DEVELOPMENT OF A NOVEL CONCEPT FOR INTEGRATED MANAGEMENT OF MUNICIPAL WASTEWATER AND BIOWASTE

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1. Keywords

Municipal wastewater, biowaste, condensate, anaerobic digestion, Periodic Anaerobic Baffled Reactor (PABR)

2. Highlights

- Revolutionize the field of waste and wastewater management
- Develop an innovative approach in the field of municipal waste and wastewater management
- Co-manage the liquid fraction of the Fermentable Municipal Solid Waste (condensate) and the Municipal Wastewater streams
- PABR is a high-rate bioreactor, designed to operate under high organic loadings in low HRTs

3. Purpose

Historically, the management of municipal solid waste and that of wastewater have evolved in two independent streams, defined by the main phase in each case: solid and liquid, respectively. Currently, the benchmark approach to municipal wastewater management consists of sewer collection, treatment in a facility aiming at removal of suspended solids through primary sedimentation, biological oxidation of organic matter, biological nutrient (N and P) removal and disposal of the clarified effluent following disinfection by chlorination. The process generates a mixture of primary and excess secondary sludge which are typically mixed, stabilized by anaerobic digestion and dewatered before disposal [1,2].

Concerning solid waste management, for many years, the fermentable organic matter, mostly food waste, is collected usually mixed with recyclables in a commingled bin and then led to the landfill. Separate collection of food waste at the source allows for (a) high quality food waste that can be valorized and (b) cleaner recyclables [3].

The purpose of present work is to develop an innovative approach in the field of municipal waste and wastewater management. More specifically, focuses on the Fermentable Municipal Solid Waste (FMSW) and the Municipal Wastewater (MWW) streams. These two streams are currently being treated as separate waste streams; FMSW is collected as part of the mixed solid waste and

landfilled and MWW is led to a wastewater treatment facility through the sewer. We hereby propose to explore an alternative that is much more meaningful and sustainable: To co-manage the liquid fraction of the Fermentable Municipal Solid Waste (condensate) and the Municipal Wastewater streams. We have recently developed a method to separate the solid and the liquid fraction of the Fermentable Municipal Solid Waste (drying and shredding process) and we aim to build upon this experience to develop an innovative and sustainable treatment framework that can revolutionize the field of waste and wastewater management [4].

4. Materials and methods

Periodic Anaerobic Buffled Reactor (PABR) is an attractive process for municipal sewage because of its low construction, operation and maintenance costs, low excess sludge production, and high capacity for biogas production at a small retention time. The PABR is a novel bioreactor, designed to operate at high organic loading rates [5, 6, 7].

We evaluated anaerobic digestion potential of the condensate/wastewater mixture by using a pilot-scale, high-rate innovative bioreactor, Periodic Anaerobic Baffled Reactor (PABR) with an operating volume 77L. Biogas productivity, methane content, pH, alkalinity, sCOD, tCOD, TSS, VSS and VFAs were measured routinely.

We developed also an activated sludge system for the treatment of the effluent of the PABR digester. The specific system was a 15L sequencing batch reactor (SBR) as it is most suitable for activated sludge experimentation at small (lab) scale. The SBR operation secure both COD and (N) removal. During the experiments sCOD, tCOD, total nitrogen (TN), alkalinity, TSS and VSS were measured regularly both in the feed and the effluent of the SBR.

5. Results and discussion

The PABR exhibited great stability in the effluent with a mean sCOD removal rate was 77%. The VSS remained below 520mg/L and TSS 610mg/L respectively. The mean biogas productivity was 51mg/L and the mean methane composition of the biogas was 66%.

For SBR it is also worth mentioning that the pH levels in the effluent remain stable and close to 8 (range between 7.7-8.3 - basic conditions), while the total alkalinity was around 1100mg$_{CaCO3}$/L. The sCOD of the effluent remained in low range 106mg/L. SBR showed satisfactory behavior in removing organic loading below the environmental discharge limit of 120mg/L. Total nitrogen was 12.4mg/L as well as the TS and VSS were 0.25 mg/L and 0.19mg/L respectively.

6. Conclusions and perspectives

Overall, PABR proves to be an innovative high-rate anaerobic digestion system capable of anaerobically processing high organic-loaded feedstocks under low HRTs. It seemed that PABR can efficiently operate under HRTs as low as 4 days. Specifically, biogas production observed when the basic operational parameters were HRT 4 d and OLR 0.94g$_{COD}$/L*d. Biogas production reached 51L/d.

The sCOD effluent in SBR remained in low range 106mg/L, while the TS and VSS remained in low levels 0.25 mg/L and 0.19mg/L respectively.

The work relies on developing a framework in which the liquid fraction (condensate) of the municipal fermentable household waste will be combined and co-managed with either the municipal wastewater in a common collection sewer system or will be transported and mixed with the excess sludge generated in conventional treatment plants, enhancing the generation of biogas.

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