Enhanced Methane Production from Food Waste in Aerobic-Anaerobic Bioreactor

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Traditional anaerobic digestion of food waste often leads to prolonged acidic phase, resulting in long time inhibition of methane production. Various methods, including mechanical, chemical, thermal and enzymatic pre-treatment methods, have been widely studied to reduce the acidic inhibition and accelerate subsequent methane production. In this study, an innovative aerobic-anaerobic treatment process was investigated to accelerate methane production from food waste.

Two laboratory-scale columns C1 and C2 were constructed to simulate the traditional anaerobic bioreactor and aerobic-anaerobic bioreactor of food waste, respectively. Both columns were made of poly-acrylic glass with an inner diameter of 15 cm and a height of 40 cm. A total amount of 1.62 kg synthesized food waste and 0.18 kg sawdust (10% on the weight basis of mixed waste) was packed into each column. Food waste was synthesized according to the typical compositions of food waste in China. Sawdust was added mainly as bulking agent. Biogas produced in this experiment was collected from the port installed on the top of the columns. Leachate was collected from the bottom of the columns and recirculated back into each column at a frequency of 300 ml/d. For C2 with pre-aeration treatment prior to the anaerobic digestion, continuous aeration (200ml/min) at the upper layer was conducted during the first 11 days, then changed to intermittent aeration (200ml/min, 8 hours/d) in the following 21 days. When the leachate pH of C2 increased above 7.0 on day 32, C2 was switched to anaerobic bioreactor.

Results showed that leachate pH of C1 and C2 decreased from the initial value of 4.0 to 3.1~3.3 in the first 10 days. Then, the pH of leachate in C1 was kept stable in the range of 3.1~3.5 during the experiment. The leachate concentrations of COD, VFA and NH_4^+-N were cumulated to over 65,000 mg/L, 18,000 mg/L and 490 mg/L, respectively. However, after 11 days continuous aeration, leachate pH of C2 gradually increased during the following intermittent aeration period and reached to above 7.0 on day 32. After ceasing aeration, COD, VFA and NH_4^+-N concentrations in C2 were gradually decreased to less than 9,000 mg/L, 4,000 mg/L and around 2,000 mg/L, respectively. Nearly no methane production in C1 could be detected during the whole experiment. In contrast, CH_4 concentration in C2 dramatically increased to over 50% within 17 days after aeration stopped and reached to >70% at the end of the experiment. Also, CH_4 production rate could reach to as high as 400 ml CH_4/kg $_{waste}$/d. Performance of the aerobic-anaerobic bioreactor of food waste indicted that the temporary aeration pretreatment at upper waste layer could greatly reduce the lag time of CH_4 generation, enhance the degradation of organic matters and increase the CH_4 yield and production rate.