TÍTULO DEL TRABAJO

"Post-treatment of sulfide loaded effluent from anaerobic treatment in laboratory-scale constructed wetlands – model experiments"

TÍTULO RESUMIDO

"Post-treatment of sulfide effluent from anaerobic treatment in laboratory scale reactor"

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FIGURAS Y TABLAS

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POST-TREATMENT OF SULFIDE LOADED EFFLUENT FROM ANAEROBIC TREATMENT IN LABORATORY-SCALE CONSTRUCTED WETLANDS – MODEL EXPERIMENTS

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ABSTRACT
Anaerobic treatment technology has found remarkable application in the treatment of wastewaters in Latin America. However, it is recognized that a sulphate-rich wastewater can cause some problems resulting from H_2S formation in the anaerobic treatment process. The technology of constructed wetlands seems to have the potential to tackle the problem of the anaerobic effluents, especially because the plants allow the transport of oxygen to the rooted soil.

The experiments made possible to characterize the sulphur species (S^o, S^{2-}, SO_3^{2-}, $S_2O_3^{2-}$, SO_4^{2-}) depending on different loading conditions. Toxicity effects of S^{2-} on plants correlated with diminished water uptake rates. Because of the presence of some remaining oxidized sulphur species and organic substrate in the model wastewater the S^{2-} concentration did not decrease. This gives the assumption that anaerobic processes prevailed. Nevertheless the concentration of ammonia nitrogen decreased remarkably, which means that also aerobic processes were running simultaneously.

KEYS WORDS: Anaerobic treatment, Constructed wetlands, Planted Fixed Bed Reactor –PFBR

RESUMEN
La tecnología de tratamiento anaerobios ha tenido una aplicación notable en el tratamiento de aguas residuales en Latin américa. Sin embargo, altas concentraciones de sulfatos causan problemas que resultan en la formación del ácido sulfídrico en el proceso anaerobio de tratamiento. La tecnología de humedales artificales parece tener un buen potencial para contra restar el problema de los efluentes anaerobios, especialemtne porque las plantas permiten el tranporte del oxígeno al suelo.

Este experimento hizo posible caracterizar la especie de sulfuros (S^o, S^{2-}, SO_3^{2-}, $S_2O_3^{2-}$, SO_4^{2-}) dependiendo de las diferente condiciones de carga. Los efectos de la toxicidad de S^{2-} en plantas tuvo correlación con la disminución en la tasa de incorporación de agua. A causa de la presencia de algunos remanentes de especies oxidadas de sulfuros y sustrato orgánico en el agua residual de estudio, la concentración de S^{2-} no disminuyó. Lo anterior supone que los procesos anaerobios prevalecieron. No obstante la concentración de nitrógeno amoniacal disminuyó notablemente, lo que significa que los procesos aeróbicos también ocurren simultáneamente.

PALABRAS CLAVES: Tratamientos anaerobios, Humedales artificiales, Reactores de lecho fijo

1. INTRODUCTION

In anaerobic conditions the sulphate-reducing bacteria start to work, breaking down the organic matter by sulphate respiration and thus producing hydrogen sulphide, which is partly transferred into the air and causes toxicity and odour problems. Because of this problem it is recommended a second treatment step to remove respectively detoxify the H_2S causing the bad odour of such effluents.

The technology of constructed wetlands seems to have the potential to tackle the problem of the anaerobic effluents. But because of insufficient experiences some questions left open like the possible H_2S toxicity effects on plants, the transformation processes of the sulphur compounds and other influencing factors. So the research is focused on following aspects:

- ?? Toxicity of H_2S to the helophytes
- ?? Nature of sulphur species within the different zones of constructed wetlands
- ?? The effectiveness of constructed wetlands to remove sulphur species
- ?? Possibilities for efficiency improvement of H_2S removal

This study shows simulation results of two Planted Fixed Bed Reactors (PFBR) fed with a synthetic wastewater with 5 mg/l sulphide, planted with *Juncus effusus* and operated at a five and 10 days residence time. The experiments made possible to characterize the sulphur species (S^o, S^{2-}, SO_3^{2-}, $S_2O_3^{2-}$, SO_4^{2-}) depending on different loading conditions.

