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# Treatment of Organic-contaminated Wastewater Using Ozone Micro-nano Bubbles

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## Introduction

The treatment of wastewater has become one of the most critical environmental challenges of the modern world. Among the numerous types of wastewater, Organic-Contaminated Wastewater (OCW) presents a particularly complex problem due to its diverse chemical composition, which can include biodegradable organic materials, pesticides, pharmaceuticals, industrial chemicals and more. These organic contaminants are often difficult to remove using conventional wastewater treatment methods, leading to the growing need for more efficient, sustainable and advanced treatment technologies. One such promising approach is the use of Ozone ($O_3$) Micro-Nano Bubbles (MNBs), which have shown significant potential for degrading organic contaminants in wastewater [1]. Ozone is a powerful oxidizing agent with a strong ability to break down a wide variety of organic pollutants, making it a versatile and effective treatment for wastewater. The introduction of micro-nano bubbles tiny gas bubbles with diameters ranging from a few micrometers to nanometers into ozone treatment systems has gained significant attention for its enhanced efficiency in contaminant removal. The extremely small size of these bubbles provides a larger surface area for gas-liquid contact, which enhances the dissolution of ozone in water and accelerates the oxidative degradation of organic pollutants [2].

The combination of ozone and micro-nano bubbles offers a novel and promising approach to wastewater treatment that can overcome some of the limitations of traditional methods. This method not only improves the efficiency of ozone utilization but also enhances mass transfer, leading to more effective oxidation of organic contaminants. Furthermore, the use of ozone micro-nano bubbles can lead to shorter reaction times, reduced energy consumption and improved overall performance, making it an attractive option for both industrial and municipal wastewater treatment applications. This treatment method is particularly effective in the removal of organic contaminants such as phenols, pesticides, surfactants, petroleum hydrocarbons, pharmaceutical residues and other toxic organic compounds commonly found in industrial effluents. The ability of ozone MNBs to oxidize complex organic molecules into less harmful by-products, such as carbon dioxide and water, is a key feature that makes it highly suitable for addressing environmental concerns associated with wastewater discharge [3].

## Description

Ozone ($O_3$) is a highly reactive, triatomic molecule composed of three oxygen atoms. It is widely recognized for its strong oxidizing properties, making it an effective treatment agent for a variety of water and wastewater treatment applications. Ozone's ability to break down organic and inorganic pollutants through oxidation makes it an ideal candidate for removing toxic substances from wastewater. In wastewater treatment, ozone is typically introduced into the water either as a gas or dissolved in the liquid phase. When dissolved in water, ozone can react with a wide range of contaminants, breaking them down into simpler, non-toxic molecules. This reaction can occur via direct oxidation or through the generation of hydroxyl radicals (•OH), which are even more reactive and can degrade complex organic compounds that may be resistant to conventional treatment methods [4].

Micro-Nano Bubbles (MNBs) are extremely small gas bubbles that typically have diameters ranging from a few Micrometers (μm) to nanometers (nm). These bubbles possess unique physical and chemical properties that distinguish them from larger bubbles. MNBs have a high surface area-to-volume ratio, which increases their reactivity and provides an excellent medium for enhanced gas-liquid contact. In the context of wastewater treatment, MNBs are used to increase the solubility of ozone in water, thereby improving the overall efficiency of the ozonation process. The small size of these bubbles allows them to remain suspended in water for much longer than larger bubbles, leading to more effective contact between ozone molecules and organic contaminants. This extended contact time results in more efficient oxidation and a greater degree of contaminant degradation. The treatment of organic-contaminated wastewater using ozone micro-nano bubbles involves a combination of several mechanisms that work synergistically to degrade the contaminants [5].

## Conclusion

The treatment of organic-contaminated wastewater is a critical issue that requires innovative and effective solutions to protect the environment and human health. Ozone Micro-Nano Bubbles (MNBs) offer a promising alternative to traditional treatment methods, combining the powerful oxidizing properties of ozoneH with the enhanced mass transfer and reactivity provided by micro-nano bubbles. This technology has demonstrated significant potential for improving the efficiency of wastewater treatment, reducing energy consumption and minimizing the formation of harmful by-products.

The ability of ozone MNBs to degrade a wide range of organic contaminants, including pharmaceuticals, pesticides and industrial chemicals, makes them highly versatile and suitable for diverse applications. Furthermore, the environmentally friendly nature of ozone, coupled with the absence of harmful residuals in the treated water, positions ozone MNB technology as a sustainable solution to the growing problem of organic-contaminated wastewater.

## Acknowledgement

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## Conflict of Interest

None.

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