Assessment of methane production from shredder waste in landfills: The influence of temperature, moisture and metals

In this study, methane (CH4) production rates from shredder waste (SW) were determined by incubation of waste samples over a period of 230 days under different operating conditions, and first-order decay kinetic constants (k-values) were calculated. SW and sterilized SW were incubated under different temperatures (20-25°C, 37°C, and 55°C), moisture contents (35% and 75% w/w) and amounts of inoculum (5% and 30% of the samples wet weight). The biochemical methane potential (BMP) from different types of SW (fresh, old and sieved) was determined and compared. The ability of metals (iron, aluminum, zinc, and copper) contained in SW to provide electrons for methanogens resulting in gas compositions with high CH4 contents and very low CO2 contents was investigated. The BMP of SW was 1.5-6.2 kg CH4/ton waste. The highest BMP was observed in fresh SW samples, while the lowest was observed in sieved samples (fine fraction of SW). Abiotic production of CH4 was not observed in laboratory incubations. The biotic experiments showed that when the moisture content was 35% w/w and the temperature was 20-25°C, CH4 production was extremely low. Increasing the temperature from 20-25°C to 37°C resulted in significantly higher CH4 production while increasing the temperature from 37°C to 55°C resulted in higher CH4 production, but to a lower extent. Increasing the moisture and inoculum content also increased CH4 production. The k-values were 0.033-0.075 yr⁻¹ at room temperature, 0.220-0.429 yr⁻¹ at 37°C and 0.235-0.488 yr⁻¹ at 55°C, indicating that higher temperatures resulted in higher k-values. It was observed that H2 can be produced by biocorrosion of iron, aluminum, and zinc and it was shown that produced H2 can be utilized by hydrogenotrophic methanogens to convert CO2 to CH4. Addition of iron and copper to SW resulted in inhibition of CH4 production, while addition of aluminum and zinc resulted in higher CH4 production. This suggested that aluminum and zinc contribute to high CH4 production from SW by providing H2 for hydrogenotrophic methanogens. Gas compositions with higher CH4 and lower CO2 observed in landfilled SW are thus most likely due to the consumption of existing CO2 in the produced biogas and the produced H2 by biocorrosion of aluminum and zinc by methanogens.

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