EDITORIAL

Retrospective and Perspectives of Thermophilic Anaerobic Digestion: Part I

For many years, what has been said of other innovations might have been said of thermophilic anaerobic digestion (TAD) at wastewater treatment plants (WWTPs): this technology is an answer in search of a problem. From the 1930s to 1990s, WWTP focus was solely on improving digestion performance because, under the most favorable conditions for each, thermophilic metabolic rates are greater than mesophilic rates, offering process improvements such as more complete solids destruction and increases in gas production. The few full-scale experiences, however, have been mixed and most of the plants that attempted TAD have gone back to mesophilic operation. The early literature cites several examples of digester instability with the accumulation of volatile fatty acids (VFAs) and a concomitant drop of the pH (reactor souring), reductions in methane production, and increases in digester gas carbon dioxide content.

Interest in TAD has been revitalized because of federal regulations on disinfection of biosolids for beneficial land application. Public concern, however, is growing because of perceived detrimental effects to the environment and public health, including for example contamination of soil and groundwater with pathogens, metals, and toxic organic compounds; transfer of pathogens through aerosols; and the potential toxic effects of biosolids odors. Though unequivocal evidence to substantiate many of these concerns has not been presented, several communities have imposed more strict requirements on biosolids land application than the federal regulations. Other communities have outright banned the practice. Therefore, it is important that WWTPs produce biosolids that meet the highest standards; conversion to TAD provides an opportunity to do so.

Recent investigations, through better understanding of the biochemistry and microbiology of thermophilic digesters, have provided plants with guidelines for TAD startup and operation that have not been available before. To convert mesophilic digesters to thermophilic operation, several recent tests suggest that quickly raising the temperature over a short period (i.e., several weeks) is the best approach. This rapid temperature rise appears to favor the development of truly thermophilic species over thermotolerant mesophiles that are likely to dominate when the digester temperature is slowly increased. Other tests have shown that it may be equally important during digester startup to maintain a high detention time initially, followed by a controlled gradual increase in the feed rate to prevent VFA accumulation and resulting digester souring. In short, a quick temperature rise combined with gradual increase of the digester feed may ensure stable thermophilic operation. An added bonus of this approach is that seeding the digester with thermophilic microbes does not seem to be necessary, thereby eliminating the time and cost associated with preparing and transporting thermophilic seed cultures. On the other hand, it appears that slow temperature changes are best if considerations such as odor or performance optimization make it necessary to adjust the operation of a digester that has a well-established thermophilic culture.

While this progress has been made in understanding the technical aspects of converting mesophilic digesters to thermophilic operation, it has primarily been driven by regulatory concerns. There are still areas for improvement so that WWTPs will be able to produce the highest quality biosolids at the lowest cost. For example, more needs to be understood about regrowth during postdigestion, as Class A limits are to be met at the last point of plant control. Preventing a temperature drop from the digester to this point has produced good results, but clearer understanding of the mechanism might lead to a cheaper and easier way to prevent regrowth. Other issues include improved time–temperature requirements for biosolids disinfection in a batch digester; public concern about possible odor release during land application; single-stage operation in a continuous mode; the choice of a suitable alternative, under the federal regulation, for demonstrating compliance with the disinfection standard; and estimation and quantification of costs. Work on these issues is needed because political, social, and further legal constraints may change in ways that increase the need for WWTPs to include thermophilic digestion in a diversified biosolids program.

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