

Investigations into titanium dioxide nanoparticle and pesticide interactions in aqueous environments

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The influence of three pesticides (glyphosate, aminomethylphosphonic acid (AMPA) and 2,4-dichlorophenoxyacetic acid (2,4-D)) on the colloidal fate of TiO₂ nanoparticles (NPs; anatase and rutile) has been investigated in aqueous conditions of variable chemical composition (Na⁺ or Ca²⁺), ionic strength (IS, 10⁻⁴–10⁻¹ M), and pH (5 or 8). Sorption and degradation of these pesticides in the presence of the NPs was evaluated.

In absence of pesticide, increasing IS, the presence of the divalent cation Ca²⁺, and a pH close to the NP isoelectric point, favored NP homoaggregation as expected. However, at low IS ($\leq 10^{-2}$ M in NaCl; $\leq 10^{-3}$ M in CaCl₂), in the presence of a few $\mu\text{g/L}$ of glyphosate and rutile in the mg/L range, NP homoaggregation was prevented, despite a pH=5 close to the NP isoelectric point (4.0–4.2). The phosphonate group of the pesticide drove glyphosate adsorption onto the NP, while the carboxylic group was responsible for electrostatic stabilization of the NP. The stabilizing effect of glyphosate on NP aggregation however appears temporary. Furthermore, TiO₂ NPs also adsorbed AMPA and promoted degradation of glyphosate to AMPA. These results highlight new evidence of NP-pesticide interactions and the differences in their fate and potential co-migration behavior in aquatic environments.