

BIOMETHANIZATION OF “ALPERUJO” (TWO PHASE OLIVE MILL WASTE) WITH CATTLE MANURE: INOCULUM ADAPTATION

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ABSTRACT

In this study, the starting up procedure of anaerobic reactors for two phase olive mill waste (2POMW) and cattle manure (CM) co-digestion at mesophilic temperature (35°C) was carried out. The mixed waste (2POMW and CM; 60:40 w/w) with an optimal C/N (25), and as inoculum, the waste water treatment plant digester in the 20% of total reactor volume, was introduced in a stirred tank reactor (4L). This reactor was operated in batch with a total solid content of 10%. Due to the non-existence of an available adapted inoculum, the reactor was re-inoculated with mesophilic effluent of a reactor of pulp beet in order to eliminate de propionic acid accumulated. After three months, with increase in the production of biogas, accompanied by a progressive decline in parameters such as total acidity and propionic acid concentration, indicates the start up of the reactor.

For evaluate the process evolution, biogas production and composition, chemical oxygen demand, pH, dissolved organic carbon and volatile fatty acid were measured periodically. In the next stage, begins a stepped reduction of the HRT in a continuous operation feeding the reactor with the same mixture of both wastes (60/40, w/w). The final objective this study is the optimization of biogas generation.

RESULTS AND DISCUSSION

Initially the experimental reactor was operating in batch, using a mixed waste of 2POMW and CM (60:40 w/w) at mesophilic temperature (35°C). This mixture was selected in based the optimal relation C/N 25 (Flotats & Sarquella, 2008). The initial inoculum was mesophilic sewage sludge. After a week, the reactor was re-inoculated with mesophilic effluent of a reactor of pulp beet between days 8, 55, 60 and 69, in order to obtain populations of microorganisms adapted to the waste mixture. The pH reactor was maintained around 8.

After two weeks, there is a production of methane (Figure 2) accompanied by consumption of volatile fatty acids accumulated (Figure 3), mainly acetic and butyric acids. Propionic acid values remained constant during this first stage of the start up. The accumulation of propionic acid causes long-term inhibition of methanogenic bacteria (Wang et al., 2009), and to avoid this, was used inoculum from a pulp beet reactor adapted to remove this acid.

