Continuous sulfamethoxazole removal by advanced activated sludge process with magnetite

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1. Introduction

Many studies have shown that PPCPs have a negative impact to the natural environments, ecosystems and human health. Antibiotics as one kind of PPCPs, can cause the proliferation of antibiotic resistant bacteria in aquatic environment. In this research, sulfamethoxazole (SMX) was used as a model antibiotic, the removals of SMX by continuous activated sludge process was studied in the presence and absence of magnetite.

2. Methods

Two identical continuous activated sludge reactors were constructed, which consisted of seven compartments (Fig. 1). Total volume of each reactor was 7 L. In the first compartment, nitrogen gas was injected to achieve anaerobic condition. The last compartment is a sedimentation tank, from which settled sludge was recycled to the first compartment with a recycling ratio of 1:1. Magnetite was added at a concentration of 1000 mg/L in one of the two reactors. HRT was one day for both reactors. Initial MLSS in each compartment was set at 2000 mg/L. The synthetic wastewater had 405 mg/L COD and 1 mg/L SMX. SMX stock solution was prepared by methanol and kept under -20℃.-Experiments were conducted at room temperatures (i.e. 20 to 23 ℃). The reactor with and without was named as magnetite added and control.

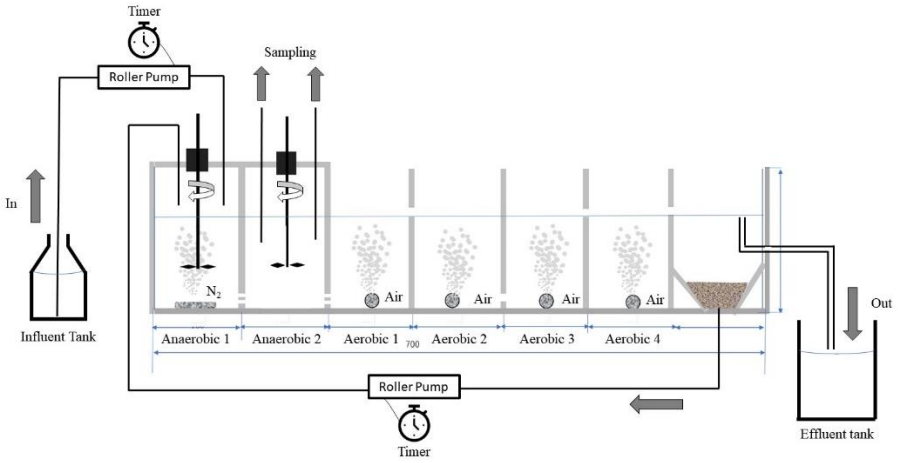

Fig. 1 Experimental apparatus of the continuous reactor

3. Results and discussion

After 3 months of operation, MLSS became around 1500 and 2000 (mg/L) in reactors with and without magnetite, respectively. pH was kept in the range of 6.5-7.5 and COD removal efficiency was around 98% in both reactors.

