7ª Jornada de Doctorandos

Comparative assessment of two biotrickling filters for siloxanes removal: effect of the addition of an organic phase

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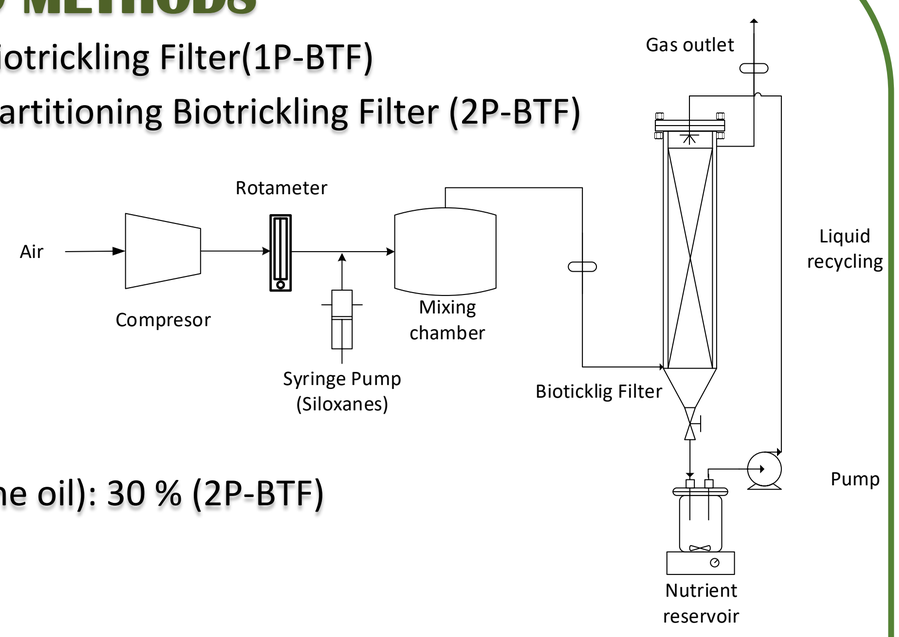
INTRODUCTION

Biogas produced at wastewater treatment plants and landfills contains trace levels of volatile methyl siloxanes (VMS) that are responsible for abrasion, corrosion and erosion of equipment during biogas storage and combustion. Therefore, the removal of siloxanes prior biogas usage is of utmost importance in any biogas-to-energy application. Biotechnologies have arisen as a cost-effective and environmentally friendly alternative to these physical-chemical processes. There are several studies focused on the implementation of biotechnologies for continuous VMS removal. For instance, Accettola et al (2008) and Popat and Deshusses (2008) operated aerobic biotrickling filters (BTF) inoculated with isolated D4-degrading bacteria. Overall, these investigations suggested that the main bottleneck during biological VMS removal is the low solubility of these compounds in the aqueous phase. In this context, the superior performance of two-phase partitioning bioreactors for the removal of hydrophobic volatile organic compounds has been consistently demonstrated during the past decade. This research comparatively evaluated the removal of the most common VMS (L2, L3, D4, and D5) under aerobic conditions in a conventional biotrickling filter (1P-BTF) and a two-phase partitioning BTF (2P-BTF) with silicone oil (at 30 %) as organic phase.

MATERIALS AND METHODS

Reactor 1: One Phase Biotrickling Filter(1P-BTF)

Reactor 2: Two-Phase Partitioning Biotrickling Filter (2P-BTF)



Operating parameters

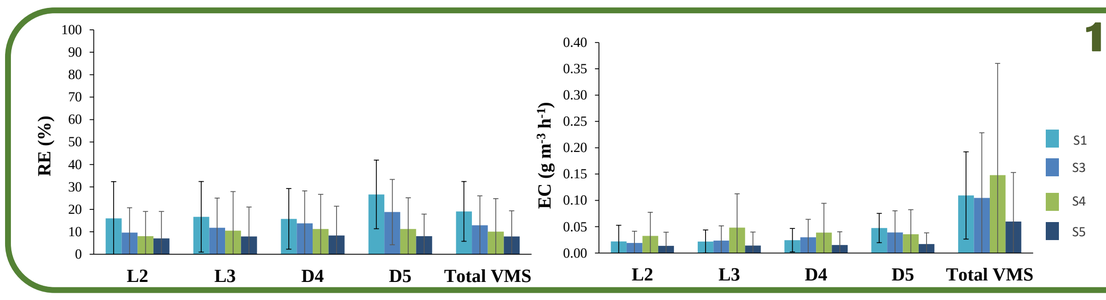
- Volume: 2 L
- EBRT: 1 h
- [VMS] ~ 650 mg m^{-3}
- Organic phase (silicone oil): 30 % (2P-BTF)