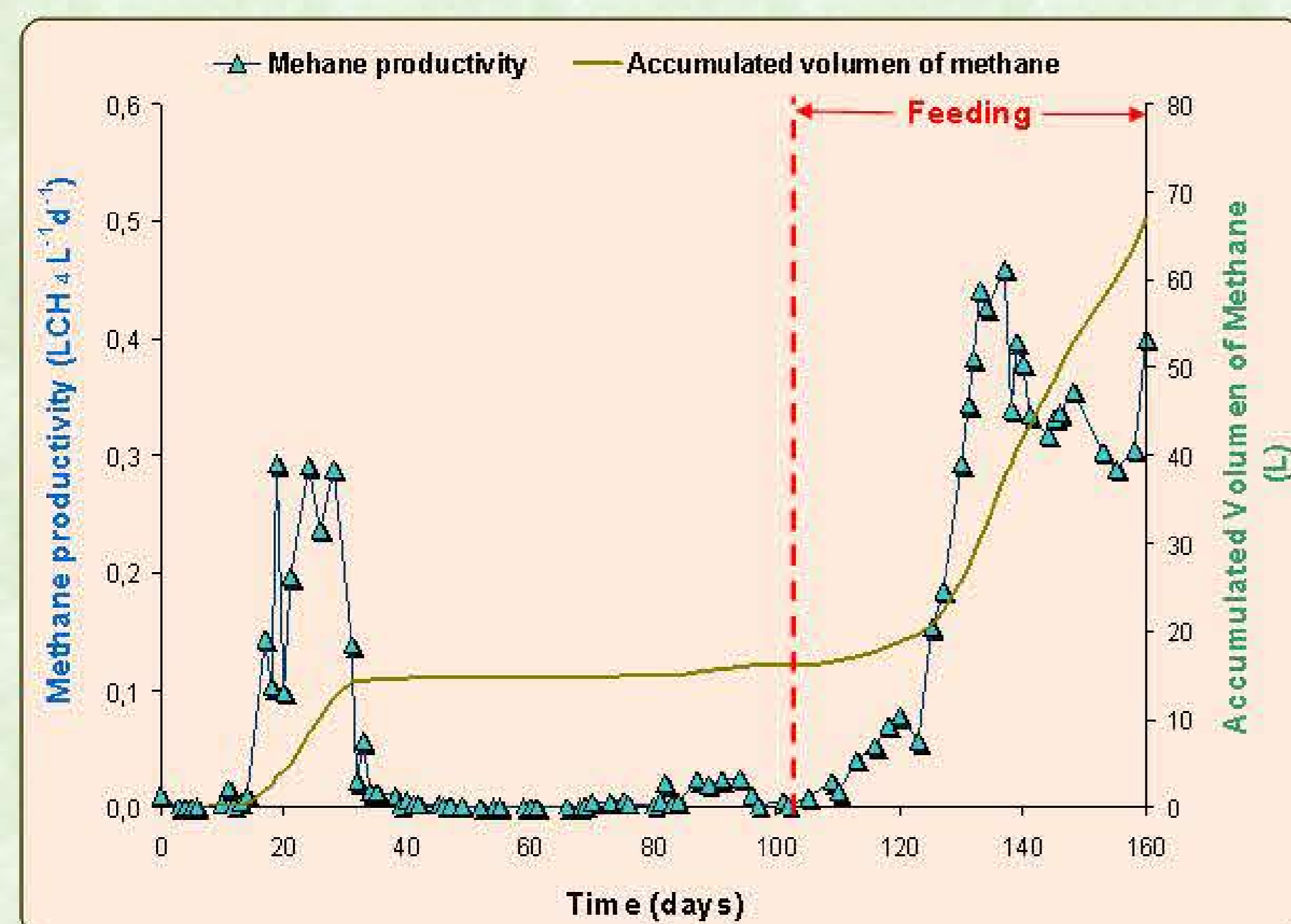


Figure 2. Evolution of methane productivity ($\text{LCH}_4 \cdot \text{L}^{-1} \cdot \text{d}^{-1}$) volume of methane (L).

