Prospects for biogas production and H2S control from the anaerobic digestion of cattle manure: The influence of microscale waste iron powder and iron oxide nanoparticles

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Abstract:

Improving the quality and quantity of biogas usually requires pre-treatment to maximize methane yields and/or post-treatment to remove H2S, which involves considerable energy consumption and higher costs. Therefore, this study proposes a cost-effective method for the enhanced anaerobic digestion (AD) of dairy manure (DM) without pre/post-treatment by directly adding waste iron powder (WIP) and iron oxide nanoparticles (INPs) to batch digesters. The results showed that the addition of iron in the form of microscale WIP (generated from the laser cutting of iron and steel) at concentrations of 100 mg/L, 500 mg/L, and 1000 mg/L improved methane yields by 36.99%, 39.36%, and 56.89%, respectively. In comparison, the equivalent dosages of INPs improved yields by 19.74%, 18.14%, and 21.11%, respectively. Additionally, the highest WIP dose (1000 mg/L) achieved the maximum improvement in the rate of hydrolysis (k), which was 1.25 times higher than in control reactions, and a maximum biomethane production rate (Rmax) of 0.045 L/gVS/d according to kinetic analysis models (i.e., first-order and the Gompertz kinetic models). The rate of H2S production was also significantly reduced (by 45.20%, 58.16%, and 77.24%) using the three WIP concentrations in comparison with INPs (which achieved reductions of 33.59%, 46.30%, and 53.52%, respectively). Therefore, the direct mixing of WIP with cattle manure is proposed as a practical and economical means of addressing complex and high-cost pre- and posttreatments that are otherwise required in the digestion process.

Keywords:

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