Impacts of Trade Wastes: Brewery Wastewater

1 Methodology

A laboratory set-up consisting of two airtight reactors: experimental (R1) and control (R2) was used for the study. The control reactor was intermittently fed with sewage while the experimental reactor was dosed with a mixture of brewery and domestic wastewater at two different proportions (10 and 25% v/v). Each reactor system was exposed to 4 pump events per day with a hydraulic retention time (HRT) of 6 hours. To mimic the real condition of a rising main, the reactors were kept under quiescent conditions except during pumping events. Raw sewage was collected from a nearby pumping station, while the brewery wastewater was collected from the Yatala Brewery Industry. The reactors were operated for several months to establish pseudo steady-state conditions and to develop mature anaerobic biofilm on the walls of the reactor and the carriers.

The study was divided into two parts: short and long-term dosing studies. In the short-term dosing study, several batch tests were performed on a sewer reactor that has never been exposed to brewery wastewater. In this study, brewery wastewater concentration of 0 to 100% v/v was used while pH was maintained at a constant level. The long-term exposition tests were carried out to the experimental reactor that has been adapted to the brewery wastewater with two different mixing ratios of 10 and 25% v/v. However, in the long-term study the pH of the system was not controlled.

2 Results

In the short-term test, different proportions (0, 5, 10, 15, 20, 25, 50, and 100%) of brewery wastewater were added into the sewer reactor separately. This was done to have different VFA levels in the system (ranging between 130 and 290 mg COD/L). During the test, pH was initially set up at pH 7 ± 0.2. The results of the short-term study are presented in Figure 1.

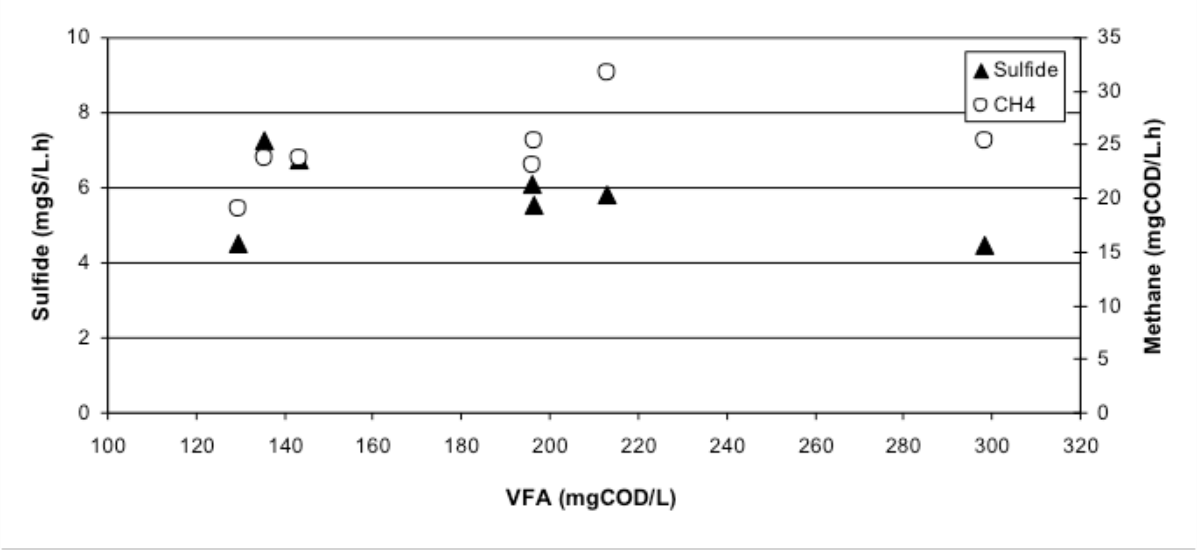

Figure 1: Sulfide and methane production rates during short-term exposition tests

