

Carollo and Purifics to Test Novel TiO₂ Photocatalysis Process for Organic and Microbial Destruction

The WaterReuse Foundation (WRF) awarded WRF-02-009, *Study of Innovative Treatments for Reclaimed Water*, to the team consisting

KEY TEAM MEMBERS
Andrew Salvesson, P.E.
 asalvesson@carollo.com
Jess Brown, Ph.D., P.E.
Vincent Hart, P.E.
Shubhra Jain

of Duke University, Carollo Engineers, the University of South Florida (USF), and the U.S. Department of Agriculture. The overall objective of the study is “to investigate the effectiveness of innovative treatment methods to inactivate, remove or destroy biological and chemical constituents of concern that may be present in reclaimed water.” One of the main tasks associated with this project is bench- and pilot-testing, which have been completed at a number of different reclaimed facilities using ozone/peroxide, UV/peroxide, and UV/peracetic acid. The final phase of the bench- and pilot-testing will focus on a photocatalytic oxidation and reduction process using a pilot unit provided by Purifics that uses illuminated, or light-activated, titanium dioxide (TiO₂) slurry catalyst. This technology will be tested at the Charlotte-Mecklenburg Utilities Sugar Creek Wastewater Treatment Plant in Charlotte, NC, in September 2007.

The UV/TiO₂ process is different than the other technologies tested because it uses a photocatalysis process instead of photolytic process (UV/peroxide). UV/TiO₂ photocatalysis uses the full spectrum of ultraviolet light to activate the TiO₂ catalyst. The UV light photo-generates electrons into the conduction band of the surface of the catalyst semiconductor and positive “holes” form at the surface of the TiO₂. The photostability of TiO₂ makes it less likely that the electron/hole will

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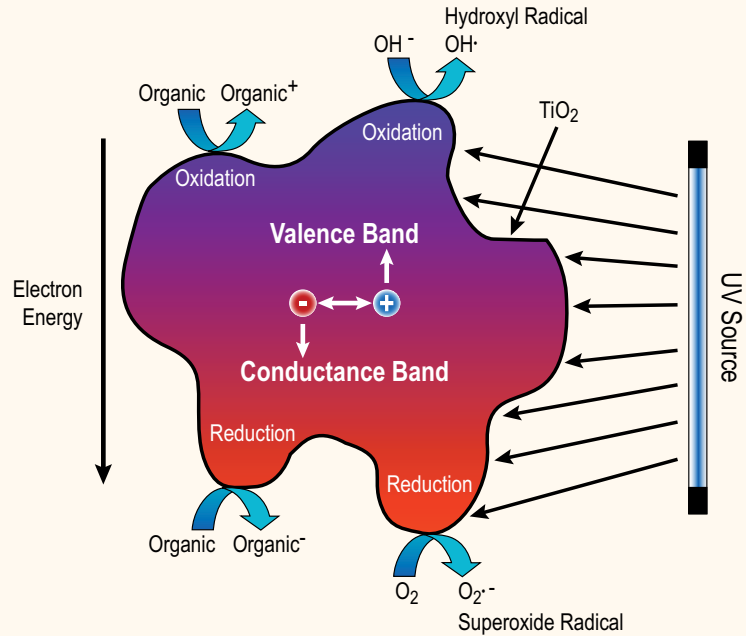
recombine. When the electron/hole makes it to the surface of the TiO₂, the catalyst is in an

activated state and four organic matter destruction pathways exist (both oxidation and reduction):

1. Photogenerated electrons reduce contaminants (direct).
2. Photogenerated holes oxidize surface-absorbed pollutants (direct).
3. Oxidation of hydroxide ions (OH⁻) to hydroxyl radicals (OH[•]) (indirect).
4. Reduction of surface absorbed oxygen (O₂) to superoxide radicals (O₂^{•-}) (indirect).

The organic contaminants are destroyed on the surface of the TiO₂ for all four degradation pathways.

The photocatalysis process recovers the TiO₂ using a ceramic microfiltration membrane, which also acts to provide an additional barrier for pathogen removal. Due to the oxidation and reduction environment, both the UV lamp sleeves and membrane surface remain continuously “cleaned” and the system does not require sleeve wipers for the UV system or clean-in-place procedures for the ceramic



The photocatalysis process indirectly creates both the superoxide radical and the hydroxyl radical, which oxidize organic material in addition to direct oxidation or reduction.

membranes. The photocatalysis process will be piloted at the Sugar Creek WWTP downstream of the tertiary filters.

The microbiological constituents and indigenous microconstituents that will be tested as part of this project are shown in Table 1 below.

Table 1. Microbiological Constituents and Indigenous Microconstituents That Will Be Tested as Part of This Project

Constituents/Microconstituents	
Microbiological	Indigenous
<ul style="list-style-type: none"> • Total Coliform • Fecal Coliform • MS2 Coliphage • <i>Cryptosporidium</i> • <i>Giardia</i> • Adenovirus • Reovirus • Coxsackievirus 	<ul style="list-style-type: none"> • Estrone • 17-b-Estadiol • Estriol • 17-a-Ethylestradiol • 4-nonylphenol • 4-octylphenol • N-nitrosodimethylamine (NDMA) • Bisphenol-a • N,N-diethyl-3-methylbenamide (DEET) • Triclosan