World Academy of Science, Engineering and Technology
International Journal of Environmental and Ecological Engineering
Vol:12, No:09, 2018

Concentration and Stability of Fatty Acids and Ammonium in the Samples from Mesophilic Anaerobic Digestion

Authors : Mari Jaakkola, Jasmiina Haverinen, Tiina Tolonen, Vesa Virtanen

Abstract : These process monitoring of biogas plant gives valuable information of the function of the process and help to maintain a stable process. The costs of basic monitoring are often much lower than the costs associated with re-establishing a biologically destabilised plant. Reactor acidification through reactor overload is one of the most common reasons for process deterioration in anaerobic digesters. This occurs because of a build-up of volatile fatty acids (VFAs) produced by acidogenic and acetogenic bacteria. VFAs cause pH values to decrease, and result in toxic conditions in the reactor. Ammonia ensures an adequate supply of nitrogen as a nutrient substance for anaerobic biomass and increases system's buffer capacity, counteracting acidification lead by VFA production. However, elevated ammonia concentration is detrimental to the process due to its toxic effect. VFAs are considered the most reliable analytes for process monitoring. To obtain accurate results, sample storage and transportation need to be carefully controlled. This may be a challenge for off-line laboratory analyses especially when the plant is located far away from the laboratory. The aim of this study was to investigate the correlation between fatty acids, ammonium, and bacteria in the anaerobic digestion samples obtained from an industrial biogas factory. The stability of the analytes was studied comparing the results of the on-site analyses performed in the factory site to the results of the samples stored at room temperature and -18°C (up to 30 days) after sampling. Samples were collected in the biogas plant consisting of three separate mesofilic AD reactors (4000 m^3 each) where the main feedstock was swine slurry together with a complex mixture of agricultural plant and animal wastes. Individual VFAs, ammonium, and nutrients (K, Ca, Mg) were studied by capillary electrophoresis (CE). Longer chain fatty acids (oleic, hexadecanoic, and stearic acids) and bacterial profiles were studied by GC-MSD (Gas Chromatography-Mass Selective Detector) and 16S rDNA, respectively. On-site monitoring of the analytes was performed by CE. The main VFA in all samples was acetic acid. However, in one reactor sample elevated levels of several individual VFAs and long chain fatty acids were detected. Also bacterial profile of this sample differed from the profiles of other samples. Acetic acid decomposed fast when the sample was stored in a room temperature. All analytes were stable when stored in a freezer. Ammonium was stable even at a room temperature for the whole testing period. One reactor sample had higher concentration of VFAs and long chain fatty acids than other samples. CE was utilized successfully in the on-site analysis of separate VFAs and NH_4 in the biogas production site. Samples should be analysed in the sampling day if stored in RT or freezed for longer storage time. Fermentation reject can be stored (and transported) at ambient temperature at least for one month without loss of NH_4. This gives flexibility to the logistic solutions when reject is used as a fertilizer.

Keywords : anaerobic digestion, capillary electrophoresis, ammonium, bacteria
Conference Title : ICBST 2018 : International Conference on Biogas Science and Technology
Conference Location : Zurich, Switzerland
Conference Dates : September 13-14, 2018