	Feed Stream	Time course (days)	VMS Concentration (mg m^{-3})
S1	VMS loaded air stream	0 - 46	515 ± 126
S2	VMS free air stream	47 - 76	-
S3	VMS loaded air stream	77 - 124	719 ± 203
S4	VMS loaded air stream	125 -137	1288 ± 217
S5	VMS loaded air stream	138 - 160	651 ± 127

	Feed Stream	Time course (days)	VMS Concentration (mg m^{-3})
S1	VMS loaded air stream	0 - 21	651 ± 181
S2	Clean air stream	22 - 70	-
S3	VMS loaded air stream	70 - 127	625 ± 137

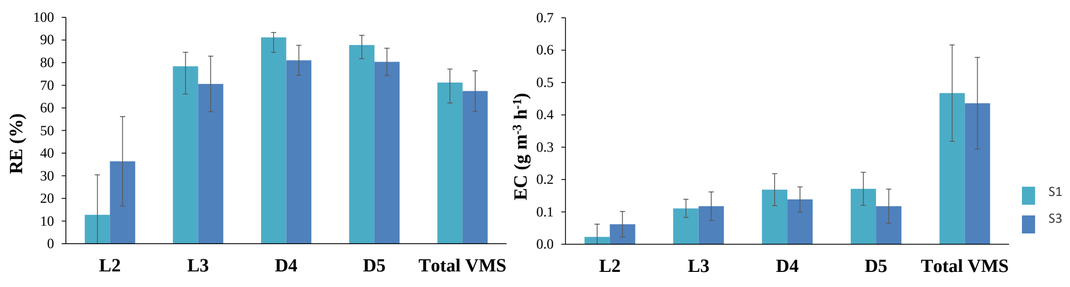
RESULTS

1P-BTF

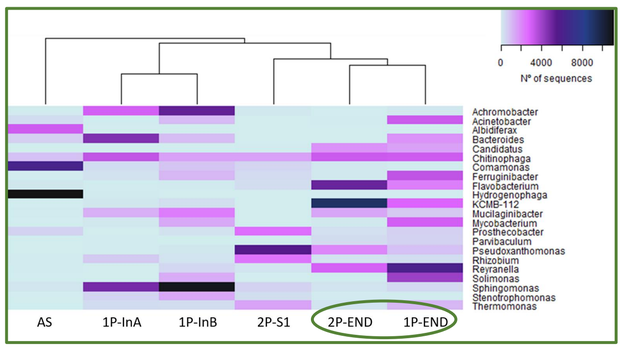


- Total VMS removal efficiency lower than 30 % for the different VMS.
- D5 reached the highest removal: RE of 26.6 ± 15.3 %, EC of 0.17 ± 0.05 g m^{-3} h^{-1}
- Increase in VMS inlet concentrations did not significantly affect VMS removal: RE:10.1 ± 14.7 %, EC to 0.16 ± 0.16 g m^{-3} h^{-1}

2P-BTF



- Total VMS RE of ~ 70 %
- The highest REs were obtained for D4 and D5:
  - D4 → RE: 91.1 ± 2.1 % ; EC: 0.17 ± 0.05 g m^{-3} h^{-1}
  - D5 → RE:87.8 ± 4.3 %, EC: 0.17 ± 0.05 g m^{-3} h^{-1}
- Slightly lower REs and ECs were obtained for L3:
  - L3 → RE: 78.4 ± 6.2; EC: 0.12 ± 0.04 g m^{-3} h^{-1}
- L2 abatement performance lower: REs ranging from 20 to 60 %, corresponding to ECs between 0.02 and 0.15 g m^{-3} h^{-1}.



A similar microbial community was found by the end of operation of both BTFs:

- *KMBC-112*
- *Reynarella*
- *Chitinophaga*

} 30 % of the total population

CONCLUSIONS

This study demonstrated the superior siloxanes abatement performance of a two-phase partitioning BTF compared to a conventional BTF. While the 1P-BTF achieved a total VMS removal lower than 30 %, this value increased up to ~ 70 % due to the addition of a non-aqueous phase (i.e. silicon oil), corresponding to an EC 5× higher than that of the 1P-BTF. This outstanding performance of the 2P-BTF was associated to the presence of silicone oil that boosted the mass transfer of VMS from the gas phase to the liquid phase. The lower removal of L2 was hindered by its higher vapor pressure compared to L3, D4 and D5, decreasing the solubility of this compound in the organic phase.

Acknowledgements

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