# Supplementary Materials

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## Contents:

This supplementary material provided additional information (**1 Figure, 1 Table**):

**Fig.S1** Elimination capacity as a function of $C_{ln}$ for $H_2S$ in Acid-BTF (a); MT in Neutral-BTF (b); DMS in Neutral-BTF (c); DMDS in Neutral-BTF (d).

**Table S1**. Biodegradation kinetics values determined from the Michaelis-Menten and Haldane models for $H_2S$ in Acid-BTF and VOSCs in Neutral-BTF.

## S1. Maximum elimination capacities of RSCs

To predict the performance of a BTF, much research has focused on modelling of correlations between substrate concentration and elimination capacity (EC) for a single compound, such as the Michaelis-Menten model as described in Equ.S1:

$$\mathrm{EC} = \frac{EC_{max} C_{ln}}{K_s + C_{ln}} \quad \text{(S1)}$$

Where, $EC_{max}$ refers to the maximal elimination capacity (g/m$^3$/h); $C_{ln}$ refers to the logarithmic average of inlet and outlet concentrations (g/m$^3$); and $K_s$ refers to the saturation constant (g/m$^3$).

In the case that biodegradation is inhibited by the substrate itself, the Haldane model is applicable as it includes an inhibition term, as described in Equ.S2:

$$\mathrm{EC} = \frac{EC^* C_{ln}}{K_S' + C_{ln} + (C_{ln}^2/K_I)} \quad \text{(S2)}$$

Where, $EC^*$ refers to the maximal elimination capacity in the absence of inhibition (g/m$^3$/h); $K_S'$ refers to the saturation constant (g/m$^3$); and $K_I$ refers to the inhibition constant (g/m$^3$).

In environments where oxygen was not the limiting factor for degradation (in the present study, where DO levels in the BTF system were always higher than 1.0 mg/L in the recirculation water), the $EC_{max}$ can be calculated based on Equ.S3 as reported by Sologar *et al.,* (Sologar et al., 2003):

$$EC_{max} = \frac{EC^*}{1 + 2\sqrt{(K_S'/K_I)}} \quad \text{(S3)}$$

Fig.S1 shows EC versus $C_{ln}$ for $H_2S$ in the acid-BTF system and the three VOSCs in the neutral-BTF system. Biodegradation kinetics values determined from the Michaelis–Menten and Haldane models are reported in Table S1. These two models were developed for a single compound on the condition that degradation was inhibited by the substrate itself. However, they can also be applied to an individual compound in a mixture, if the influence of other compounds in the mixture are negligible (Li et al., 2003). In this study, the degradation of $H_2S$ in acid-BTF was not affected by the

presence of VOSCs, while the degradation of MT in neutral-BTF was not affected by the small quantity of $H_2S$ that transfers from the acid-BTF (Fig.S1a). The degradation of DMS and DMDS were strongly inhibited by $H_2S$ and MT in the neutral-BTF as previously reported (Cáceres et al., 2012; Ramírez et al., 2011). It is of note, that this study did not focus on the interrelationships between the biodegradation of RSCs, so inhibitory effects were not considered when fitting the models but can be distinguished clearly in Fig.S1.

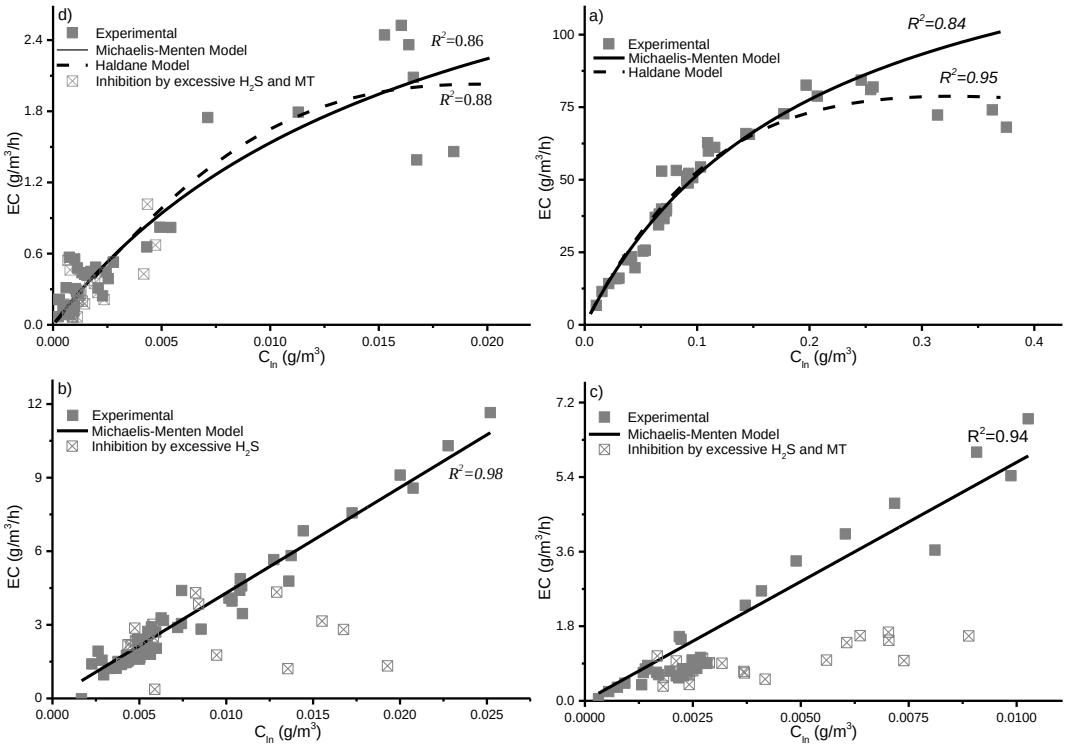


**Fig.S1** Elimination capacity as a function of $C_{ln}$ for $H_2S$ in Acid-BTF (a); MT in Neutral-BTF (b); DMS in Neutral-BTF (c); DMDS in Neutral-BTF (d).

