FULL-TEXT

Influence of zero valent iron nanoparticles and magnetic iron oxide nanoparticles on biogas and methane production from anaerobic digestion of manure

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ABSTRACT

In this study, nanoparticles (NPs) were hypothesized to enhance the anaerobic process and to accelerate the slurry digestion, which increases the biogas and methane production. The effects of NPs on biogas and methane production were investigated using a specially designed batch anaerobic system. For this purpose, a series of 2 L biodigesters were manufactured and implemented to study the effects of the nanoparticles of Iron (Fe) and Iron Oxide (Fe_3O_4) with different concentrations on biogas and methane production. The best results of NPs additives were selected based on the statistical analysis (Least Significant Difference using M-Stat) of biogas and methane production, which were 20 mg/L Fe NPs and 20 mg/L Fe_3O_4 magnetic NPs ($p<0.05$). The aforementioned NPs additives delivered the highest biogas and methane yields in comparison with their other concentrations (5, 10 and 20 mg/L), their salt ($FeCl_3$) and the control. Furthermore, the addition of 20 mg/L Fe NPs and 20 mg/L Fe_3O_4 magnetic NPs significantly increased the biogas volume ($p<0.05$) by 1.45 and 1.66 times the biogas volume produced by the control, respectively. Moreover, the aforementioned additives significantly increased the methane volume ($p<0.05$) by 1.59 and 1.96 times the methane volume produced by the control, respectively. The highest specific biogas and methane production were attained with 20 mg/L Fe_3O_4 magnetic NPs, and were 584 ml Biogas g^{-1} VS and 351.8 ml CH_4 g^{-1} VS, respectively compared with the control which yielded only 352.6 ml Biogas g^{-1} VS and 179.6 ml CH_4 g^{-1} VS.

Keywords: nanotechnology, nanoparticles, anaerobic digestion, biogas, methane production, trace metals, chemical additives, manure management, slurry treatment.