Natural Attenuation of the Photo-catalytic Characteristic of Titanium Dioxide Nanoparticles

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Disposal of domestic products containing engineered titanium dioxide nanoparticles (TiO2-NP) result in their release into sewage collection systems and partial discharge into downstream aquatic systems. TiO2-NP can be photo-activated by ultraviolet light producing strong reactive oxygen species, including hydroxyl radicals (·OH). Photo-activation of TiO2-NP in aquatic systems can oxidize variant materials and has been implicated in the ecotoxicological impact on marine and aquatic organisms. These ecotoxicological studies were conducted exclusively with pure TiO2-NP in de-ionized water (DIW). The point of my study was to evaluate whether TiO2-NP in natural water systems involve reactions that inactivate the photo-catalytic characteristic. A “quick” test developed to measure TiO2-NP photo-activation and oxidation of methylene blue (MB) was used to evaluate whether specific reactants inhibit TiO2-NP photo-activation, and whether TiO2-NP photo-activation was attenuated when mixed into water samples collected from natural water systems. Results indicate greater removal of MB in the TiO2-NP-amended reactors, through ·OH formation and MB oxidation, relative to TiO2-NP-free reactors. Natural reactants tested inactivated TiO2-NP photo-activation as indicated by a decrease in MB photo-oxidation. Natural water samples show a wide range in chemical and physical characteristics, and result in the inactivation of TiO2-NP relative to DIW controls. A clear trend was not established between MB oxidation and water quality parameters including total organic carbon, metals, ionic strength/conductivity, total suspended solids, and pH. Results suggest multiple, undifferentiated mechanisms played a role in the natural attenuation of TiO2-NP photo-catalytic activity.