As shown in Fig.S1a, the experimental EC for $H_2S$ in the acid-BTF was best fitted by the Haldane model ($r^2$=0.95). The experimental maximum EC value observed for $H_2S$ was 84.33 g/m$^3$/h, while the $EC_{max}$ estimated using the Haldane model (Table S1) was 78.76 mg/m$^3$/h, which was below the maximum EC observed in the absence of inhibition (EC*: 213.556 mg/m$^3$), showing that a significant inhibitory effect occurred. The results for MT (Fig.S1b) in the neutral-BTF show no flat region occurred at $C_{ln}$= 0.002~0.025 ($r^2$= 0.98), indicating the feasibility of load lifting. It is of note, that the degradation was strongly inhibited by $H_2S$, but could be recovered if the inlet $H_2S$

concentration was reduced. Similar results were observed for the degradation of DMS (Fig.S1c) in the neutral-BTF, with inhibition caused by $H_2S$, while MT showed no flat region at $C_{ln}$= 0.001~0.01 g/m$^3$ when the inhibitory effect was not taken into account. Therefore, the $EC_{max}$ for MT and DMS in the neutral-BTF were 11.65 and 6.80 g/m$^3$/h, respectively.

**Table S1.** Biodegradation kinetics values determined from the Michaelis-Menten and Haldane models for $H_2S$ in Acid-BTF and VOSCs in Neutral-BTF.

| | $H_2S$ in Acid-BTF | MT in Neutral-BTF | DMS in Neutral-BTF | DMDS in Neutral-BTF |
|---|---|---|---|---|
| Experimental EC | $EC_{max}$ =84.33 g/m$^3$/h | $EC_{max}$ =11.65 g/m$^3$/h | $EC_{max}$ =6.80 g/m$^3$/h | $EC_{max}$ =2.44 g/m$^3$/h |
| Michaelis-Menten model | $EC_{max}$ =156.479 g/m$^3$/h<br>$K_s$ =0.203 g/m$^3$ | $EC_{max}$ =429.9 $C_{ln}$ | $EC_{max}$ =575.7$C_{ln}$ | $EC_{max}$ =4.17 g/m$^3$/h<br>$K_s$ = 0.017 g/m$^3$ |
| Haldane model | $EC^*$ =213.556 g/m$^3$/h<br>$K_s$'=0.279 g/m$^3$<br>$K_I$ =0.381 g/m$^3$<br>$EC_{max}$ =78.76 g/m$^3$/h | - | - | $EC^*$ = 98.384 g/m$^3$/h<br>$K_s$'=0.465 g/m$^3$<br>$K_I$ =8.25*10$^{-4}$ g/m$^3$<br>$EC_{max}$ =2.03 g/m$^3$/h |

The experimental ECs for DMDS in the neutral-BTF did not fit well to either the Michaelis-Menten nor Haldane models ($r^2$=0.86 and 0.88, respectively) (Fig.S1d). This shows that degradation was not affected by excessive $H_2S$ and MT but was inhibited at high concentrations of DMDS itself, which has not been reported in previous studies. Chen *et al.,* (Chen et al., 2016) reported a DMDS-degrading BTF system that achieved stable removal (>95%) when the inlet concentration was maintained at ~410 mg/m$^3$ and the EBRT was 123s, without any inhibition observed due to the substrate itself. Interestingly, in the study by Chen *et al.,* (2016) the performance of degrading

bacterium was susceptible to DMDS concentrations during the start-up period (1 ~ 20 day) and showed fluctuations. This result is similar to the fluctuated removal efficiency of DMDS observed in the present study throughout the 73-day operational period (Fig.2a). This effect may be partly attributed to the incomplete acclimation of DMDS-degrading bacteria, due to the low inlet DMDS concentration in the WWTP off-gas (an average of 2.7±2.6 mg/m$^3$) without adjustment using cylinder gas. Considering that the maximum experimental EC was 2.44 g/m$^3$/h, the $EC_{max}$ was determined to be 2.03 g/m$^3$/h using the Haldane model, which was lower than the values reported in some previous studies (Arellano-García et al., 2012; Devai and DeLaune, 1999; Ramírez, 2011; Wan et al., 2011), ranging from 13 to 53 g/m$^3$/h.

Along with the degradation of MT and DMS, the $EC_{max}$ of the three VOSCs in the neutral-BTF were equal to or slightly lower than the values reported in previous studies on two-BTF systems, listed in Table 5. According to previous studies on the emission characteristic of other WWTPs (Table 1), concentrations of MT, DMS and DMDS range from 0.003 to 288, 0.021 to 41.26 and 0 to 0.81 mg/m$^3$, respectively. High concentrations of VOSCs are not discussed in this study, while Fig.S1 shows the feasibility of load lifting for this system.

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