

## Effect of ionic strength and pH on the size and dynamic aggregation of TiO<sub>2</sub> nanoparticle dispersions

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The widespread use of TiO<sub>2</sub> nanoparticles in many products has led to increased concern over their fate in the environment. The stability of TiO<sub>2</sub> nanoparticles in aqueous dispersions plays a key role in the aggregation process and subsequently affect the retention and transport of nanoparticles in aquatic systems. We investigated the effect of ionic strength (0.0001-1 M NaCl), and pH (3-11) on the hydrodynamic size and zeta potential of 50 mg L<sup>-1</sup> TiO<sub>2</sub> dispersions. Dynamic aggregation of the TiO<sub>2</sub> nanoparticles was monitored via time-resolved optical absorbance at a wavelength of 300 nm. Results showed that the hydrodynamic size of the TiO<sub>2</sub> nanoparticles increased by increasing the ionic strength at all pH values. The average hydrodynamic size of the TiO<sub>2</sub> nanoparticle dispersions with ionic strength of 1-0.1M reached 1522 nm. At lower ionic strength (0.01-0.0001M), the hydrodynamic size varied considerably by variation in pH values. Smaller hydrodynamic size was observed at both lower (3-5) and highest (11) pH values, and the hydrodynamic size reached 292 and 255 nm, respectively. For TiO<sub>2</sub> dispersions with pH values 7 to 9, the hydrodynamic size reached 1595 nm because of the lower surface charge as the pH of the dispersion approaches the point of zero charge of the TiO<sub>2</sub> nanoparticles. Zeta potential of the TiO<sub>2</sub> nanoparticles were found to be positive for pH ≤ 5 and reached an average of 9.2 and 30.9 mV for TiO<sub>2</sub> dispersions with 1-0.1M and 0.01-0.0001M, respectively. For pH ≥ 7, zeta potential was negative and showed the largest value of -42.6 mV at lower ionic strength and pH values above 9. Increasing the ionic strength caused the relative concentration (C/C<sub>0</sub>) of the TiO<sub>2</sub> nanoparticles to decline indicating lower TiO<sub>2</sub> nanoparticles stability. The average relative concentration of the TiO<sub>2</sub> nanoparticles reached 0.14, 0.17, and 0.23 for the 1, 0.1, and < 0.01M, respectively. The maximum TiO<sub>2</sub> nanoparticles stability reached an average of 0.79, and was observed at pH values of 3 and 11 and ionic strength of < 0.01M. DLVO theory calculations were carried out to qualitatively explain the effect of ionic strength and pH on the stability of the TiO<sub>2</sub> nanoparticles. Our results suggest that the TiO<sub>2</sub> nanoparticles were relatively unstable and can be subject to aggregation and removal due to changes in the solution chemistry. Such information is essential to the assessment and prediction of TiO<sub>2</sub> nanoparticles fate in the environment.