Ozonation Provides Successful Removal of Micropollutants and Endocrine Disruptors

Conventional water and wastewater treatment processes have proven to be ineffective at removing micropollutants in aquatic environments. A collective term used to describe organic compounds or heavy metals at low concentrations, micropollutants or emerging contaminants, put the environment in jeopardy by contaminating surface and ground waters. However, new technologies are being studied and developed to solve this public health and environmental issue. After years of laboratory research, pilot studies and full scale testing, ozonation has emerged as one of the most effective and reliable solutions.

For decades, numerous reports from around the world have shown the environmental impact to areas in close proximity to wastewater discharges. With the improvement of water analytical methods in the late 1990's, scientists were able to identify micropollutants as a hidden threat in wastewater discharges. Extensive investigations in recent years have shown the impacts of micropollutants are even more pronounced that originally speculated. Micropollutants can bypass conventional treatment technologies and have detrimental effects on the aquatic environment. One example is the feminization and gender-morphing of fish species. Due to the well documented effects on animals and the environment, researchers are now studying another threat: the possible long-term risk to human health.

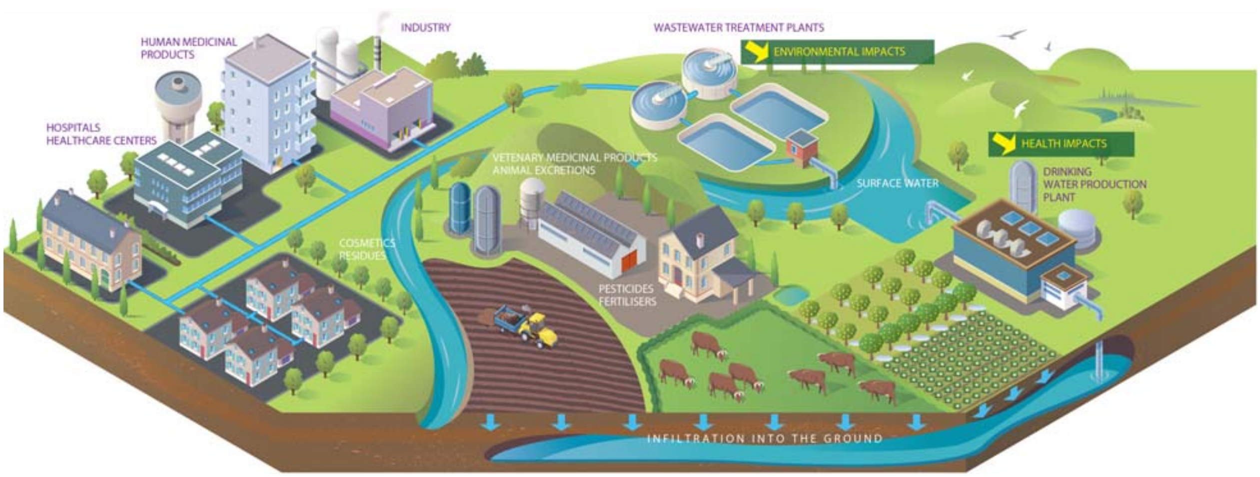

Figure 1

In the US and Europe, research programs have evaluated the effectiveness of conventional wastewater treatment plants on micropollutants. The research suggests that plants designed in the 1970's removed only 25% of emerging pollutants while plants designed in the 1980's and 1990's could eliminate up to 45% and 60% with secondary and tertiary treatment processes, respectively. In the future, the removal rates of typical plants will become insufficient due to the increased use of pharmaceuticals and personal care products (PCPPs) as well as the threat linked to the 'cocktail effect' (Abegglen et al 2008) of the combined action of many different types of micropollutants. A 2007 US National Institute of Environmental Health Sciences (NIEHS) report indicated that as the widespread use and distribution of PPCPs and other micropollutants increases, the risk from the combined effect of many different types of Endocrine Disrupting Chemicals (EDCs) also increases. "Combinations of endocrine disrupters are able to produce significant effect even when each chemical is present at low doses that individually do not induce observable effects." (Andreas Kortenkamp 2007).

Between 2008 and 2012, international research program collaborations were launched to provide valuable information on micropollutant treatment technology alternatives and environmental and human health impacts. Several treatment technologies were studied in laboratory testing, pilot essays and full scale applications including: activated carbon, membranes, Ultraviolet (UV) light, Advanced Oxidation Processes (AOPs), nanofiltration and ozone. OZONIA took part in several studies with various governmental, industrial and academic organizations (FOEN 2008 & 2012, AMPERES 2009, EAWAG 2010, RHODANOS 2011, ARMISTIQ 2012).

Technology Comparison

Only a small portion of the treatment technologies studied were able to reach a micropollutant removal target of 80% as well as the capital and operating cost targets. The studies demonstrated that nanofiltration, reverse osmosis, some AOPs (O_3/H_2O_2, UV/H_2O_2), activated carbon and ozonation were the technologies able to reach high removal rates (Figure 2). Ozonation was shown to be the most cost-effective solution, followed by O_3/H_2O_2 (AOP), UV/H_2O_2 (AOP) and Granular Activated Carbon (GAC), respectively (Figure 3).

