ANAEROBIC FERMENTATION OF FOOD WASTE: COMPARISON OF TWO BIOREACTOR SYSTEMS

V. Kastner, W. Schnitzhofer
PROFACTOR GmbH, Department of Innovative Energy Systems

Introduction

The primary aim of this project is an efficient utilization of waste from food industry, which can be realized by anaerobic fermentation. These organic residues are strongly varying mixtures of different kinds of waste tending to cause process failures.

Depending on the main component of the produced biogas the anaerobic process can be designed as a single stage fermentation to achieve mainly methane or as a two stage fermentation to obtain hydrogen and methane.

In this study the single step fermentation was investigated comparing two different types of bioreactor systems: On the one hand the biogas production was performed in a conventional Continuous Stirred Tank Reactor (CSTR), which served as a reference for the second system, and on the other hand, the fermentation was carried out in a Fluidized Bed Reactor (FBR).

Systems like the FBR are characterized by a higher stability of the process as well as higher biogas yields and productivities, due to retaining biomass. Besides the mentioned advantages of the FBR, this system is expected to stand significantly higher organic loads compared to the CSTR.

Methods

The substrate used for the fermentations was derived from the biogas plant of Zellinger GmbH in Upper Austria and consisted of fruits and vegetables, vegetable and animal feedstuff, leftovers, biological residues, waste from industrial kitchen, manure, content of fat separator, waste from dairies as well as blood. The fermentation temperature was set to 40 °C.

The experiments in both reactors were conducted in a continuous mode with increasing organic loads. The process was monitored by measuring gas volume and gas composition (GC), pH, redox potential, dry matter, organic dry matter according to standard methods, as well as volatile fatty acids (HPLC).

The bioreactors were designed and constructed based on the schemes displayed in Fig. 1.

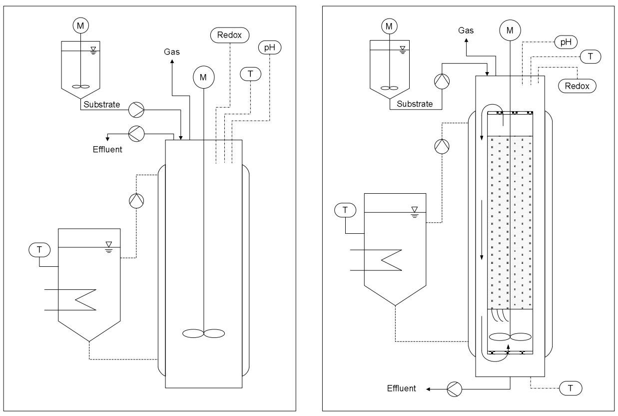

Figure 1: Scheme of CSTR system (left) and FBR system (right)

Results

Comparing the biogas yields (Fig. 2a) at increasing organic loads, for the fermentation in the CSTR system high levels were obtained with simultaneous remarkable fluctuations from 520 to 900 NL/kg organic dry matter (oDM), whereas yields of the FBR fermentation were steadily increasing (350 – 700 NL/kg oDM). The varying values for CSTR yields were most probably devoted to numerous influences: substrate change and partial overload (between 2.3 and 5 g/(L*d)) led to lower yields. This fact caused periods with moderately increased organic loadings (5 – 7.3 g/(L*d)) and resulted in high yields, leaving sufficient time for adaption. The increasing figures for FBR yields could be attributed to slowly developing biofilm.

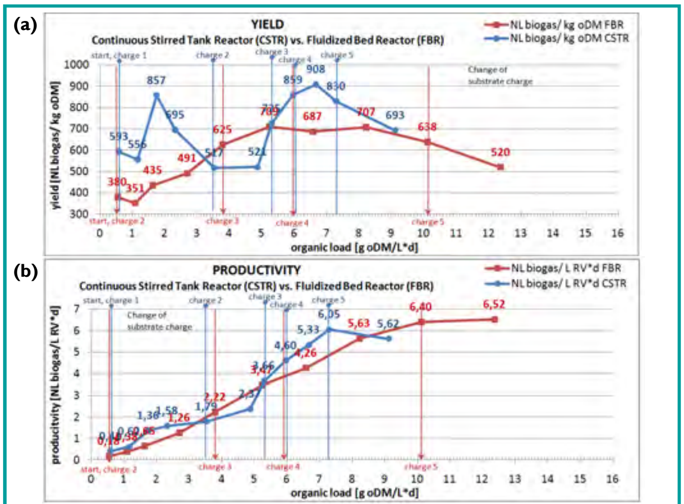

Figure 2: Compared biogas yields (a) and productivities (b) of food waste fermentations in CSTR and FBR, average of organic load levels, vertical lines indicate changes of substrate charge (blue for CSTR, red for FBR)

Biogas productivity did rise with increasing organic load in general (Fig. 2b). The CSTR fermentation run exhibited a maximal productivity of 6.0 NL/(L*d) at 7.3 g/(L*d) to slightly decrease at higher organic loads. The maximal productivity found for the FBR fermentation was 6.5 NL/(L*d) at a organic load of 12.4 g/(L*d).

Conclusion

Efficient biogas production from food waste using different bioreactor systems was successfully demonstrated.

- FBR: Highly stable operation at high organic loads was proven.
- CSTR: Considerable good performance at elevated, but limited organic loads was found.

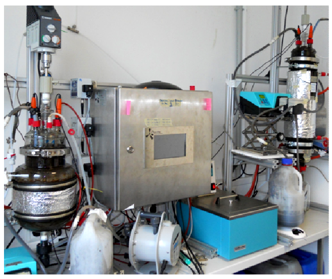

Figure 3: Experimental set-up

PROFACTOR GmbH
Im Stadtgut A2
A-4407 Steyr-Gleink

Verena Kastner
Tel +43(0)7252/885-403
Fax +43(0)7252/885-101
verena.kastner@profactor.at
www.profactor.at

The described experiments were performed in the context of the project „REWEFERM“, which is funded by the Austrian Research Promotion Agency (FFG) within the category „Basisprogramm“.

Cooperation partners are: Komptech and Technisches Büro Dr. Walter Somitsch