Evaluation of the effect of the concentration of TiO_2 nanoparticles on the operation of an aerobic bioreactor with biofilms

Emerging pollutants and managing wastewater and waste

UNESCO-IWRA ONLINE CONFERENCE 17-19 JANUARY 2023 3rd IN THE IWRA ONLINE CONFERENCE SERIES

Introduction

The growing area of nanoparticles (NPs) in industrial and domestic applications leads to the release of these materials into the environment. The risk assessment of these NPs requires an understanding of their mobility, reactivity, ecotoxicity and persistence (Ripp and Henry, 2011, Zhuang and Gentry, 2011). TiO2 NPs rank second among the most manufactured nanomaterials, to some studies where they have been reported to be only below the production of SiO NPs according with Keller and Lazareva, 2013 (Fig. 1). Due to the biotoxicity of TiO NPs, it is essential to evaluate their impacts on the performance of biological wastewater treatment systems (Zheng et al., 2011), as wastewater treatment facilities worldwide are mainly biologically based, such as aerobic and anaerobic processes (Puyol et al., 2017).

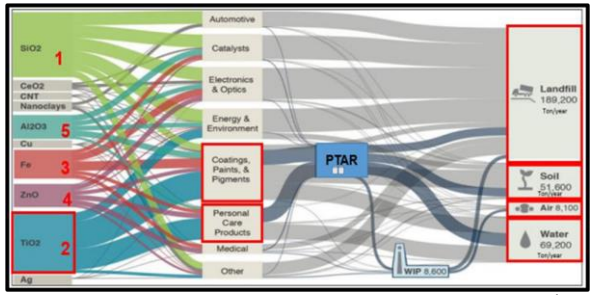
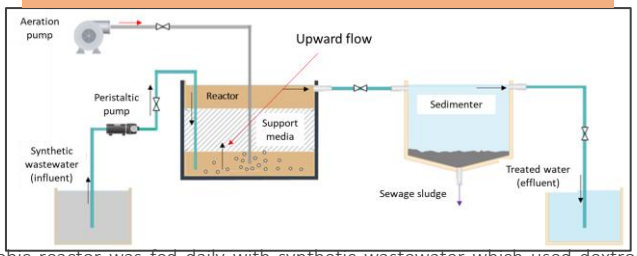


Fig. 1 Flow of the 10 world production NP (production > 100 ton/ year) estimated up to 2010 (Keller &Lazareva, 2013)

Metodology and experimentation

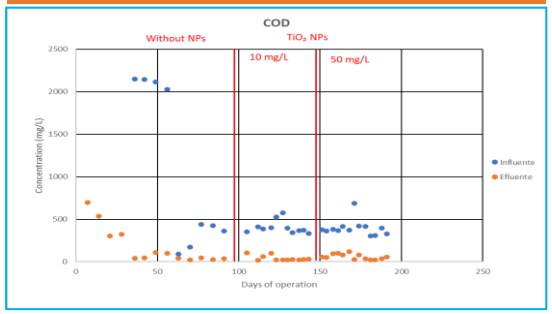
This research was carried out in two stages; the first was the stabilization stage, in which parameters such as Chemical Oxigen Demand (COD), ammoniacal nitrogen and phosphates without the presence of NPs were monitored. In the second experimental stage, a substitution of TiO2 NPs was prepared, at concentrations of 10 mg/L and 50 mg/L

Components of the system

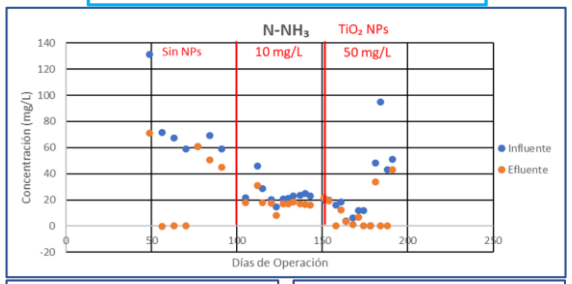


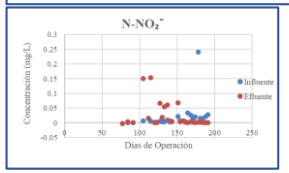
The aerobic reactor was fed daily with synthetic wastewater which used dextrose as a source of carbon, ammonium chloride as a source of nitrogen, and potassium phosphate as a source of phosphorus.

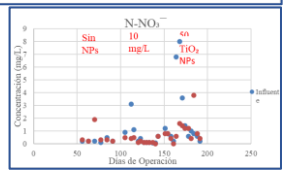
Results

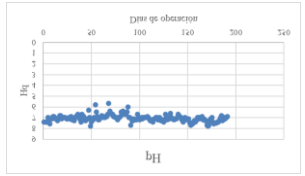


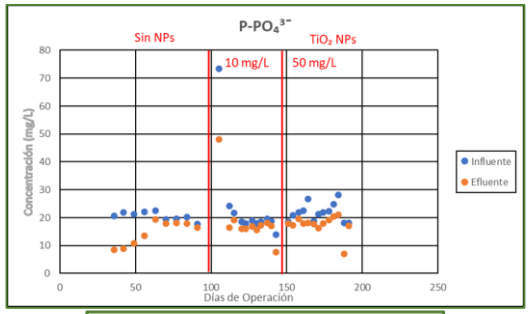
NPs concentration	average removal
0 mg/L	80.46%
10 mg/L	89.42%
50 mg/L	84.77 %











NPs concentration	average removal
0 mg/L	28%
10 mg/L	16.41%
50 mg/L	13 %

Conclusions

From the experimental results, it was observed that the removal of organic matter did not have a significant change in the presence of TiO NPs. Its removal increased by 9% in concentration of 10 mg/L of TiO NPs, and by 5% in the presence of 50 mg/L of TiO NPs.

The presence of NPs did have a significant impact on ammoniacal nitrogen removal, since with the concentration of 10 mg/L, the percentage of removal decreased by 31% with respect to the system without NPs. However, it was observed that the concentration of 50 mg/L of TiO NPs favored removal, reaching a 3% increase with respect to the system without NPs.

On the other hand, the removal of orthophosphates presented a direct relationship with the presence of NPs, being diminished when the concentration of TiO NPs increased . The average removal was 28%, 16% and 13% for concentrations of 0, 10 mg/L and 50 mg/L of TiO NPs respectively.

References

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