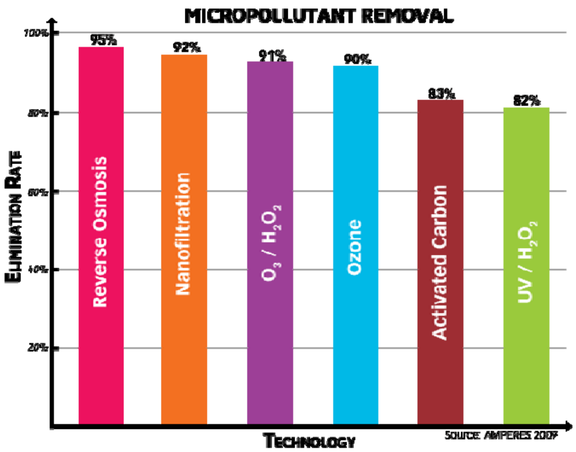

Figure 2

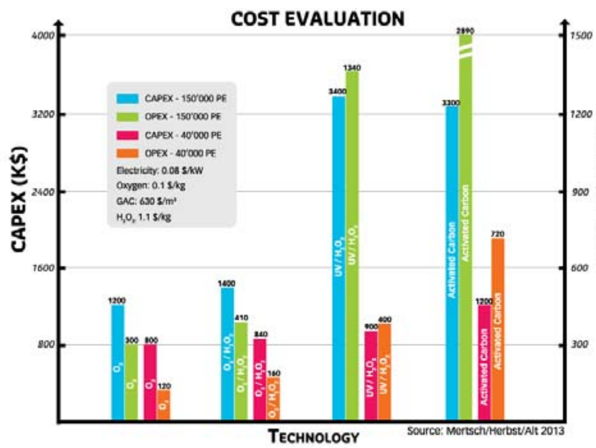

Figure 3

The studies referenced above were completed on a wide range of pilot and operating plants effluents. The diverse data set allowed researchers to evaluate results between the different programs (BG & FOEN 2012, BAFU 2008, Dohman & al. 2005, Turk & al. 2011) and lead to convergent conclusions. After the results of the different research programs were finalized, ozonation was clearly accepted as the best technology option for the removal of micropollutants.

Ozonation Principles

The benefit of ozone treatment is derived from its strong oxidation potential and ability to transform and degrade most organic substances. In many wastewater treatment plants (WWTP) the biological treatment process eliminates biodegradable or adsorbable substances on suspended solids but is relatively inefficient when eliminating micropollutants. Ozonation can serve a vital role by eliminating micropollutants in the final stage of the treatment chain.

Besides the elimination of micropollutants, ozone treatment also improves the overall treatment performance of the plant. If a malfunction were to affect performance in the early stages of treatment, ozonation would compensate for losses by oxidizing pollutants that had slipped through untreated. FOEN indicated ozonation produced a limited amount of by-products and ozonation can be matched with a biologically active treatment, such as biofilters or fluidized bed filters to act as an added safeguard against by-product formation (FOEN 2008, Turk & al. 2011).

Ozonation Performance

The pilot projects and full scale plant tests utilized a wide range of water quality conditions to evaluate different combinations of effluents, treatment processes, and constraints in the upstream and downstream environment. Ozone treatment significantly exceeded the expected removal targets for micropollutants (>95% elimination achieved) and increased removal of more conventional contaminants throughout the process train (+50%). All of the benefits of the ozone system were provided while increasing operating costs less than 4% (from +1.7% to +3.5%). The studies also illustrated ozone technology's ease of use, and excellent safety and reliability records (Regensdorf Final Report 2009). Additionally, the ozonation process ensures quality discharges to the local environment by improving the organoleptic characteristics of the water such as taste, odor and color. Ozone also exhibited other benefits over alternative treatment technologies including improved carbon neutrality and environmental sustainability.

OZONE PERFORMANCE

- >90% Removal rate for 2/3 of all substances
- >98% Removal rate for pharmaceuticals
- 50% Improvement of general treatment performance
- >99% Disinfection and removal of viruses and bacteria
- 1.7 – 3.5% increase of operating costs

Ozone in Action: Sophia Antipolis (France)

The Sophia Antipolis plant plays an important role in protecting the local environment and feeds into the drinking water resource of Antibes. In the summer of 2012, the Sophia Antipolis wastewater treatment plant became the first French facility to install a system to treat micropollutants.

When the municipality committed to upgrade its wastewater treatment plant, it decided to upgrade the treatment line by including an ozone stage. The ozonation treatment step fits ideally into the existing process train between the biological treatment stage and the biofiltration stage.

OZONIA supplied a turnkey ozone system designed around an OZATCFV-10 ozone generator (8.21 kg/h at 10 % wt. using oxygen) which allowed the Sophia Antipolis plant to adapt the ozone system to its current and future requirements. In 2030, a population equivalent of 50'000 is expected.

As the first ozone micropollutant treatment system installation in France, the municipality's visionary investment in next generation technology will help the Sophia Antipolis community achieve their sustainable development goals.

Ozone in Action: Zürich (Switzerland)

Due to the Swiss FOEN study and Micro-Poll project, the removal of micropollutants is now a priority in Switzerland. In 2012, the Swiss government revised its water treatment legislation with a new law expected to come into effect in 2014. The new law requires 100 of the country's 700 treatment plants (treating 50% of all waste water) to use advanced treatment techniques. The goal is 80% removal

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of micropollutants in the upgraded plants, and a 50% overall elimination of micropollutants in Switzerland.

The “Neugut” water treatment plant in Dübendorf (Zürich) is one of the first Swiss facilities that will eliminate micropollutants and will be the first to comply with the new Swiss regulation for the treatment of trace compounds. OZONIA was selected to supply a full-scale ozone treatment system that will be completed in the spring of 2014. The Neugut facilities will be designed to treat up to 1’455 m^3/h and will include ozone generation, dome diffusion, vent ozone destruction and control equipment. The city of Dübendorf’s innovative micropollutant reduction system will be used as a benchmark for future projects in Switzerland.

Summary

Micropollutant removal is one of the primary environmental and public health threats directly related to water resources. After several years of research, piloting and first full-scale testing, ozone has emerged as a cost effective and efficient micropollutant removal solution that can protect the global community from this growing challenge.

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