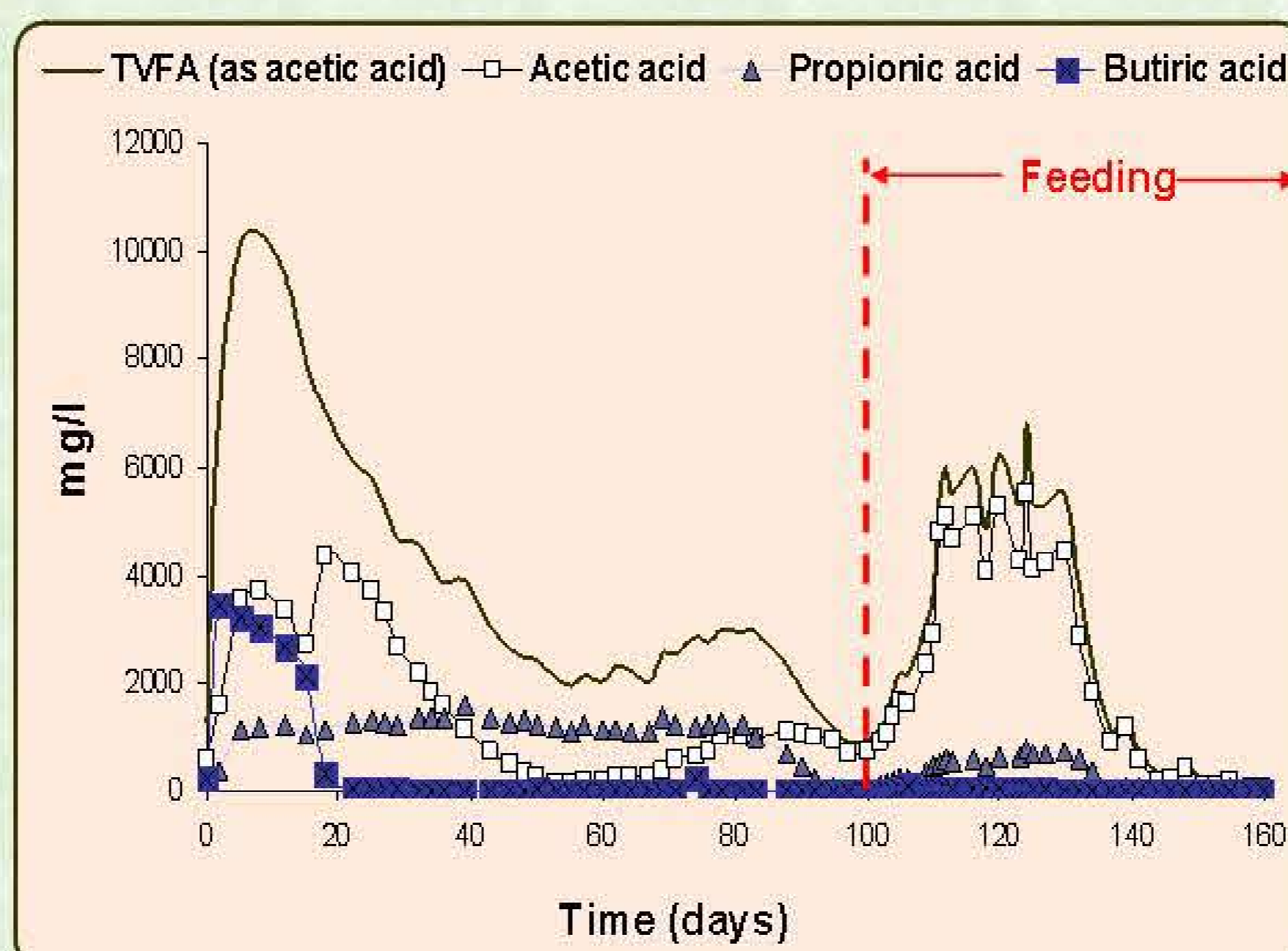


Figure 3. Evolution of TVFA and individual acids and accumulated (mg/l).

CONCLUSIONS

Due to the complexity of the wastes and the need of an adapted inoculum, the startup time and stabilization of the anaerobic reactor is lengthy compared to other complex waste, reaching to 97 days. To ensure the stabilization of the process is necessary a sufficient degradation of the accumulated volatile fatty acids, in particular propionic acid, preventing the inhibition of methanogenic bacterial populations.

The use of a mixture 60:40 w/w of 2POMW and CM wastes in the co-digestion process is adequate as shown the stable operation in the stepped reduction of the HRT in a continuous operation feeding of the reactor.

METHODS

The experiments were carried out in a glass anaerobic reactor of four litres of effective volume. The reactor temperature was maintained at $35 \pm 1^\circ\text{C}$ by circulating water through the water jacket (Figure 1).

The reactor was inoculated initially with anaerobic mesophilic sludge from waste water treatment plant digester. The use of effluent from a mesophilic reactor of pulp beet was also used as a source of inoculum due to its adaptation to degrade volatile fatty acids and specifically propionic acid.