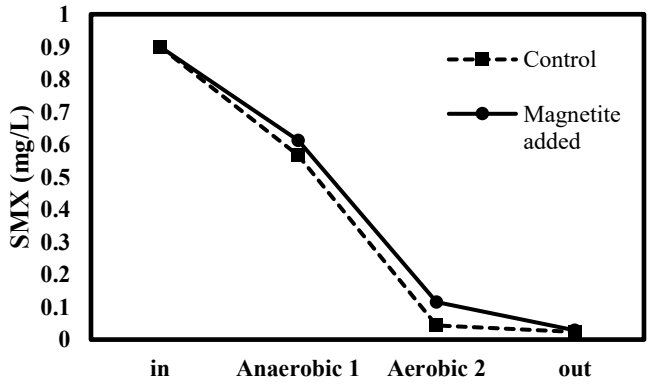

Fig. 2 SMX concentration in both reactor

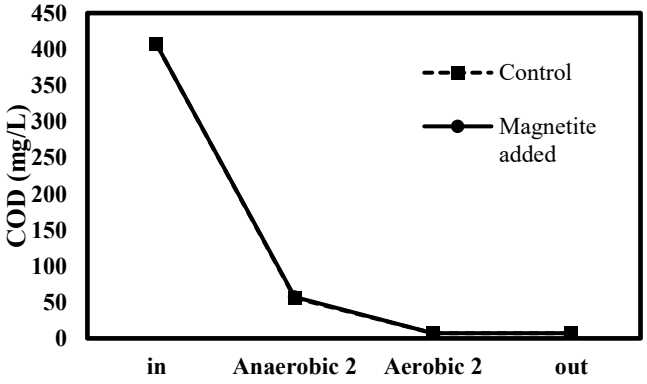

Fig. 3 COD concentration in both reactor

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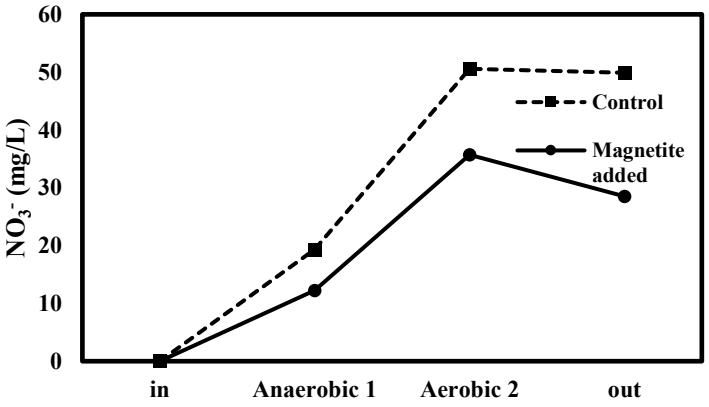

Fig. 4 NO_3^- concentration in both reactor

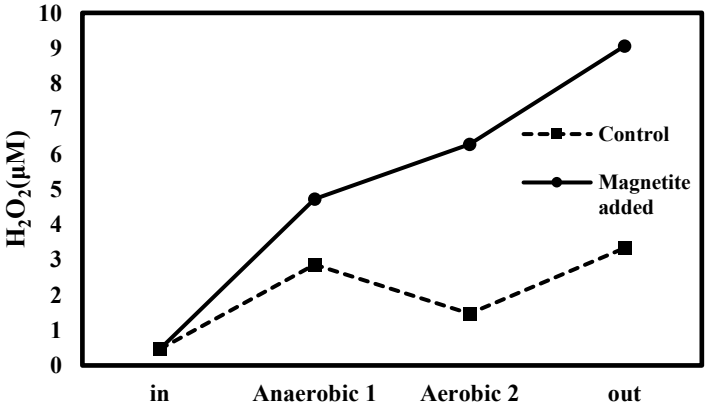

Fig. 5 H_2O_2 concentration in both reactor

Fig. 2 shows distributions of SMX concentration in the two reactors. SMX concentration with magnetite was decreased from 0.9 to 0.02(mg/L), so the removal efficiency of SMX was 98%, which was the same to that without magnetite. These results indicated that both activated process reactors had a strong ability to remove SMX. COD was also removed almost completely in both reactors (Fig. 3).

Fig. 4 shows nitrate distributions. Nitrate was largely produced in both reactors, which were finally 50 mg/L in control reactor and 28 mg/L in magnetite added reactor. Nitrate was recycled to the first compartment and was denitrified about 60% and 57% in control and magnetite added reactors, respectively. Nödler et al. (2012) reported that SMX could be removed through denitrification. Denitrification was observed in anaerobic compartments in both continuous reactors, suggesting SMX might be removed by denitrification.

Fig. 5 shows distributions of H_2O_2. In the reactor with magnetite, around 9 μM of H_2O_2 was produced after aerobic process, which was higher than that in control reactor. This result indicated the addition of magnetite accelerated the production of H_2O_2. Comparing with the observed results in an advanced SBR (Shen et al., 2022), H_2O_2 levels were several times smaller in this study.

8. Conclusion

Two continuous activated sludge reactors used in this study showed similar potential performances in terms of COD and SMX removals. The addition of magnetite accelerated the formation of H_2O_2. Further studies are needed to evaluate removal performances of COD, antibiotics and nutrients under different operating conditions.

REFERENCES

Karsten Nödler, Tobias Licha, Manuela Barbieri, Sandra Pérez: Evidence for the microbially mediated abiotic formation of reversible and non-reversible sulfamethoxazole transformation products during denitrification, Water Research, Volume 46, Issue 7, 2012, pp. 2131-2139.

Tong Shen, Yoshihiko Inagaki, Yutaka Sakakibara, Masahito Komori: Enhancement of sulfamethoxazole removal in an anaerobic/aerobic sequencing batch reactor with magnetite, Japan Society on Water Environment 56th annual conference, 2022, pp. 356-356.