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Impacts of Cerium Oxide Nanoparticles on Functional Bacterial Community in Activated Sludge

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Abstract : Nanotechnology promises significant improvements of advanced materials and manufacturing techniques with a vast range of applications, which are critical for the future competitiveness of national industries. The manipulations and productions of materials, whilst, controlling the optical properties and surface area to a nanosize scale enabled a birth of a new field known as nanotechnology. However, their rapidly developing industry raises concerns about the environmental impacts of nanoparticles, as their effects on functional bacterial community in wastewater treatment remain unclear. The present research assessed the impact of cerium Oxide nanoparticles (nCeO) on the bacterial microbiome of an activated sludge system, which influenced its performance of this system on nutrient removal. Out of 15875 reads sequenced, a total of 13133 reads were non-chimeric. The wastewater samples were more dominant to the unclassified bacteria (51.07% of bacteria community) followed with the classified bacteria (48.93). Proteobacteria was the most dominant phylum in both classified and unclassified bacteria, whereas 18% of bacteria could even not be assigned a phylum and remained unclassified suggesting hitherto vast untapped microbial diversity. The bacterial operational taxonomic units (OTUs) ranged from 1014 to 2629 over the experimental period. The denitrification related species including Diaphorobacter species, Thauera species and those in the Sphaerotilus and Leptothrix group were found to be inhibited in a high concentration of CeO-NP. The diversity indices suggested that the bacterial community inhabiting the wastewater samples were less diverse as the concentration of CeO increases. The canonical correspondence analysis (CCA) results highlighted that the bacterial community variance had the strongest relationship with water temperature, conductivity, pH, and dissolved oxygen (DO) content as well as nCeO. The results provided the relationships between the microbial community and environmental variables in the wastewater samples.

Keywords : bacterial community, next generation, cerium oxide, wastewater, activated sludge, nanoparticles, nanotechnology
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