Overall, the addition of brewery wastewater resulted in a higher sulfide production rate compared to the one that did not receive brewery wastewater (control). Since the pH was not the inhibiting factor for SRBs in this case, higher fermentable COD in the system, as the impact of brewery wastewater dosing, has increased the activity of SRBs thereby increasing the sulfide generation rate. However, the general result shows a decreasing trend of the sulfide production rate with further increase in VFA levels. This indicates some inhibiting effects of high VFA. The tests also indicated higher production rates of methane in reactors that were dosed with the brewery wastewater. Availability of fermentable COD at a higher concentration seems to have resulted in a higher methane production rate. However, the production of methane was not inhibited by higher VFA concentration as observed in the case of sulfide generation. Spatial distribution of the SRBs and methanogens (SRB developing near the biofilm surface and methanogens developing in layers deeper in the biofilm) might have resulted in this difference, as the methanogens are not directly exposed to higher VFA concentration as the SBRs.

Results from the long-term exposition tests are shown in Figure 2 (sulfide) and Figure 3 (methane). Both the figures can be divided into three different periods: Period 1 - baseline study (23rd May-12th Nov 2008), where experimental and control reactors were operated with domestic wastewater; Period 2 - continuous dosing of brewery wastewater at 10% v/v into the experimental reactor (10^{th}Dec 2008-24^{th}Feb 2009); and Period 3 - continuous addition of brewery wastewater at 25% v/v to the experimental reactor (10^{th} March-29^{th}April 2009). By adding brewery wastewater continuously into the system at 10% v/v, the pH of the sewer system dropped down to 6.6 $\pm$ 0.2 with VFA levels of 144.6 $\pm$ 63.5. Under steady state conditions, the sulfide and methane production rates increased up to 40% and 30%, respectively. The lower pH initially resulted in a lower sulfide production rate, but this recovered as the dosing continued. This could be related to the microbial shock load when the new pH level was introduced. However, the microbial community seems to adapt well to the changed pH after 4 weeks of continuous exposition. It is worth mentioning here that the pH varied from 6.6 to about 5.7 during a pumping cycle. This was direct impact of fermentation occurring in the system.

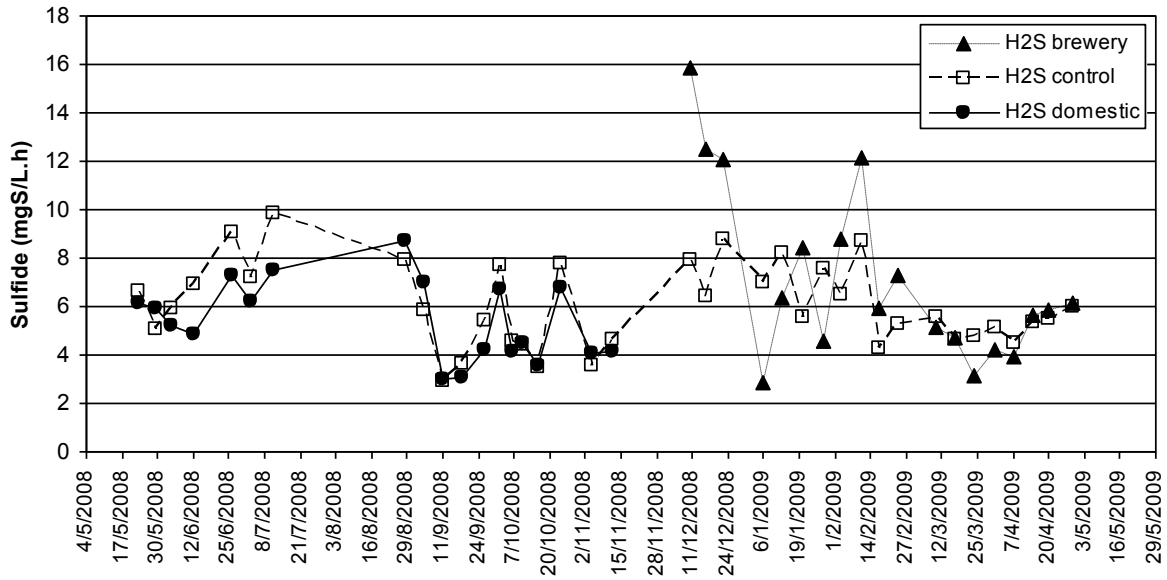

Figure 2: Sulfide production rates during the long-term exposition tests

By increasing the proportion of brewery wastewater to 25% v/v, pH in the reactor was further reduced to 6.2$\pm$0.3 with a VFA level of 212.0$\pm$34.0. The sulfide generation rates under steady state conditions

