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Improving Process Stability and Methane Yield in Mesophilic Anaerobic Digestion of Whey Using Digested Sludge

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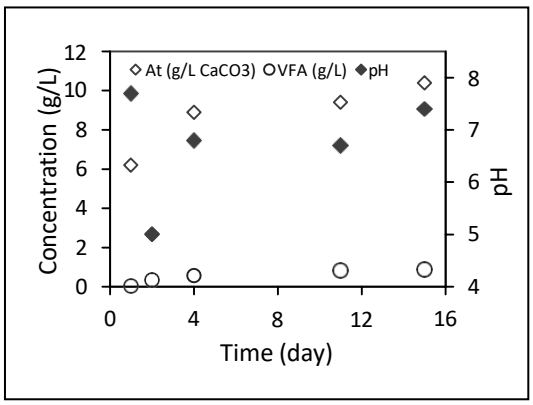
Introduction :

With the increasing global environmental awareness, anaerobic digestion has emerged as one of the most effective methods for the treatment and management of waste, particularly effluents from food processing industries such as dairies. These industries generate hundreds of millions of kilograms of milk and milk products each year, producing significant quantities of whey, with global production estimated at around 190 billion kilograms per year. Whey is a valuable energy resource that is still largely underexploited [1]. When processed by anaerobic digestion, it can produce biogas, a renewable energy source that can be used for heat and electricity. Thanks to its high organic load expressed as COD (57 to 140 g O_2/L), whey offers considerable potential for bioenergy production [1]-[5]. However, several studies [6],[7] have highlighted an instability of the anaerobic digestion process of whey, mainly linked to the acidification of the environment, which leads to the inhibition of the methanogenic flora and can lead to the cessation of methanization. To overcome this limitation, co-digestion with other substrates or inocula with a buffering capacity, such as manure, sewage treatment plant (STP) sludge or wastewater, appears to be a promising alternative. Much research has been devoted to this approach [3], [5]-[13], and more recently, other studies have reinforced its interest [2], [5], [14], [15]

Résultats:



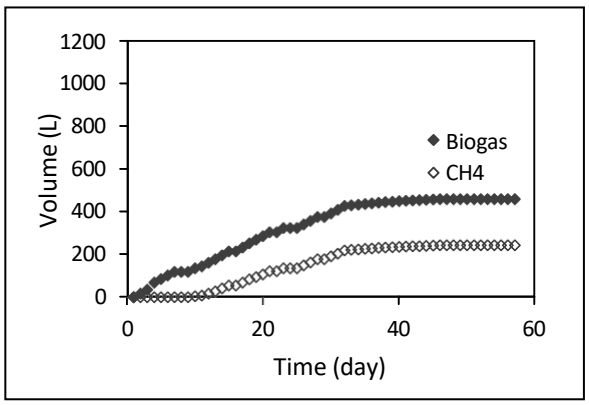


Fig. 1: pH, At and VFAs during anaerobic digestion 50W:50DS.

Fig. 2. Cumulative production of biogas and CH_4 during anaerobic digestion 50W:50DS.

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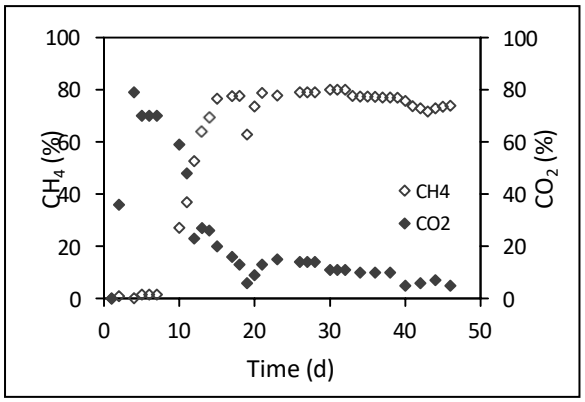

Fig. 3. Daily production of CH_4 (%) and CO_2 (%) during anaerobic digestion of 50W:50DS.

- Commentaires

- Fig. 1 shows that at the beginning of the anaerobic co-digestion (50:50) at 40 °C, the pH drops from 7.7 to 5.0 due to the production of VFAs (0.88 g/L) during the acidogenesis phase. This acidification is stabilized by a high alkalinity (>6 g/L), maintained through the addition of sodium carbonates to balance the medium.
- Fig. 2 illustrates the cumulative production of biogas and methane during the anaerobic digestion of a 50W: 50DS mixture. Overall, the optimization of anaerobic codigestion depends not only on the total amount of biogas produced but more importantly on the specific methane yield, which reflects the efficiency of the process. The methanogenic yield reached 252.8 L CH_4/kg VS. This result is consistent with those reported in the literature for similar substrates.
- According to Fig. 3, anaerobic co-digestion produces high-quality biogas with methane content reaching up to 80%, indicating an efficient and well-stabilized digestion process.

Conclusion :

Mesophilic anaerobic digestion of whey, inoculated with digested sludge, was carried out in a 50 L pilot-scale digester. The process was tightly monitored to prevent the accumulation of potentially inhibitory compounds that could compromise system stability. The results showed a specific methane yield of 0.25 m^3 CH_4/kg of volatile solids (VS) added, with a methane content in the biogas reaching up to 80%, indicating efficient substrate conversion.

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