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The Ability of Consortium Wastewater Protozoan and Bacterial Species to Remove Chemical Oxygen Demand in the Presence of Nanomaterials under Varying pH Conditions

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Abstract : The aim of this study was to ascertain the survival limit and capability of commonly found wastewater protozoan (Aspidisca sp, Trachelophyllum sp, and Peranema sp) and bacterial (Bacillus licheniformis, Brevibacillus laterosporus, and Pseudomonas putida) species to remove COD while exposed to commercial nanomaterials under varying pH conditions. The experimental study was carried out in modified mixed liquor media adjusted to various pH levels (pH 2, 7 and 10), and a comparative study was performed to determine the difference between the cytotoxicity effects of commercial zinc oxide (nZnO) and silver (nAg) nanomaterials (NMs) on the target wastewater microbial communities using standard methods. The selected microbial communities were exposed to lethal concentrations ranging from 0.015 g/L to 40 g/L for nZnO and from 0.015 g/L to 2 g/L for nAg for a period of 5 days of incubation at 30°C (100 r/min). Compared with the absence of NMs in wastewater mixed liquor, the relevant environmental concentration ranging between 10 µg/L and 100 µg/L, for both nZnO and nAg caused no adverse effects, but the presence of 20 g of nZnO/L and 0.65 g of nAg/L significantly inhibited microbial growth. Statistical evidence showed that nAg was significantly more toxic compared to nZnO, but there was an insignificant difference in toxicity between microbial communities and pH variations. A significant decrease in the removal of COD by microbial populations was observed in the presence of NMs with a moderate correlation of r = 0.3 to r = 0.7 at all pH levels. It was evident that there was a physical interaction between commercial NMs and target wastewater microbial communities; although not quantitatively assessed, cell morphology and cell death were observed. Such phenomena suggest the high resilience of the microbial community, but it is the accumulation of NMs that will have adverse effects on the performance in terms of COD removal.

Keywords : bacteria, biological treatment, chemical oxygen demand (COD) and nanomaterials, consortium, pH, protozoan
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