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Co-digestion of press water and food waste in a biowaste digester for improvement of biogas production

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ABSTRACT

Co-digestion of press water from organic municipal wastes and of homogenized food residues with defibered kitchen wastes (food waste) as the main substrate was examined to improve biogas production. Although the biowaste digester was operated already at high organic loading (OLR) of 12.3 kg COD m^{-3} d^{-1} during the week, addition of co-substrates not only increased biogas production rates but also improved total biogas production. By feeding the two co-substrates up to 20 kg COD m^{-3} d^{-1} gas production followed the increasing OLR linearly. When the OLR was further increased with food waste, not more gas than for 20 kg COD m^{-3} d^{-1} OLR was obtained, indicating the maximum metabolic capabilities of the microbes. During weekends (no biowaste available) food waste could substitute for biowaste to maintain biogas production. Addition of press water or food waste to biowaste co-digestion resulted in more buffer capacity, allowing very high loadings without pH control.

1. Introduction

Worldwide municipal solid waste amounts increase 2–3% annually (OECD, 2004; Salhofer et al., 2007). More than 3000 million t/a are generated in Europe (EEA, 2003). In Germany about 66% of municipal wastes are non-recyclable, including 7% biowastes (Gallert et al., 2000; Gallert and Winter, 2002). Biowastes may be one source of renewable energies, which might contribute up to 20% of the total energy consumption in 2020 (EC, 2009; Kaltschmitt and Weber, 2006).

For treatment of the organic fraction of municipal solid waste (OFMSW), anaerobic digestion is a proven technology. An optimization of existing digesters by co-digestion with other types of wastes would be a strategy to maximize renewable energy production in line with an optimization of municipal solid waste management. Moreover, improvement of biogas production makes anaerobic digesters economically more feasible (Ahring et al., 1992). Co-digestion of the OFMSW with other organic wastes offers advantages such as an increased process stability and biogas yield and a better handling of mixed waste streams (Mata-Alvarez et al., 2000). A balanced nutrient supply and a stable pH are prerequisites for reliable process performance. An optimized C/N ratio during co-digestion for instance, was reported to be beneficial for the gas yield (Sosnowski et al., 2003). Addition of clay and Fe-compounds may counteract the inhibitory effect of high ammonia and sulfide concentrations (Hartmann et al., 2003). Mshandete et al. (2004) reported an improvement of the buffer capacity as an advantage of co-digestion. However, a careless decision on the type of wastes for co-digestion and the ratio of biowaste:co-substrate in full-scale anaerobic digesters often lead to a significant reduction of the biogas amount or even to failure of the biogas process (Murto et al., 2004; Zaher et al., 2008).

This study aims to examine the suitability of food waste and press water as co-substrates for anaerobic digestion of biowaste, added during night time or at weekends, when no biowaste is available. The maximal organic loading rate (OLR) by addition of increasing amounts of co-substrates was determined.

2. Methods

2.1. Substrates

Biowaste suspensions, taken batch-wise from the interim storage tank of the biowaste treatment plant in Karlsruhe-Durlach, were the main substrate used in this study. For preparation, source-sorted biowaste was squeeze-milled to tear apart plastic bags and then portions of 6 m^3 were suspended in 12 m^3 process water (supernatant of centrifuged digester effluent + rain water) for 30 min defibering in a hydropulper. During hydropulping heavy materials (stones, broken pieces of ceramics, knifes, forks, spoons,

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