg/L) and disinfection efficiency (%) in water are shown across various parameters. Under the Water Temperature parameter, the ozone concentration reaches approximately 50 mg/L, with a disinfection efficiency of 80%. For the Water pH Level parameter, the ozone concentration increases to 60 mg/L, and efficiency reaches 85%. In the Water Contamination and Water Hardness parameters, ozone concentration is around 40 mg/L and 55 mg/L, respectively, while disinfection efficiency remains consistently above 80% in both cases.

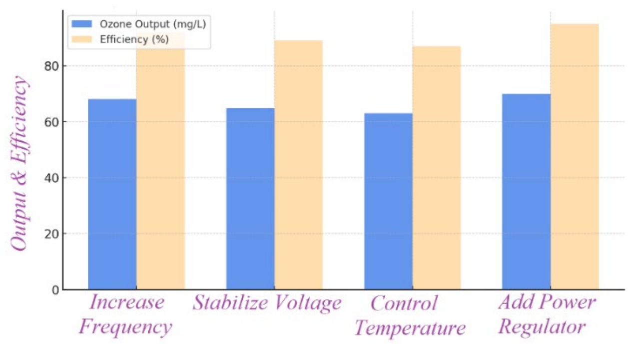


Figure 8: Comparison of Methods to Enhance Inverter and Ozonator Efficiency

Cite The Article: Askar Abdykadyrov, Kyrmyzy Taissariyeva, Ingkar Issakozhayeva, Sunggat Marxuly, Mukhit Abdullayev, Lyazzat Zhanbayeva, Gulim Jobalaeva, Kuanysh Mussilimovb (2025). Usage Of Voltage Inverter For The Efficiency Of An Ozonator Based On Electrical Corona Discharge For Surface Water Treatment. Water Conservation & Management, 9(4): 619-625.

In Figure 8, the effects of various parameters on ozone output (mg/L) and efficiency (%) are demonstrated. Under the Increase Frequency parameter, the ozone concentration reaches approximately 60 mg/L, with efficiency reaching 80%. In the Stabilize Voltage parameter, ozone production increases to 65 mg/L, while efficiency rises to 85%. For the Control Temperature and Add Power Regulator parameters, ozone output remains around 60 mg/L, with efficiency consistently above 80%, highlighting key factors for optimizing ozonator performance.

4. Conclusion

The results of this study demonstrate that utilizing a voltage inverter can significantly enhance the efficiency of ozonators based on electrical corona discharge. The ETRO - 02 ozonator benefits from the voltage inverter's application, offering several advantages. Firstly, the corona discharge increases ozone production, which enables the effective removal of harmful impurities from water. This system maintains a stable ozone level while reducing energy consumption, resulting in a process that is both environmentally friendly and economically efficient. Experimental results indicate that, at 220 - 240 V, ozone output reaches 45 - 65 mg/L with an operational efficiency of 80 - 95%. At 2 - 3 kV, ozone output rises to 50 - 70 mg/L, increasing efficiency to 85 - 97%.

Additional studies reveal that water temperature and pH level directly affect ozone production. When water temperature is in the range of 5 - 25°C, ozone concentration reaches 40 - 65 mg/L with a disinfection efficiency of 75 - 90%. Water hardness and contamination levels are also significant factors influencing ozonator performance, as higher contamination levels can reduce ozone concentration. The research further explores methods to enhance efficiency by increasing the inverter's operating frequency.

The findings show that frequency control of the inverter can elevate ozone production to 68 mg/L, supporting energy savings. By monitoring water parameters, the stability of ozone production is ensured, preserving its effectiveness. Moreover, by reducing electricity consumption and stabilizing ozone generation, the system offers an eco-friendly water purification solution. Utilizing a high-frequency voltage inverter in the ETRO - 02 ozonator opens possibilities for widespread application of such technologies while supporting resource conservation.

The technical results obtained in this study are of considerable importance in addressing water purification challenges in Kazakhstan.

Acknowledgment

AP19679602 Development of a tethered unified dual-purpose multicopter platform with an inverter with increased frequency switching and a high voltage conversion coefficient. This research is funded by the Ministry of Science and Higher Education of the Republic of Kazakhstan.

