Bioenergy: Challenges and Opportunities
International Conference and Exhibition on Bioenergy
April 6th – 9th 2008
Universidade do Minho, Guimarães, Portugal

DEVELOPMENT OF A NOVEL REACTOR FOR HIGH-RATE ANAEROBIC TREATMENT OF LCFA CONTAINING WASTEWATER

M.A. Picavet, A.J. Cavaleiro, M.M. Alves
* IBB – Institute for Biotechnology and Bioengineering, Centre of Biological Engineering, University of Minho, Braga, Portugal

Keywords: LCFA; Reactor; Biogas

High-rate anaerobic technology is an accepted technology for industrial wastewater treatment. More than 2,000 full-scale installations are running worldwide (Van Lier, 2007) and mainly treat wastewaters containing readily degradable organic pollutants such as volatile fatty acids and carbohydrates. Lipids do not belong to this group, since their hydrolysis results in the production of long chain fatty acids (LCFA). Until recently these were considered toxic to anaerobic bacteria and a nuisance because they induce floatation of biomass (Hwu, 1997). Since the success of conventional anaerobic treatment systems is based on optimisation of biomass sedimentation, floatation leads to washout and subsequent process disruption. Therefore, lipids are normally removed from wastewater prior to anaerobic treatment using *e.g.* dissolved air floatation.

Pereira *et al.* (2002) showed that lipids are not toxic and can be converted to biogas. As to prevent washout induced by LCFA adsorption, a sequential process including at least a feeding and reaction phase was proposed as the preferred technology for anaerobic LCFA removal from wastewater (Pereira *et al.*, 2005). It was further postulated that the specific contact area between bacteria and LCFA should be maximised as to maximise LCFA adsorption and minimise mass transfer limitations. The sequential process was applied at lab scale by Cavaleiro *et al.* (2007). Volumetric loading rates up to 20 kg COD/m^3/day were achieved on lab scale with 80% conversion to methane. Furthermore, the feeding phase could be prolonged with every cycle, showing that a continuous process for LCFA treatment should be possible. This resulted in a novel patented reactor concept (Alves *et al.*, 2007) which is currently being tested in our lab and will go to pilot scale at the end of 2007.

From the current problems encountered at industrial scale with LCFA and the research results from Pereira *et al.* (2002-2005) two main principles may be postulated for the design of a reactor capable of high-rate anaerobic treatment of LCFA containing wastewater. These form the base of the proposed reactor concept:

1. Maximise the contact area between biomass and LCFA as to optimize LCFA adsorption, since LCFA adsorption forms the first step in effective LCFA conversion to biogas.
2. Use floatation as the primary biomass retention technique, since LCFA induced floatation is currently the main reason why LCFA are removed prior to anaerobic treatment.

These two principles imply that conventional primary biomass retention techniques such as granulation or biomass fixation cannot be applied. However, a settling step is still needed, because sludge settles well again after effective LCFA conversion. This settled sludge can subsequently be intimately contacted with LCFA containing wastewater as to maximise adsorption. Thus, a sludge recycle loop should be present over the reactor. This loop could further provide the mild shear stress needed to maximise the sludge surface area. Additionally, it provides the means to control mixing intensity inside the reactor and limit possible mass transfer limitations even further. Summarising, an effective reactor would need to provide the following:

1. Primary biomass retention through floatation.
2. Secondary biomass retention through settling.
3. Contact area maximisation using mild shear stress.
4. Mass transfer maximisation by adequately controlling mixing intensity.

5. LCFA adsorption induction through intimate contact between influent and recycles settled sludge.

Figure 1 shows a schematical representation of the reactor concept.

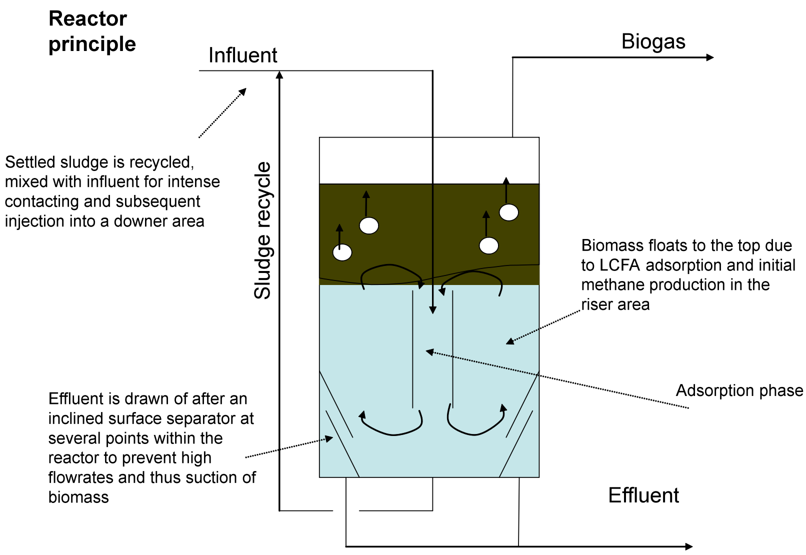

Fig. 1- Reactor concept.

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