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Effect Of Graphene Oxide Nanoparticles on the Performance of Aerobic Granular Sludge Treatment System

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1. Introduction

Carbon-based nanomaterials, such as graphene oxide nanoparticles (GO NPs) have received increasing interest in biomedical applications; therefore, GO NPs will release into the environment and would inevitably reach in the wastewater [1,2]. The aerobic granular sludge (AGS) wastewater treatment process is a relatively new technology and have many advantages against with the conventional activated sludge (CAS) [3]. Previous literature reported that the GO NPs negatively influenced the nutrient removal in case of CAS [2]. The aim of this study was to investigate the effects of GO NPs on the AGS biological treatment processes.

2. Materials and methods

The control AGS sequencing batch reactor (SBR) was fed with synthetic wastewater (SWW), whereas six AGS reactor were fed with GO NP-contaminated SWW at different concentrations (15, 25, 35, 55, 75, and 95 mg/L GO NPs) over 1 week. The chemical oxygen demand (COD), NH_4-N, NO_2-N, NO_3-N, and PO_4-P concentrations were continuously measured, while the extracellular polymeric substance (EPS) content, biomass, and microbial composition were determined at the end of experiments [4].

3. Results

In case of control bioreactor, the effluent COD, NH_4-N, NO_2-N, NO_3-N, and PO_4-P contents were 83.12, 0.05, 0.03, 0.31, and 0.79 mg/L during the experiment. In all experiments, the concentrations of nitrite and nitrate remained stable throughout the whole operation period, even in the control bioreactor. These observations correspond to the previous AGS studies wherein CuO NPs and Ag NPs did not influence the removal efficiency of these components [5,6]. In contrast, at 25 mg/L GO NPs, NH_4-N concentration in the effluent increased marginally after 5.5 day and was 2.39 mg/L after 7 days. In the case of 75 and 95 mg/L GO NPs, the effluent ammonia concentration continuously increased to 13.41 and 21.75 mg/L. The addition of GO NPs showed similar effects on COD removal efficiency than in case of NH_4-N removal. In contrast, GO NPs influenced negatively the phosphorus removal, even at low concentration. When the SWW contained 15 and 95 mg/L GO NPs, the PO_4-P concentration was 3.42 and 6.38 mg/L. Similar observations were also reported, wherein ZnO and CuO NPs negatively influenced the phosphorus removal in case of AGS [6,7]. At 15, 25, and 35 mg/L GO NPs, the secretion of polysaccharide (PS) slightly decreased, whereas the concentration of protein (PN) increased considerably (***Figure 1***).

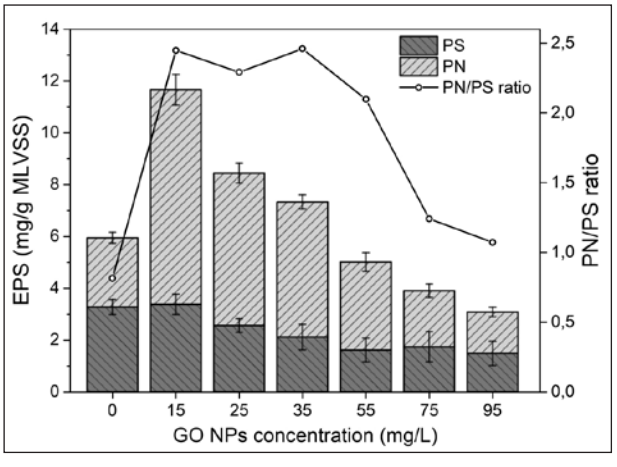

Figure 1 *Effects of GO NPs on EPS contents of AGS*

However, when the SWW GO NPs contents were 55, 75, and 95 mg/L, the EPS production decreased. These observations suggest that a high amount of PN largely protects microorganisms from suffering the toxicity of GO NPs.

The *Paracoccus* sp., *Acidovorax* sp., and *Klebsiella* sp. were the most tolerant strains against the GO NPs exposure; they remained detectable when the amount of nanoparticles was 95 mg/L.

4. Conclusions

The GO NPs at 15, 25, and 35 mg/L stimulated the secretion of EPS, the removal rate of COD and NH_4-N was not significantly reduced, while at higher concentrations the production of EPS and the removal of nutrients decreased considerably. The NPs resulted a shift in the microbial community composition.

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