Foaming in manure based digesters

Causes and solutions

Kougias, Panagiotis; Boe, Kanokwan; Angelidaki, Irini

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Foaming in manure based digesters- Causes and solutions

P.G. Kougias, K. Boe and I. Angelidaki
Department of Environmental Engineering, Technical University of Denmark, Kgs. Lyngby, DK-2800, Denmark
(E-mail:panak@env.dtu.dk, kanb@env.dtu.dk, iria@env.dtu.dk)

Anaerobic digestion foaming is one of the major problems that occasionally occurred in the Danish full-scale biogas plants, affecting negatively the overall digestion process. The foam is typically formatted in the main biogas reactor or in the pre-storage tank and the entrapped solids in the foam cause severe operational problems, such as blockage of mixing devices, and collapse of pumps. Furthermore, the foaming problem is linked with economic consequences for biogas plants, due to income losses derived from the reduced biogas production, extra labour work and additional maintenance costs. Moreover, foaming presents adverse environmental impacts owing to the overflowing of the pre-storage or digester tanks.

So far, there has never been thoroughly investigation of foaming problem in manure-based digester, which is the main anaerobic digestion applied in Denmark. The purpose of the present study was to identify potential causes of foaming in manure based digesters. Moreover, it was also an aim to investigate possible solutions to counteract foam formation with the use of antifoam agents.

Thus, the impact of organic loading rate and content of feeding substrate on anaerobic digestion foaming was studied in continuous mode experiments. Two sets of treatments were examined in duplicate using 5 continuous stirred tank reactors (working volume 1.5L), operating in thermophilic conditions. Two replicate reactors were fed with cattle manure and gelatine, as a representative of proteins, while the other two replicates were fed with cattle manure and Na-oleate, as a representative of lipids. One reactor was kept as a control and was fed only with cattle manure. The experiment was divided in 5 periods. During the 1^{st}, 3^{rd} and 5^{th} period the organic loading rate of all reactors was increased by the addition of glucose in the feeding substrate. During the 2^{nd} and 4^{th} period the organic loading rate was maintained constant, but instead of glucose, higher concentration of Na-oleate or gelatine was added in the feeding substrate.

The results obtained from the above experiment showed that the organic loading rate has a significant impact on foam formation, lowering the methane yield of the reactor. Moreover, it was found that an increase in gelatine concentration does not promote foam, while an increase in Na-oleate concentration enhances stable foam.

Based on the above results, a new experiment was designed, where the antifoam efficiency of different commercial and non-commercial compounds, was investigated. The antifoam potential of the compounds was determined by aeration method. The apparatus comprised of a glass cylinder with a diffuser placed at the bottom. A 50 mL sample, derived from a foaming reactor, was aerated in the cylinder with an air flow rate of 60 mL/min for 10 minutes. After that, the aeration was repeated adding different concentrations of antifoam solutions in the sample. The foam height in the cylinder was measured as soon as the aeration was stopped and again 1 hour later. The antifoam potential was defined using two parameters: foaming tendency and foam stability. Foaming tendency (mL-foam/(mL-air·min)) was calculated from the volume of foam (mL) right after aeration divided by air flow rate (mL/min). Foam stability was determined as percentage of foam remaining in the cylinder 1 h after aeration compared to the volume of foam right after aeration.