

How Microelectronics Fabricators Are Achieving Net-Zero Discharge



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The rapid rise of cutting-edge technologies like AI and medical devices has bolstered the already high demand for [microelectronics](#). However, recent supply chain challenges, combined with geopolitical tensions between Asian and Western nations, have prompted manufacturers to reassess their production locations. This shift to more localized manufacturing in North America and Europe is putting emphasis on the need for sustainable manufacturing practices, in particular net-zero discharge.

Several factors are propelling the microelectronics industry toward net-zero discharge. First, most parts of the West have higher public awareness of water quality issues and more stringent enforcement from regulatory agencies compared to some parts of Asia. Second, there's the challenge of water scarcity in areas such as Arizona and California, as well as the overall greater focus on climate impacts on water usage throughout the West. Third, technological advancements have paved the way for efficient net-zero discharge practices that make it cost-effective compared to consuming and treating municipal water for production.

Precision In The Face Of Complexity

The unique nature of microelectronics fabrication processes necessitates a careful approach to water treatment. Microelectronics fabrication involves the

use of a wide range of chemicals, covering virtually every element from the periodic table. The complexity of these chemical processes poses a significant challenge in treating the wastewater effectively (Figure 1). The diversity of chemicals demands a tailored approach to ensure that each type is adequately addressed during the treatment process.

In addition, microelectronics manufacturing demands an unparalleled

level of water purity, with total organic carbon (TOC) levels often needing to be less than one part per billion. Achieving and maintaining such stringent purity requirements throughout the water treatment process poses a formidable challenge, especially considering the range of contaminants involved.

Balancing cost-effectiveness with treatment outcomes is challenging. Some chemicals used in the fabrication

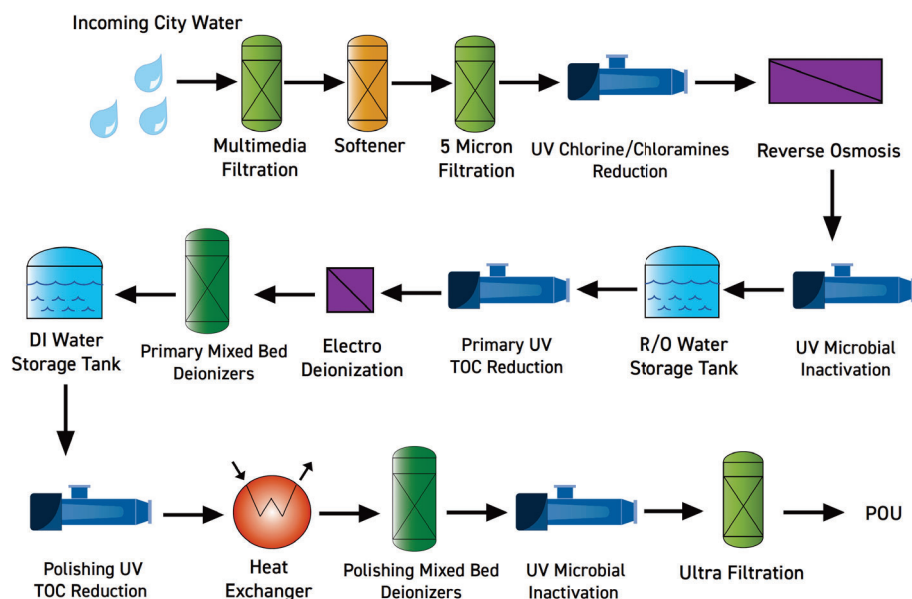


Photo courtesy of Trojan Technologies

Figure 1. The above illustration shows an example of a treatment train for ultra-pure water for microelectronics production. UV plays a pivotal role in biological inactivation and TOC reduction.

process may be expensive to remove and determining the most cost-effective methods to treat specific contaminants becomes crucial. The challenge is to strike a balance between effective treatment and managing operational costs.

How UV AOP Enables Sustainable Microelectronics

UV-photolysis for TOC reduction and UV disinfection assume critical roles in the ultra-pure water treatment process for microelectronics. For example, fabricating a 3-nanometer chip is equivalent to building a skyscraper on a tiny surface. Every particle or trace of organic material can potentially change and impact the quality of that chip. As such, UV advanced oxidation processes (AOP) have emerged as an ideal solution for difficult-to-remove substances. UV AOP extends beyond traditional UV disinfection by incorporating the use of oxidants, such as hydrogen peroxide, to target and destroy trace organic contaminants effectively. This enhances the overall efficiency of the water treatment system.

In particular, Trojan Technologies' [Aquafine technology](#) boasts a long history in microelectronics, with systems still operational since 1980. Leveraging insights from the [municipal market](#), Trojan Technologies brings valuable perspectives to the microelectronics industry, such as prioritizing disinfection byproducts and adhering to regulatory standards, which have proven beneficial in addressing similar concerns within the industrial landscape.

Moreover, newer Aquafine models, such as the [Avant product line](#) (Figure 2), showcase advancements in energy efficiency. Through the optimization of lamp technology and computational fluid dynamics (CFD) modeling, these systems achieve the same flow rates with reduced lamp requirements. This results in significant energy savings and operational efficiency. Additionally, the Avant series features a unique function allowing for the dimming and regrouping of lamps, offering flexibility to adapt to changing water conditions and chemical inputs. This capability ensures optimal performance



Photo courtesy of Trojan Technologies

Figure 2. Trojan Technologies' Aquafine Avant system utilizes UV technology to break down trace chemicals such as total organic carbon (TOC), chlorine and chloramines, and ozone, all while providing microbial inactivation.

and power usage tailored to specific microelectronics facility requirements.

Seamless Upgrades

Microelectronics facilities often have intricate water treatment systems with interconnected pipes and components. As UV systems age and need replacement or upgrades, it can be challenging to fit new systems in the same space without major reconfiguration of the treatment train. Trojan Technologies' Center-to-Center Replacement service aims to design new UV systems that are compatible with the existing infrastructure. This includes considerations for pipe connections, flange specifications, and overall system dimensions. The primary goal is to minimize disruption to microelectronics manufacturing processes. By designing UV systems that align with the dimensions and connection points of the old systems, the replacement can be carried out more efficiently. This approach allows for a quicker turnaround time, reducing the

overall impact on facility operations.

In the ever-evolving landscape of microelectronics, the demand for cutting-edge technology intertwines with the need for sustainable practices. As manufacturers pivot toward localized production, Trojan Technologies' Aquafine offers historical expertise combined with innovative solutions. With a focus on sustainable advancements and a commitment to seamless upgrades, the industry charts a course toward a future where precision, efficiency, and environmental responsibility converge to shape the industry moving forward.

About Trojan Technologies

Trojan Technologies serves performance-driven municipal, industrial, and residential water treatment professionals by engineering solutions that enable our customers to meet their water quality objectives and improve the lives of more than 1 billion people globally. ■