2 MATERIALS AND METHODS

The Planted Fixed Bed Reactor- PFBR employed in this study, were units with a free volumes of 13.2 litres (h = 280 mm), with gravel (? 2-4 mm, porosity 0.42) as medium, and planted with *J. effusus* (143 shoots per reactor).

The PFBR was dosed with a synthetic influent which had a ratio of 10:5:1 about BOD_5, Nitrogen and Phosphor, respectively. Initially the influent contained 50.1 mg S/L and after 44 days of carried out the experiment, 5 mg S/L was added into the influent. At low sulfate concentration in the influent (1.04 mg S/L) the reactor was operated during 141 days and finally the hydraulic retention time was changed from 5 to 10 days the last 56 days.

Water samples were taken weekly, for the inflow was taken by introducing a beaker into the storage tank, 10 minutes after the addition of $Na_2S{\cdot}9H_2O$. Effluent samples were taken from the recirculation pipe, the first 10 ml collected were discarded to exclude of the sample.

The concentration of free sulfide was determined with sulfide ion-specific Ag^+/S^{2-} electrode (Silver/Sulfide-Electrode Ag 500 WTW). The inorganic highly reactive sulfur compounds in the water samples were analyzed by high performance liquid chromatography (HPLC, modified method according to Rethmeier et al., 1997). Concentration of ammonia, nitrite and nitrate were analysed by ion chromatography (DIONEX 100, Idstein, Germany)

3. RESULTS

The reduction in concentrations of both ammonium and nitrite in both reactors indicate nitrification (30 and 42% of NH_4^+-N at rich and deficient sulfate medium respectively for PFBR 1; and 68 and 62% at rich and deficient sulfate medium respectively for PFBR 2), which did not result in higher nitrate concentration in the effluent. The removal of total N showed a significant correlation with plant biomass (40 and 47 shoots per month for PFBR 1 and PFBR 2, respectively), which can indicate that the presence of the plants increases biofilm biomass and the transport of oxygen to the rooted soil.

With respect phosphorus removal, were 17 and 46% at rich and deficient sulfate medium respectively for PFBR 1 and 75 and 74% of PO_4^{3-} at rich and deficient sulfate medium respectively for PFBR 2

As the HRT was increased (from 5 to 10 days) both reactors presented the best removal efficiency for NH_4^+ (average of 65 and 84 %, respectively) and for phosphorous the removal efficiency increase until reach values up to 80% as has been reported in planted wetlands.

The total sulfur balances showed that at rich sulfate medium the removal of sulfur was lower than at sulfate deficient medium (26 and 31% for PFBR 1 respectively and 35 and 54% for PFBR 2 respectively). Although was possible to find removal efficiency of total sulfur, in some cases was sulfide, sulfite and sulfate produced.

At the end of the experiment in both reactors the redox potential values rose probably as a consequence of the higher number of plants, which is an indicative of more available aerobic condition and hence should promote greater and more rapid aerobic heterotrophic utilization of COD, favour nitrification, and inhibit sulfate reducing bacteria, the primary agent of sulfate removal.

4. CONCLUSION

It is possible to remove sulfur species in the PFBR, although some remaining sulfide species and organic substrate in the model wastewater did not decrease sulfate and sulfide. Nevertheless the concentration of ammonia nitrogen decreased remarkably, which means that also aerobic processes were running simultaneously The presence of This gives the assumption that anaerobic processes prevailed..

Further research will focus on the relation on the competition of H2S and ammonia for oxidizing equivalents and technological strategies like intermittent loading regimes for improving H_2S-removal efficiency.

