World Academy of Science, Engineering and Technology
International Journal of Environmental and Ecological Engineering
Vol:14, No:05, 2020

Effect of the Magnetite Nanoparticles Concentration on Biogas and Methane Production from Chicken Litter

Authors : Guadalupe Stefanny Aguilar-Moreno, Miguel Angel Aguilar-Mendez, Teodoro Espinosa-Solares

Abstract : In the agricultural sector, one of the main emitters of greenhouse gases is manure management, which has been increased considerably in recent years. Biogas is an energy source that can be produced from different organic materials through anaerobic digestion (AD); however, production efficiency is still low. Several techniques have been studied to increase its performance, such as co-digestion, the variation of digestion conditions, and nanomaterials used. Therefore, the aim of this investigation was to evaluate the effect of magnetite nanoparticles (NPs) concentration, synthesized by co-precipitation, on the biogas and methane production in AD using chicken litter as a substrate. Synthesis of NPs was performed according to the co-precipitation method, for which a fractional factorial experimental design 25^{-2} with two replications was used. The study factors were concentrations (precursors and passivating), time of sonication and dissolution temperatures, and the response variables were size, hydrodynamic diameter (HD) and zeta potential. Subsequently, the treatment that presented the smallest NPs was chosen for their use on AD. The AD was established in serological bottles with a working volume of 250 mL, incubated at 36 ± 1 °C for 80 days. The treatments consisted of the addition of different concentrations of NPs in the microcosms: chicken litter only (control), 20 mg•L^{-1} of NPs + chicken litter, 40 mg•L^{-1} of NPs + chicken litter and 60 mg•L^{-1} of NPs + chicken litter, all by triplicate. Methane and biogas production were evaluated daily. The smallest HD (49.5 nm) and the most stable NPs (21.22 mV) were obtained with the highest passivating concentration and the lower precursors dissolution temperature, which were the only factors that had a significant effect on the HD. In the transmission electron microscopy performed to these NPs, an average size of 4.2 ± 0.73 nm was observed. The highest biogas and methane production was obtained with the treatment that had 20 mg•L^{-1} of NPs, being 29.5 and 73.9%, respectively, higher than the control, while the treatment with the highest concentration of NPs was not statistically different from the control. From the above, it can be concluded that the magnetite NPs promote the biogas and methane production in AD; however, high concentrations may cause inhibitory effects among methanogenic microorganisms.

Keywords : agricultural sector, anaerobic digestion, nanotechnology, waste management
Conference Title : ICEPP 2020 : International Conference on Environment Pollution and Prevention
Conference Location : Rome, Italy
Conference Dates : May 04-05, 2020