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TiO_2 Nanoparticles Aggregation and Disaggregation in Presence of Alginates and Humic Acids: pH and Concentration Effects on Suspension Stability

Frédéric Loosli (1), Philippe Le Coustumer (2,3), and Serge Stoll (1)

(1) University of Geneva, F.-A. Forel Institute, Group of Environmental Physical Chemistry, 10 route de Suisse, 1290 Versoix, Switzerland (Frederic.Loosli@unige.ch), (2) Université de Bordeaux 3, EA 4592 Géoressources & Environnement, ENSEGID, 1 allée F. Daguin, 33607 Pessac, France, (3) Université Bordeaux 1, UFR STM, B.18 Av. Des facultés 33405 Talence, France

The behavior of manufactured TiO_2 nanoparticles is studied here in a systematic way as a function of pH and in the presence of Suwannee river humic acids and alginate, at variable concentrations, which represent two major components found in aquatic systems. TiO_2 nanoparticles aggregation, disaggregation and stabilization are investigated using dynamic light scattering and electrophoretic experiments allowing the measurement and evolution determination of z-average hydrodynamic diameters and zeta potential values. Stability of the TiO_2 nanoparticles is carried out by considering three pH-dependent electrostatic scenarios (below the point of zero charge of the nanoparticles, at the point of zero charge and above it). In the first scenario, when pH is below the point of zero charge of the TiO_2 nanoparticles, nanoparticles exhibit a positively charged surface whereas alginate and Suwannee river humic acids are negatively charged. Fast adsorption at the TiO_2 nanoparticles occurs, promotes surface charge neutralization and aggregation and, by increasing further Alginate and Suwannee river humic acids, results in charge inversion and thus stabilization of TiO_2 nanoparticles. In the second electrostatic scenario, at the pH of the TiO_2 surface charge neutralization, TiO_2 nanoparticles are rapidly forming aggregates and adsorption of alginate and Suwannee river humic acid on aggregates surface leads to the partial disaggregation of aggregates. In the third electrostatic scenario, when nanoparticles, alginates and Suwannee river humic acids are negatively charged a small amount of Suwannee river humic acids is adsorbed via hydrophobic interactions. It is found that the fate and behavior of individual and aggregated TiO_2 nanoparticles in presence of environmental compounds are strongly dependent on the electrostatic, concentration ratio, and to a less extend to the amphiphilic compounds character and that environmental aquatic concentration ranges of humic acids and biopolymers will largely modify the stability of TiO_2 nanoparticles.