5. REFERENCES

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6. FIGURES

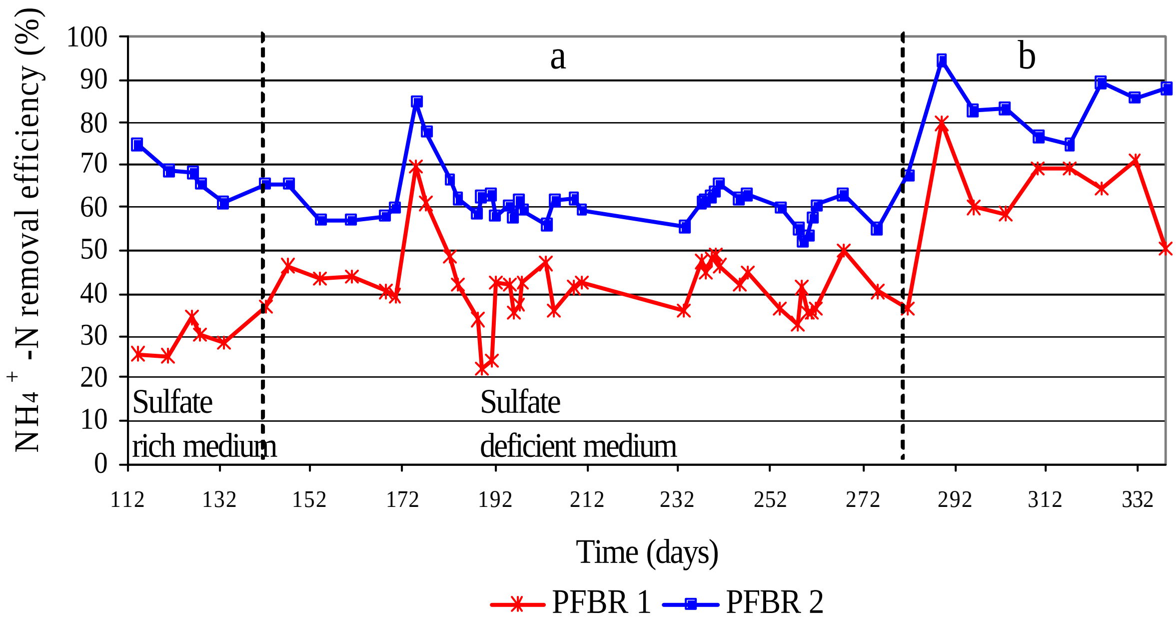

Figure 1 Removal efficiency of NH4 $^{+}$-N during the operation period of the Planted Fixed Bed Reactor 1 and 2 (a, HRT of 5 days and b, HRT of 10 days).

