Anaerobic digestion with micro-aeration for enhanced methane yield at high organic loading rates

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Anaerobic digestion (AD) has been widely applied for bioenergy production from diverse organic substrates with concomitant remediation of organic wastes. AD process, however, is equally susceptible to failure, especially at high organic loading rates (OLRs) due to accumulation of volatile fatty acids (VFAs). We developed and validated an oxidation-reduction potential (ORP)-based micro-aeration system to precisely dose oxygen in the AD system to enhance methane yield and to improve process stability under high OLRs. At an OLR of 5 g volatile solids (VS)/L.day, rapid accumulation of total VFAs up to 11 g/L as acetic acid (HAc) caused a drastic drop in pH (<6.0) and methane yield, and the reactors were on the verge of failure. Once the ORP-based micro-aeration was introduced every other day, the total VFA concentration declined rapidly to less than 2 g HAc/L, and methane yield increased by 252% without adding alkalinity or reducing feeding rate. 16S rRNA gene sequence analyses revealed that micro-aeration promoted facultative bacteria while preserved crucial methanogens to effectively produce methane under a high OLR condition. This is the first attempt to implement the ORP-controlled micro-aeration as an effective strategy for recovering unstable AD system as well as maintaining long-term system stability with enhanced methane yield.