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Photocatalytic reduction and removal of Cr(VI) and Se(VI) using TiO_2 and $NaTaO_3$ nanopowder

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As the limits for the concentration of contaminants such as Cr(VI) and Se(VI) in waters keeps increasing, it is necessary to develop an efficient and clean method to remove them. Photocatalysts such as TiO_2 can take advantage of surface hydroxyl groups to bind Cr(VI) or Se(VI) and reduce them with photogenerated electrons, allowing for removal them as $Cr(OH)_3$ and Se. In industrial wastewater or areas rich in minerals like Arizona, Cr(IV) and Se(VI) often coexists, so simultaneous reduction could save costs and time. For effective removal, the Se(VI) or Cr(VI) species must have good adsorption onto TiO_2 and the presence of suitable hole scavengers (electron donors) to react with photogenerated holes as sacrificial reagents. Both Cr(VI) and Se(VI) exist as anions in aqueous environments, so a photocatalyst with a high point of zero charge (PZC) can allow that the reduction to occur in a neutral or basic environment. Impurity ions present in the water may also affect the adsorption. For the reduction of Cr(VI), different hole scavengers were evaluated and sodium sulfite was found to be the most effective when used with TiO_2 or $NaTaO_3$ as photocatalyst. Sodium sulfite could even reduce Cr(VI) in the basic environment by itself without a photocatalyst. The photocatalysts were less effective for the reduction of Se(VI)/Se, which has a more negative redox potential than Cr(VI)/Cr(III) in water at neutral pH in the presence of different sacrificial reagents. The choice of photocatalysts and the effect of sacrificial reagent, pH and impurities of solution would be discussed for the simultaneous reduction of Cr(VI) and Se(VI).