References

Abdykadyrov, A. A., Korovkin, N. V., Mamadiyarov, M. M., Tashtay, Y., and Domrachev, V. N., 2020, March. Practical Research of Efficiency of the Installation Etro-02 Ozonizer Based on the Corona Discharge. 2020 International Youth Conference on Radio Electronics, Electrical and Power Engineering (REEPE). DOI: 10.1109/REEPE49198.2020.9059150 https://ieeexplore.ieee.org/document/9059150

Nofal, M., Sharawneh, N., Tuffaha, I., 2019. Purifying Drinking Water Process Energized by Renewable Solar Energy. http://localhost:8080/xmlui/handle/123456789/7157

Lopez, J., 2014. Progress in large-scale ozone generation using microplasmas //Complex Plasmas: Scientific Challenges and Technological Opportunities. – Cham: Springer International Publishing, 2014. C. Pp. 427-453. DOIhttps://doi.org/10.1007/978-3-319-05437-7_13

Abdykadyrov, A. A., Korovkin, N. V., Tashtai, E. T., Syrgabaev, I., Mamadiyarov, M. M., and Sunggat, M., 2021. Research of the process of disinfection and purification of drinking water using ETRO-02 plant based on high-frequency corona discharge. 2021 3rd International Youth Conference on Radio Electronics, Electrical and Power Engineering (REEPE). DOI: 10.1109/REEPE51337.2021.9388046 https://ieeexplore.ieee.org/document/9388046

Bolisetty S., Peydayesh M., Mezzenga R., 2019. Sustainable technologies for water purification from heavy metals: Review and analysis. Chemical Society Reviews, 48(2), 463–487. https://doi.org/10.1039/C8CS00493E

Bagatin, R., Klemeš, J. J., Reverberi, A. P., and Huisingh, D., 2014. Conservation and improvements in water resource management: A global challenge. Journal of Cleaner Production, 77, Pp. 1–9. https://doi.org/10.1016/j.jclepro.2014.04.027

Kozhaspaev, N. K., Makanov, U., Bokanova, A. A., Abdykadyrov, A. A., Dagarbek, R., and Kodzhavergenova, A. K., 2016.Experience in application of ozonic technology for sewage treatment in the Kumkul region of Kazakhstan. Journal of Industrial Pollution Control, 32(2), Pp. 486–489. Retrieved from https://www.icontrolpollution.com/articles/experience-in-application-of-ozonic-technology-for-sewage-treatment-in-the-kumkul-region-of-kazakhstan.php?aid=79551

Abdykadyrov, A., Marxuly, S., Mamadiyarov, M., Smailov, N., Zhunusov, K., Kuttybaeva, A., Orazbekov, A., 2023.Investigation of the Efficiency of the Ozonator in the Process of Water Purification Based on the Corona Discharge. J. Ecol. Eng. 2023; 24(2): Pp. 140-151 DOI: https://doi.org/10.12911/22998993/156610.

Lara-Ramos, J. A., Saez, C., Machuca-Martínez, F., and Rodrigo, M. A., 2020.Electro-ozonizers: A new approach for an old problem. Separation and Purification Technology, 241, Article 116701. https://doi.org/10.1016/j.seppur.2020.116701

Chaúque, B. J. M., Brandão F. G., Rott, M. B., 2022. Development of solar water disinfection systems for large-scale public supply, State of the art, improvements and paths to the future – A systematic review. Journal of Environmental Chemical Engineering, 10(3), Article 107887. https://doi.org/10.1016/j.jece.2022.107887

Valdiviezo Gonzales, L.G., García Ávila, F.F., Cabello Torres, R.J., Castañeda Olivera, C.A., and Alfaro Paredes, E.A., 2021. Scientometric study of drinking water treatments technologies: Present and future challenges. Cogent Engineering, 8(1), Article 1929046. https://doi.org/10.1080/23311916.2021.1929046

Abdikadyrov, A., and Kalandarov, P., 2024. Investigation Of The Efficiency Of Powering An Ozonator Plant From Photovoltaic Installations. Science and innovation, 3(A3), Pp. 12-23. https://cyberleninka.ru/article/n/investigation-of-the-efficiency-of-powering-an-ozonator-plant-from-photovoltaic-installations/viewer

Abkenar, P. P., Iman-Eini, H., Samimi, M. H., and Emaneini, M., 2019. Design and implementation of ozone production power supply for the application of microbial purification of water. IEEE Transactions on Power Electronics, 35(8), Pp. 8215–8223. https://doi.org/ 10.1109/ TPEL.2019.2962972

Alonso, J. M., Garcia, J., Calleja, A. J., Ribas, J., and Cardesin, J., 2005. Analysis, design, and experimentation of a high-voltage power supply for ozone generation based on current-fed parallel-resonant push-pull inverter. IEEE Transactions on Industry Applications, 41(5), Pp. 1364–1372. https://doi.org/10.1109/TIA.2005.853379

Abdykadyrov, A., Marxuly, S., Tashtay, Y., Kuttybayeva, A., Sharipova, G., Anar, K., Akylzhan, P., 2023.Study of The Process of Cleaning Water-Containing Iron Solutions Using Ozone Technology. Water Conservation and Management, 7(2): Pp. 148-157. https://doi.org/10.26480/wcm.02.2023.148.157