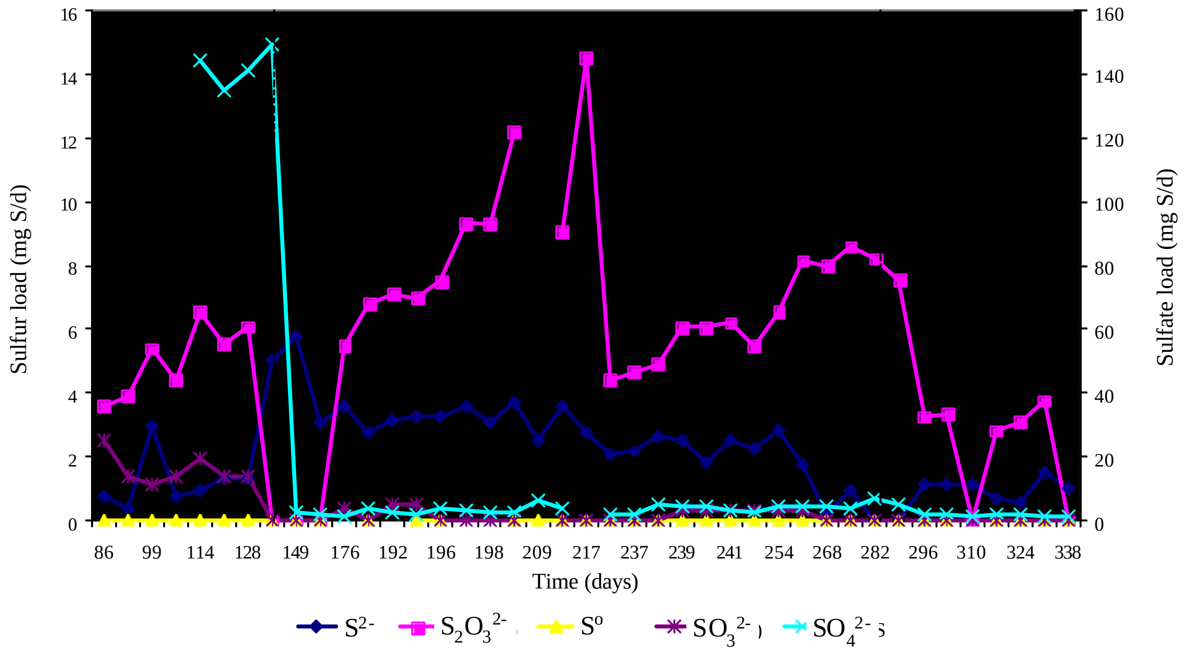

Figure 2 Sulfur load species in the inflow, during the operation period of the Planted Fixed Bed Reactor 1

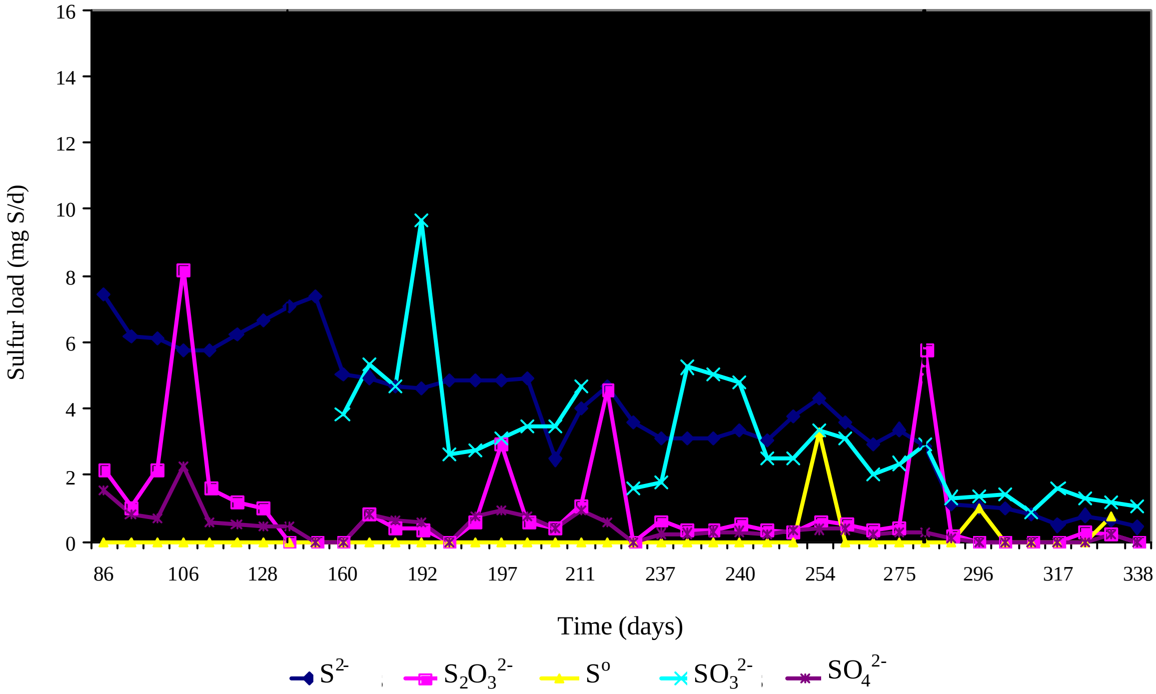

Figure 3 Sulfur load species in the effluent, during the operation period of the Planted Fixed Bed Reactor 1 (a, HRT 5 days and b, HRT 10 days).