Stability of Mixture of Nanoparticles and Associated Health Risks from Environment

ABSTRACT

This research was carried out to understand the stability of mixture of nanoparticles in aquatic system and risk associated with these mixtures of nanoparticles. Stability of mixture in different suspension chemistry was studied to understand role of various factors such as pH, ionic strength, presence of clay, humic acid (HA) and organic compound. For ZnO and CuO nanoparticles, model equations were developed for predicting values of their (i) aggregation rate constant, (ii) settling rate constant, (iii) difference in zeta potential, (iv) percentage change of metal in suspension function of pH, ionic strength and NP concentration. In another experiment, heteroaggregation of mixture of ZnO and CuO nanoparticles (NPs) with clay was analysed by determining aggregation rate constant (0.281-8.63nm/min), critical coagulation concentration (120.7mM,1144mM), and attachment efficiency for mixture system. This study provided information on aggregate characterization of mixture of metal oxide nanoparticles (ZnO and CuO) in HA and clay presence, which is useful in understanding aggregation formation and in characterizing exposure dose for environmental risk assessment. Effect of organic pollutant (Bisphenol A) on stability of mixture of nanoparticles (TiO_2+ZnO) released from sunscreen in seawater was also determined and presence of BPA was found to increase or decrease the aggregation state of system depending on pH condition and NPs ratio condition. The information about aggregation rate constant and size change may help in assessing aquatic risk and human health risk due to mixture of nanoparticles in seawater. Human health risk assessment framework to estimate health risks due to exposure of mixture of nanoparticles (NP) and ions from surface water, exposure of nanoparticles through fish grown in NP contaminated water was developed for the first time in this study. Maximum allowable concentration of NPs in various exposure medium as single NPs and mixture of NPs were determined in this study (value= 0.207mg/L for ZnO NPs as well as CuO NPs when present in mixture). Similarly, maximum allowable values of NP were found to be 0.115mg/L, 0.152mg/L, and 1.77×10^7 mg/L for single ZnO, CuO, and TiO_2 NP, respectively for oral ingestion route. Top three most hazard causing NPs were suggested in various medium which require urgent monitoring and also values of their revised guidelines in mixture condition were also proposed. The identified top three risk-posing NPs can be used for conducting toxicity

studies for mixture of NPs and long-term monitoring so that it can be used in the proposed framework for setting up guideline values for NPs in mixture for environment.

Overall, stability of mixture of nanoparticles considering various transformation process needs to be analysed to determine various kinetic parameters for aggregation, dissolution process and incorporate these nanoparticle characteristics for predicting their fate in aquatic system and defining risk.

***Keywords*: Nanoparticles, Mixture, Health risks, Stability**