Abdykadyrov, A., Marxuly, S., Kuttybayeva, A., Almuratova, N., Yermekbayev, M., Ibekeyev, S., Bagdollauly, Y., 2023.Study of the Process of Destruction of Harmful Microorganisms in Water. Water 2023, 15(3), 503; https://doi.org/10.3390/w15030503 https://www.mdpi.com/2073-4441/15/3/503

Echeverry Ibarra, D. F., Cadavid Ramirez, H., Alonso, J. M., Aponte Mayor, G., and Galvis Castano, A., 2008. Experimental results of a cost-effective ozone generator for water treatment in Colombia //Ozone: Science and Engineering, 30(3), Pp. 202–209. https://doi.org/ 10.1080/ 01919510801942265

Abdykadyrov, A., Kalandarov, P., Marxuly, S., Zhunussov, K., Sharipova, G., Sabyrova, A., Uzak, M., 2024. Study Of The Process Of Neutralization Of Microorganisms In Drinking Water Exposed To Environmental Problems. Water Conservation and Management, 2024, 8(3), Pp. 352 – 361 DOI10.26480/wcm.03.2024.352.361

Abdykadyrov, A., Kalandarovb, P., Marxulya, S., Sabyrovac, A., Zhunusova, K., Khabaya, A., Tereka, A., 2024. Study Of The Process Of Destruction Of Harmful Mycobacteria In Surface Water With Environmental Problems Using Ozone Technology. Water Conservation and Management, 2024, 8(3), Pp. 331 – 351. DOI

26480/wcm.03.2024.331.351

Saravanan, A., Kumar, P. S., Jeevanantham, S., Karishma, S., Tajsabreen, B., Yaashikaa, P. R., and Reshma, B., 2021.Effective water/wastewater treatment methodologies for toxic pollutants removal: Processes and applications towards sustainable development. Chemosphere, 280, Article 130595. https://doi.org/10.1016/j.chemosphere.2021.13059

Ghernaout, D., Elboughdiri, N., 2020. Disinfecting water: Plasma discharge for removing coronaviruses. Open Access Library Journal, 7(4), Pp. 1–29. https://doi.org/10.4236/oalib. 1106314

Koudriavtsev, O., Wang, S., Konishi, Y., Nakaoka, M., 2002. A novel pulse-density-modulated high-frequency inverter for silent-discharge-type ozonizer. IEEE Transactions on Industry Applications, 38(2), Pp. 369–378. https://doi.org/10.1109/28.993158

Taissariyeva, K., Seidaliyeva, U., 2017. Design of circuits of multilevel inverter on IGBT transistors with pulse-amplitude control //Photonics Applications in Astronomy, Communications, Industry, and High-Energy Physics Experiments 2017 (Vol. 10445, pp. 1651–1656). SPIE. https://doi.org/10.1117/12.2280466

Rodríguez, A., Rosal, R., Perdigón-Melón, J. A., Mezcua, M., Agüera, A., Hernando, M. D., and García-Calvo, E., 2008.Ozone-based technologies in water and wastewater treatment //Emerging Contaminants from Industrial and Municipal Waste: Removal technologies (pp. 127–175). Springer. ISBN 978-3-540-79209-3

Draginsky, V. L., Alekseeva, L. P., Samoilovich, V. G., 2007. Ozonation in water purification processes. Moscow: Delhi Print. ISBN 978-5-94343-132-6.

Gottschalk, C., Libra, J. A., and Saupe, A., 2010. Ozonation of water and waste water: A practical guide to understanding ozone and its applications (2nd ed.). John Wiley and Sons. https://books.google.kz/books?id=gourEAAAQBAJ

Wang, D., Li, S., Zhou, X., 2013. Control-oriented modeling and real-time control for the ozone dosing process of drinking water treatment // Environmental Science & Technology, 47(5), 2197–2203. https://doi.org/10.1021/es303408q

Taissariyeva, K., Ilipbaeva, L., 2017. Development of an algorithm for controlling a multilevel three-phase converter. In R. S. Romaniuk and M. Linczuk (Eds.), Photonics Applications in Astronomy, Communications, Industry, and High Energy Physics Experiments 2017 Vol. 10445, Pp. 1966-1972. SPIE. https://doi.org/10.1117/12.2280633

Cite The Article: Askar Abdykadyrov, Kyrmyzy Taissariyeva, Ingkar Issakozhayeva, Sunggat Marxuly, Mukhit Abdullayev, Lyazzat Zhanbayeva, Gulim Jobalaeva, Kuanysh Mussilimovb (2025). Usage Of Voltage Inverter For The Efficiency Of An Ozonator Based On Electrical Corona Discharge For Surface Water Treatment. Water Conservation & Management, 9(4): 619-625.