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High-rate algal pounds as post treatment of anaerobically pretreated sewage: Review about operational conditions and greenhouse emissions relationship

Piteira Carvalho, B. G.*, Mota Filho, C. R.*

*** Department of Sanitary and Environmental Engineer, Federal University of Minas Gerais, Belo Horizonte City, Brazil**

Highlights:

- High-rate algal pounds is a good option to wastewater post treatment due several compounds removal and low cost operational
- Anaerobically pretreated sewage contains dissolved methane that can be consumed by specific microorganisms in biological post treatment
- Nitrification process in high-rate algal pounds need to be control to mitigate nitrous oxide generation
- Suitable operational conditions can mitigate GHG emissions in high-rate algal pounds, including oxygen control, avoid acid pH and nitrite accumulation

Keywords: Greenhouse Emissions; High-Rate Algal Pounds; Municipal Wastewater

INTRODUCTION

Due the worsening consequences of climate change, the efforts to reduce greenhouse gas (GHG) emissions have become an environmental priority (ROCKSTRÖM et al., 2009). The wastewater treatment plants (WWTPs) play a fundamental role in reducing negative impacts arising from the disposal of sanitary sewage on the environment and public health. However, some wastewater treatment technologies have been identified as significant sources of GHG due operational conditions, reactor configurations, raw wastewater composition, etc. The gases methane (CH_4) and nitrous oxide (N_2O) are the strongest GHG (LEE et al., 2022) and also the most generated GHG in anaerobic wastewater treatment (CH_4) (CAKIR & STENSTROM, 2005) and in biological nitrogen removal systems (CAMPOS et al., 2016).

The use of anaerobic wastewater treatment technologies is widespread in tropical regions such as Brazil, but they require additional treatments to meet release criteria (CHERNICHARO et al., 2015). The high-rate algal pounds comprise a sustainable and low-cost alternative for post-treatment of anaerobic effluents (ESPINOSA et al., 2021; VASSALLE et al., 2020).

However, it is necessary to investigate the potential for GHG production and emission in high-rate algal pounds, as well as the effects of operating conditions on this process. Thus, this work proposes a review of CH4 and N2O dynamics in high-rate algal pounds, considering risk factors for GHG production and emission. Once high-rate algal pounds consist in a tendency for post-treatment of anaerobically pretreated sewage, the advantages and challenges of its application, considering performance and GHG emissions will be discussed on order to help the decisions-making in these systems.

METHODOLOGY

This study includes a review about high-rate algal pounds for post-treatment of anaerobically pretreated sewage, specifically the relationship among performance reactors, microbial community and the potential of GHG production and emission (N_2O and CH_4). Several researchers were investigated in this sense, in order to elucidate the roles that the different conditions play for GHG production and emission, once it is affected by several factors, such as the influent characteristics, reactor configurations, operational conditions and microbial community.

RESULTS AND CONCLUSIONS

The high-rate algal pounds system as post-treatment of up flow anaerobic sludge blanket reactors (UASB) can remove the remaining organic matter and nutrients, pathogenic microorganisms (ABD-ELMAKSOUD et al., 2021) and micropollutants (VASSALLE et al., 2020b). Therefore, the use of these systems together can be conceived from the perspective of sustainability and co-product recovery, while promoting sanitation (VASSALLE et al., 2020b).

However, the potential of these system generate GHG must be investigated. It is due nitrification process that occur in these systems and can generate N_2O. The anaerobically pretreated wastewater from UASB reactors contain reminiscent organic matter and dissolved methane (Carvalho, 2024). Thus, the investigation of high-rate algal pounds as its post treatment must include GHG dynamic. Once there is little information about GHG dynamic in high-rate algal pounds, it is important to stablish a relationship between factors that contribute GHG production and emission and to investigate if these conditions are observed in high-rate algal pounds. Additionally, it is important to propose the operational conditions that may prevent GHG generation.

According to Cakir & Stenstrom (2005), there is CH_4 remains retained in UASB effluent (as dissolved gas) that can be consumed in aerobic post-treatments through microbial metabolism. However, the dissolved methane can be stripping to atmosphere in several post treatment systems. Thus, it is important to control dissolved methane levels in UASB effluent.

There is poor information about CH_4 dynamic in high-rate algal pounds. However, it is known that these systems have high oxygen concentrations, which can favour reminiscent CH_4 by microbial metabolism (CAKIR & STENSTROM, 2005). Thus, in the presence of dissolved CH_4, operational conditions must to guarantee suitable oxygen levels in the system.

However, N_2O generation can be a challenge for these systems, once N_2O is produced mostly in nitrification process (TOOR et al., 2015), which is present in high-rate algal pounds. The N_2O emission increase due to factors such as acidic pH, presence of nitrite, high dissolved oxygen and low carbon/nitrogen ratio (TOOR et al., 2015, LEE et al, 2022).

Once the conditions for N_2O generation are frequently observed in high-rate algal pounds, it is important to know the save operational conditions for mitigation of GHG emission in high-rate algal pounds, in order to increase the advantages of these technology and help to achieve sustainability in wastewater treatment.

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