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The Effect of Magnetite Particle Size on Methane Production by Fresh and Degassed Anaerobic Sludge

Authors : E. Al-Essa, R. Bello-Mendoza, D. G. Wareham

Abstract : Anaerobic batch experiments were conducted to investigate the effect of magnetite-supplementation (7 mM) on methane production from digested sludge undergoing two different microbial growth phases, namely fresh sludge (exponential growth phase) and degassed sludge (endogenous decay phase). Three different particle sizes were assessed: small (50 - 150 nm), medium (168 – 490 nm) and large (800 nm - 4.5 µm) particles. Results show that, in the case of the fresh sludge, magnetite significantly enhanced the methane production rate (up to 32%) and reduced the lag phase (by 15% - 41%) as compared to the control, regardless of the particle size used. However, the cumulative methane produced at the end of the incubation was comparable in all treatment and control bottles. In the case of the degassed sludge, only the medium-sized magnetite particles increased significantly the methane production rate (12% higher) as compared to the control. Small and large particles had little effect on the methane production rate but did result in an extended lag phase which led to significantly lower cumulative methane production at the end of the incubation period. These results suggest that magnetite produces a clear and positive effect on methane production only when an active and balanced microbial community is present in the anaerobic digester. It is concluded that, (i) the effect of magnetite particle size on increasing the methane production rate and reducing lag phase duration is strongly influenced by the initial metabolic state of the microbial consortium, and (ii) the particle size would positively affect the methane production if it is provided within the nanometer size range.

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