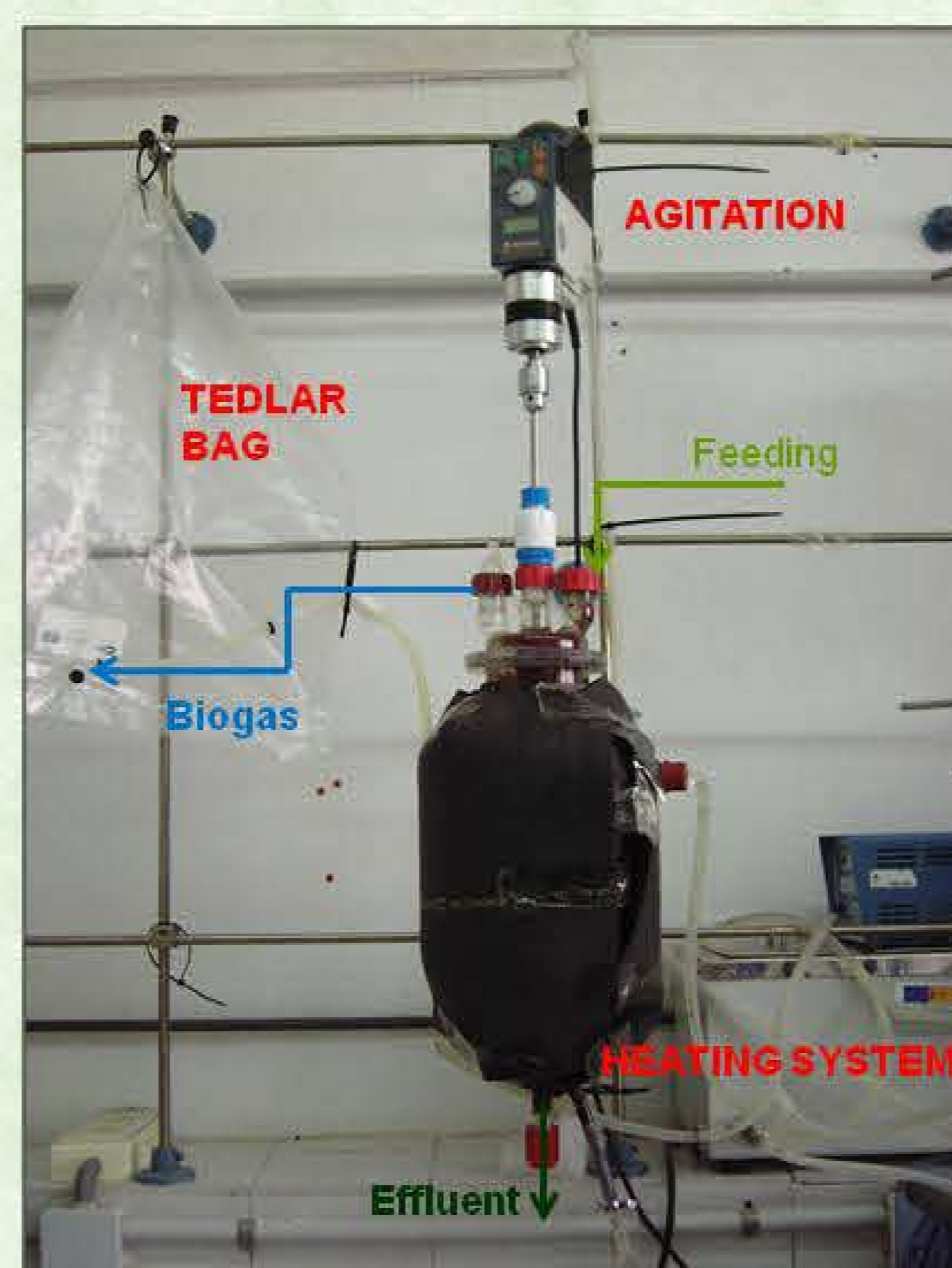


Figure 1.

Table 1. Characteristics of the wastes used

| | Unit | 2POMW | CM |
|-----|----------------------|--------|--------|
| pH | - | 5.41 | 7.84 |
| TS | g/kg | 315.00 | 182.95 |
| VS | g/kg | 282.74 | 143.91 |
| DOC | g/kg | 525.50 | 164.57 |
| COD | g O ₂ /kg | 142.16 | 43.20 |

The result of the reinoculations is a progressive decline in total acidity and the reduction of propionic acid concentration. The degradation of accumulate propionic acid is indicative of the start up of the process. Then the reactor was fed with initial HRT of 40 d (day 97) with a mixed waste of 2POMW and CM (60:40 w/w). In this moment there is an increase of total acidity in the reactor, mainly acetic acid, as a result of the initial steps of anaerobic digestion). Once the methanogenic microbiote are acclimated, there is a significant increase in daily production of methane and the removal of accumulated acetic and propionic acids.

REFERENCES

- Wang, Y., Zhang, Y., Wang, J. and Meng, L. (2009). Effects of volatile fatty acid concentrations on methane yield and methanogenic bacteria. *Biomass and bioenergy*, 33, 848-853.
- Mackie, R. L. and Bryant, M. P. (1995). Anaerobic digestion of cattle waste at mesophilic and thermophilic temperatures. *Appl Microbiol Biotechnol*, 43, 346-350.
- Borja, R., Rincón B., Raposo F., Alba J. and Martín A. (2002). A study of anaerobic digestibility of two-phases olive mill solid waste (OMSW) at mesophilic temperature. *Process Biochemistry*, 38, 733-742.
- X. Flotats y L. Sarquella. (2008). Producció de biogàs per digestió anaeròbia, Ed. Institut Català d'Energia.