Influence of Lipid Acclimatization on the Oleic Acid Toxicity towards Methanogenic Acetoclastic Bacteria

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The acetoclastic bacteria are probably the weakest link in the overall anaerobic digestion chain[1]. Long chain fatty acids (LCFA) are one of the most important inhibitors of the anaerobic consortium and toxic effect is dependent on the temperature, sludge structure (granular or dispersed), presence of calcium or magnesium saltz. Sludge origin is considered to be unrelevant[2]. It is suggested that LCFA exert a bactericidal effect on methanogenic bacteria[3]. From the existing literature acetoclastic bacteria do not adapt to LCFA neither upon repeated exposure to toxic concentrations, nor after prolonged exposure to non-toxic concentrations. However, most of the results were obtained in batch tests which does not take into account the real operating times in anaerobic digestion. In this work, the resistance to oleic acid toxicity and the its biodegradation capacity was followed during a long term operation in a fixed bed reactor. Two bioreactors (RI and RII) were running in parallel for 426 days. In a first period RI received a lipidic substrate (whole milk based) and RII received a non fat substrate (skim milk based). Following this period both digesters received the same substrate which was initially composed f skim milk and oleic acid (Period II) and after by oleic acid as the sole carbon source (period III). The effect of feeding increasing lipid concentrations on biomass resistance after changing the feed to oleic acid was evaluated. It was observed that biomass from RII developed a higher resistance during the period I, but, after changing the feeding to be composed of skim milk and oleic acid, the biomass from RI which had been fed with lipids, exibited an higher tolerance to oleic acid toxicity. This suggests that the acclimatization with lipids is beneficial to treat LCFA based wastewaters. However, when oleate was the sole carbon source fed (Period III), both sludges lost their potential resistence. In this final period the biomass was found to be encapsulated with oleate, which was evidenced by the extremely high values of the background methane production in batch assays without any added substrate and after successive washings with an anaerobic buffer. Furthermore the degradation rates of this background substrate (probably adsorbed oleate) was higher than the maximum achieved oleate degradation rate measured by biodegradability tests (105.4±0.9 versus 86.3±4.6 mg COD-CH_4/gVS.day), indicating that adsorbed oleate can be more easily degraded than added oleate. It was also observed that added oleate retarded the degradation of adsorbed oleate.

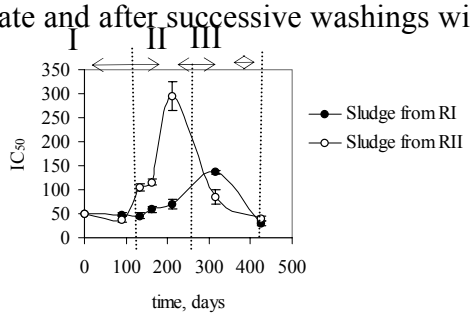

Figure 1 - Toxicity limit along the operation period

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