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ABSTRACT

MESOPHILIC AND THERMOPHILIC BIOFILTRATION OF N,N-DIMETHYLFORMAMIDE: LONG-TERM PERFORMANCE EVALUATION AND MICROBIAL COMMUNITIES' EVOLUTION

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N,N-Dimethylformamide (DMF) is an organic solvent produced in large quantities worldwide for the manufacture of synthetic fibers, and polyurethane leather, among others. It is considered as a hazardous air pollutant, therefore, the implementation of end-of-pipe technologies to control and reduce its emission and exposure is of paramount importance. As such, biofiltration is an effective and sustainable technique for the treatment of waste gas streams loaded with odours and Volatile Organic Compounds (VOCs). However, to the best of our knowledge, only a very limited number of studies (3) have been performed on the removal of gaseous DMF by biological technologies. Moreover, an in-depth study where intermediate products, microbial populations, and thermophilic conditions - as those present in practice - are evaluated, is missing.

In this presentation, we evaluate the removal of DMF under mesophilic and thermophilic conditions in a lab-scale biofilter packed with wood chips and compost. The performance of the biofilter was studied under varying inlet loads (ILs) and operational conditions (Empty Bed Residence Time (EBRT) and temperature) using Selected Ion Flow Tube Mass Spectrometry (SIFT-MS). Furthermore, microbial analysis data will be presented to (i) identify the species responsible for DMF removal and (ii) understand the impact of applying different ILs and temperatures on the evolution of microbial populations. Preliminary experimental results show that, at ambient temperature (~21 °C), the biofilter achieved removal efficiencies above 98% at ILs up to 297 ± 52 g DFM m^{-3} h^{-1} (EBRTs > 10.7 s). However, a decrease in EBRT (6.4 s) associated with an increase in IL (380 ± 129 g DFM m^{-3} h^{-1}) led to an unstable outlet stream and thus, to a drop in the biofilter performance. Moreover, an increase in temperature - from 21 to 65 °C - led to a decrease in removal efficiency.

The analysis of the biofilter leachate showed that ammonia was produced from DMF. Ammonia was then nitrified to nitrite and nitrate, the latter being the main - nitrogen -

compound accumulating in the leachate. Similarly, analysis of the outlet gas stream indicated that ammonia was the main metabolite when the performance of the biofilter dropped.

Overall, our experimental results indicate that biofiltration is a promising technique to remove DMF from waste gas streams. However, due to the interplay between operational conditions and biofilter performance, and the complexity of the biodegradation pathways of this compound, a mechanistic understanding is needed to exploit its potential and rapid implementation in full-scale installations.

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