The hybrid anaerobic baffled reactor: an appropriate technology for wastewater treatment

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Context

Considering climate changes, the scarcity of resources and the increase of world energy demand, Europe promotes the development of innovative wastewater treatment concepts from the lab to the market. In particular, one challenge is to recover efficiently energy from wastewaters. In Europe, more than 99% of 286 000 food and drink companies are SMEs. Current anaerobic technologies available in the market are well established but they are extremely expensive for SMEs.

The focus of this research is to develop a simple, robust and low cost wastewater treatment technology specifically designed to treat liquid effluents from agro-food SMEs. The technological scheme is based on a modified anaerobic baffled reactor. The modifications were realized in order to enhance biological performances while the reactor remains simple and easy to operate. The main objective is to design an efficient reactor with a high sludge retention time with very little loss of slow-growing microorganisms from the reactor while providing a good mixing to ensure a high rate of contact between the bacteria and their substrate.

Material & Methods

Figure 1 - 400 L pilot reactor: (a) Schematic layout of the pilot hybrid anaerobic baffled reactor (HABR). This HABR consists of alternating hanging and standing baffles, which compartmentalize the reactor, and that force the wastewater flow up and down from one compartment to the next. To maintain the reactor well mixed and promoting the formation of anaerobic granular sludge, the second compartment was equipped with a perforated plate. The last compartment is a clarifier which allows the solid-liquid separation. (b) Velocity (m/s) of wastewater passing through perforated plates and around baffles. (c) Construction of the pilot with acrylic plastic.

Performance efficiency

Figure 2: (a) Performance efficiency against various loading rates (from the start-up to the steady-state) (b) COD profiles at the inlet and outlet of the HABR.

Conclusions

- **Performance**: long-term operation (200 days) of the HABR - described in this study - indicated that the reactor configuration can be exploited for treatment of high strength industrial wastewater such as dairy wastewater at low HRT (10 hours) with an average effluent COD concentration of 1.05 g O₂/L. The HABR can be designed with an OLR of 15 kg COD/m².d at 36°C, with the possibility of absorbing peaks up to 20 kg COD/m².d.
- **Biomass characteristics**: long biomass retention times are possible without anaerobic granular sludge thanks to transformations of the fourth compartment into UAFB.
- **Investment costs**: considering that some of SMEs require an installation able to treat between 300 to 1500 kg of COD per day, the investment costs for a global turnkey solution (including buffering tanks, screening chambers, the HABR technology and the valorization of biogas) were estimated to be in the range of 200 € to 650 € per kg of COD planned to be treated. The first full-scale reactor is expected to enter the commissioning stage before the end of 2016.