were reduced by 10% as compared to the reference reactor, but the methane generation rate increased by up to 30%. The lower pH seems to reduce the SRB activity in this case. However, the methane production rate was high even at a lower pH. Higher VFA level in the reactor seems to increase the methane production as more VFA is available for methanogenesis. Also, higher COD due to the increase of brewery wastewater proportion results in higher level of fermentation products including hydrogen, which also increases the methanogenic activity. However, in the case of SRB, the impacts of pH seem to have more influence than the increase in VFA as seen by a lower sulfide production rate.

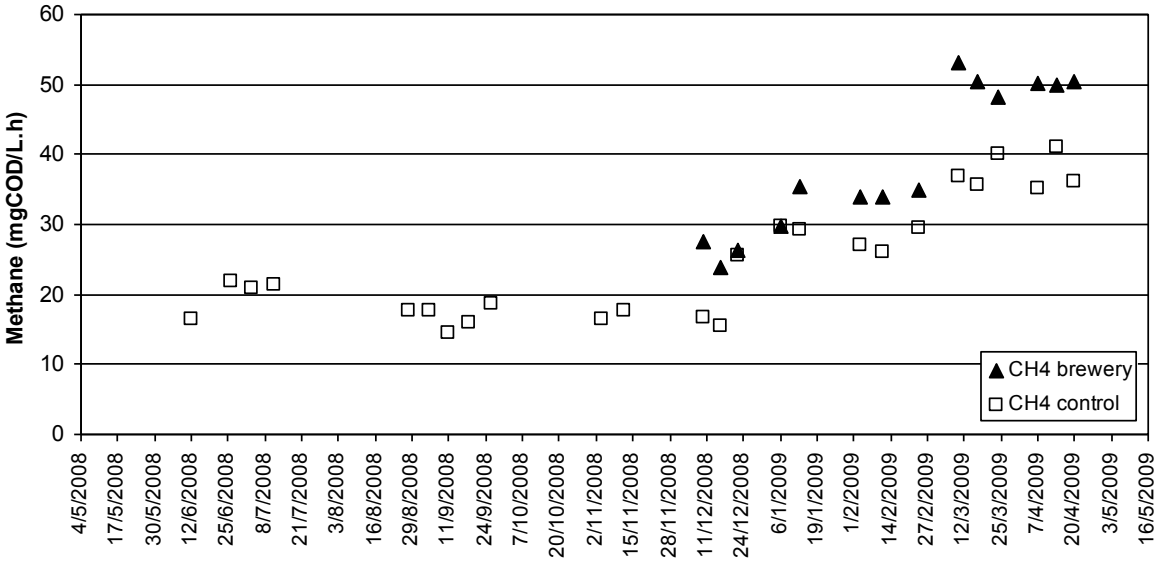

Figure 3: Methane production rates during the long-term exposition tests

3 Conclusions

The addition of brewery wastewater affects both sulfide and methane production in sewers. The introduction of brewery wastewater has two impacts: decrease of pH; and increase in VFA levels. Both of these changes are expected to influence the microbial activity in the system. In the short-term exposition test, introduction of brewery wastewater increased the rates of sulfide and methane production at a constant pH. The sulfide production rate decreased with increased proportion of brewery wastewater, while the methane generation rate increased. In the long-term exposition test with 10% brewery wastewater, higher sulfide and methane production rates as compared to the reference system were observed. When the proportion of brewery wastewater was further increased to 25%, the sulfide generation rate decreased, but opposite was the case with methane production.

Further information can be obtained as follows:

- Paper: A laboratory assessment of the impact of brewery wastewater discharge on sulfide and methane production in a sewer by Sudarjanto et al. (2011)
