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Cincinnati OH 45268

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Project Summary

Enzyme Addition to the Anaerobic Digestion of Municipal Wastewater Primary Sludge

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This study was conducted to evaluate the effects of adding enzymes to a municipal wastewater (MWW) sludge anaerobic digester. The primary objective was to examine the impact of using enzymes to enhance the degradation of the cellulosic and the oil- and grease-rich sludge fractions. This project was conducted under a cooperative agreement to the City of Xenia, Ohio, with subcontracting to Systech Corporation, Xenia, Ohio.

This Project Summary was developed by EPA's Water Engineering Research Laboratory, Cincinnati, OH, to announce the major results of a project that is documented in a separate report of the same title (see Project Report ordering information on the back page).

Introduction

One of the most commonly employed treatment methods for municipal wastewater (MWW) solids is anaerobic digestion followed by one of a number of ultimate disposal options. This process is particularly advantageous in that it produces a sludge suitable for land application, efficiently reduces pathogenic organisms, produces a potentially useful by-product fuel gas, and is generally accompanied by low operating costs. Despite these advantages, currently used anaerobic digestion technology has several operational and technical limitations. One of the most significant of these is the level of volume reduction achieved. Although anaerobic digestion reduces sludge volume and mass, the constantly growing cost and number of federal and state regulations governing the disposal of MWW sludges requires that current technology be optimized to produce the smallest amounts of sludge possible.

The objective of this program was to evaluate the application of enzyme augmentation to current MWW anaerobic digestion practices. This concept was viewed as a method to enhance the sludge volume reduction and fuel gas production. Although commercial enzyme augmentation products are available for use in MWW treatment systems, an extensive search of the relevant experimental literature conducted during this project indicated very few useful data regarding their use.

Cellulase Enzyme Addition

The application of cellulase enzymes to enhance the anaerobic digestion of cellulosic component of MWW sludge was evaluated in a series of laboratory-scale studies. Three modes of applying the enzymes were examined — as a pretreatment, post-treatment, and simultaneous treatment option with respect to anaerobic digestion. The pretreatment option incorporated a two-phase digestion process and was by far the most technically successful of the options examined. However, the advantages of this option were largely due to the two-phase process used to accommodate the pH requirements of the enzyme rather than to the enzyme additions. Compared with a single-phase digestion system, increases of 45 and 44 percent were observed for total solids reduction and methane production as a result of the two-phase digestion process alone. Addition of enzyme to the two-

phase system further increased solids reduction and methane production to 60 and 66 percent.

Experimental data scaled to the size of the Xenia facility were compared with typical operations at a 15-day hydraulic-retention-time, single-phase digester system modeled on the Xenia facility. Results indicated that a net yearly savings of $11,133, equivalent to a 7-mo payback period for additional equipment, could be achieved by using the two-phase digestion process without enzyme addition. To accomplish this result, the facility would need a minimal increase in tankage capacity. Based on the current cost of commercially available enzyme, an additional yearly savings of $1,525 would result from adding enzyme to the two-phase system. This savings could increase if enzyme costs could be reduced.

Lipase Enzyme Addition

The use of lipase enzymes to increase the rate of decomposition of the oil and grease component of MWW sludge solids was evaluated in a similar series of laboratory experiments conducted with direct enzyme addition to a single-phase anaerobic digestion system operated at a 15-day hydraulic retention time. Compared with control conditions, increases of 2 and 4 percent were observed for total solids reduction and methane production as a result of lipase enzyme addition. Based on current enzyme costs, a net yearly savings of $701 would result from the use of lipase enzymes. No additional tankage capacity would be required for this process. Further increases could potentially be achieved by operating the system at a longer retention time.

Conclusions

The overall results of the project show little advantage for enzyme addition to anaerobic digestion. The major improvements seen were due to the staging of the digestion process, which was done in order to accommodate the pH requirements of the cellulase enzyme. The conclusions are, therefore, as follows:

(1) Two-phase digestion used to accommodate cellulase addition in this study shows promise for increasing the efficiency for anaerobic digestion.

(2) The addition of cellulase enzyn shows a moderate improvement c the two-phase digestion proc without enzyme addition.

(3) The addition of lipase enzyme un the condition studied shows onl minimal improvement in anaero digestion.

The full report was submitted in full ment of Cooperative Agreement No. (810279 by the City of Xenia, Ohio, unc the sponsorship of the U.S. Environme tal Protection Agency.

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The complete report, entitled "Enzyme Addition to the Anaerobic Digestion of Municipal Wastewater Primary Sludge," (Order No. PB 87-101 788/AS; Cost: $16.95, subject to change) will be available only from:

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