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Colloidal stability of CeO_2 nanoparticles coated with either natural organic matter or organic polymers under various hydrochemical conditions

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The worldwide marked for engineered nanoparticles (ENPs) is growing and concerns on the environmental fate- and toxicity of ENPs are rising. Understanding the transport of ENPs within and between environmental compartments such as surface water and groundwater is crucial for exposition modeling, risk assessment and ultimately the protection of drinking water resources. The transport of ENPs is strongly influenced by the surface properties and aggregation behavior of the particles, which is strongly controlled by synthetic and natural organic coatings. Both, surface properties and aggregation characteristics are also key properties for the industrial application of ENPs, which leads to the development and commercialization of an increasing number of surface-functionalized ENPs. These include metals and oxides such as Cerium dioxide (CeO_2) with various organic coatings.

Therefore, we investigate CeO_2 ENPs with different surface coatings such as weakly anionic polyvinyl alcohol (PVA) or strongly anionic poly acrylic acid (PAA) with respect to their colloidal stability in aqueous matrix under various hydrochemical conditions (pH, ionic strength) and their transport behavior in sand filter columns. Furthermore, we investigate the interaction of naturally occurring organic matter (NOM) with CeO_2 ENPs and its effect on surface charge (zeta potential), colloidal stability and transport. While uncoated CeO_2 ENPs aggregate at pH $>$ 4 in aqueous matrix, our results show that PAA and PVA surface coatings as well as NOM sorbed to CeO_2-NP surfaces can stabilize CeO_2 ENPs under neutral and alkaline pH conditions in 1 mM KCl solution. Under slightly acidic conditions, differences between the three particle types were observed. PVA can stabilize particle suspensions in presence of 1 mM KCl at pH $>$ 4.3, PAA at pH $>$4.0 and NOM at $>$3.2. While the presence of KCl did not influence particle size of NOM-CeO_2 ENPs, $CaCl_2$ at $>$2 mM lead to aggregation. Further results on the influence of KCl and $CaCl_2$ on aggregation of coated CeO_2 ENPs and transport in sand filter columns will be presented.