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AGRICULTURAL UTILIZATION OF LIME STABILIZED SLUDGES

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Introduction

The traditional liquid process train for lime stabilization of municipal sludge has been used for many years, especially by small treatment plants and for interim and backup sludge handling. The direct addition of dry quicklime (CaO) is a new technique for lime addition which offers a number of advantages over the traditional liquid method. For our land application projects, we at Bio Gro Systems have found this dry lime addition to be relatively simple to implement and cost effective for the sludge generator.

Sludge Disinfection Processes

Adding lime to sludge creates a high pH environment which is hostile to biological activity. This process inhibits or destroys both the microorganisms involved in the decomposition of organic material (thereby reducing odor potential) and pathogenic organisms (thereby disinfecting or stabilizing the sludge). The design criteria for a lime stabilization system include: pH, contact time, and lime dosage. As noted in the 1979 EPA Process Design Manual "Sludge Treatment and Disposal", the objective of a lime stabilization process is to maintain a pH above 12 for about two hours to insure pathogen kill and to provide enough residual alkalinity so that the pH will remain above 11 for several days. The EPA manual provides data on the amounts of lime required for stabilization when sludge is treated in the liquid state (the traditional method) and refers only indirectly to the use of dry lime for disinfection.

Data reported by Westphal and Christensen in the WPCF Journal (November 1983) established the efficacy of lime disinfection when compared with digestion and mesophilic composting in reducing fecal coliform and fecal streptococcus densities. The study also evaluated two process modifications: (1) increasing the lime dose in a conventional iron and lime conditioning process prior to vacuum filtration and (2) adding dry lime to dewatered, polymer-conditioned cake sludge. Both these modifications provide increased cost-effectiveness for the lime stabilization option as a result of decreased sludge volume. Both process modifications were also found to be as effective as the standard lime stabilization process so long as the amounts of lime added meet the EPA criteria. The study also established that the addition of dry quicklime worked well at a relatively low lime dose and maintained a stable pH (greater than 12) over the 7 day period of the study.

Advantages of Using Quicklime for Disinfection

The differences between the process designs described in the research have been borne out by our experiences in using dry quicklime to disinfect municipal sludges. Many of the deficiencies and problems noted in the past for lime stabilization are overcome when the

complex chemical reactions that occur in lime treatment of sludge take place in the dewatered sludge by the direct addition of dry CaO. The direct use of quicklime accomplishes the following technological advancements to:

- o Simplify the design of the lime stabilization technology; there is no slaking operation nor are mixing and holding tanks required as are needed for liquid lime treatment.

- o Allow continuous operation of dry lime addition; thus providing much greater flexibility in the operation in response to varying sludge outputs.

- o Maximize the efficiency of the reactions with sludge; this self-contained reaction of quicklime and sludge also produces no liquid side stream.

- o Reduce the amount of lime needed to meet disinfection requirements; the research referenced above established the reduced total lime demand necessary to meet pathogen reduction requirements, and has been verififed by our operational experience.

Unlike digestion processes, lime stabilization can be readily verified by pH monitoring on site at appropriate time intervals. The empirical approach of adding lime as needed to achieve stabilization (pH) provides great flexibility in process control. It is a relatively simple matter to increase lime addition during the initial phases of an operation and gradually reduce such additions while continuing to verify that the desired pH levels are being maintained.

Land Application of Lime Stabilized Sludge

For land application, lime stabilized sludge offers significant advantages over other types of sludges. In many parts of the country, soils tend to be naturally acidic. As a precautionary measure to prevent the uptake of trace metals from sludges, federal and most state regulations require that soil pH be adjusted to 6.5 or greater at the time of sludge application. Providing lime through the addition of lime stabilized sludge increases soil pH, and the regulatory requirement for pH adjustment is met automatically without any need for a separate lime application.

The lime value to the farmer is an additional benefit provided by the use of lime stabilized sludge. The value of adding lime to acid soils is well known agronomically. One of the most common recommendations for increasing crop yields in areas with low soil pH's is to lime the fields. Applying lime stabilized sludge supplies this needed lime along with two out of three of the major plant nutrients (nitrogen and phosphorus), micronutrients and organic matter. This organic matter acts as a soil conditioner to improve the soil physical properties and water holding capacity. The lime added from the application of lime stabilized sludge is a substantial portion of the overall value of a sludge application. Table 1 shows the estimated value of a typical application of sludge stabilized by adding dry quicklime.

When used in conjunction with an agricultural land application program, stabilization with quicklime produces sludges with a somewhat lower liming potential than are produced by liquid lime stabilization. This lower lime content provides a more balanced material to be applied to farm sites. We have found that it is agronomically more desirable to manage a lime stabilized sludge which has been treated by the addition of

dry quicklime rather than by either the liquid process or by increased addition of hydrated lime prior to vacuum filtration. By reducing the potential for excessive application of lime, we are able to provide a more acceptable agricultural product.

Bio Gro is currently operating two projects in the Maryland-Virginia area using both of the process modifications reported in the WPCF Journal research article.

Case Histories

Anne Arundel County Project

Under contract to the Anne Arundel County (Maryland) Department of Utilities, Bio Gro has designed, built and is operating four dewatering facilities which process sludge and add dry quicklime to stabilize cake sludges. The dewatering equipment is housed in separate buildings at each plant with containers on the outside to hold the sludge for pickup by transport vehicles. Lime silos installed at each plant contain approximately one month's supply of quicklime.

Primary and secondary liquid sludges are polymer-conditioned and dewatered using belt presses to approximately 18 - 20% solids. Dewatered sludge cake is carried by a conveyer belt to a screw conveyer and hopper system for the dry quicklime addition. The sludge/lime mixture moves through a covered screw conveyer to mix the lime with the dewatered sludge as it is carried upward to be dropped into the containers outside the dewatering building. Other types of mixers, such as pug mills, may also be used to mix lime and sludge. For this project, we also add water to the sludge along with quicklime as it moves through the screw conveyer to the outside of the building. This added water allows the sludge to be pumped as a liquid from the containers to tanker trucks which carry it to our agricultural field operations. The additional handling and mixing of sludge, lime and added water insures that stabilization criteria are met.

For the Anne Arundel County sludges, the amounts of lime needed to meet pathogen reduction requirements range from approximately 15 to 22% (dry weight basis) for the various sludges (as shown in Table 2). We check pH hourly while we are operating the dewatering facilities to provide continuous verification of adequate lime addition. Since even similar sludges will vary somewhat in their lime demand, it is important to establish at the beginning of a project the amounts of lime needed to meet stabilization requirements for a particular sludge.

We transport sludge from the Anne Arundel County facilities in tanker trucks as a liquid containing approximately 10 to 15% dry solids. Weight tickets from the trucks provide the documentation for invoicing and for calculating both lime and sludge additions to each land application site.

We have elected to use a liquid operation for the Anne Arundel County project in order to be able to inject the sludge into the soil on agricultural sites. Where injection is not necessary or desirable, the system can be operated so as to produce a dewatered cake which can be applied in much the same way as animal manure.

Blue Plains Project

The Blue Plains Wastewater Treatment Plant which serves Washington, DC and several suburban counties in Maryland and Virginia, is one of the largest wastewater treatment facilities (over 300 million gallons per day capacity) in the country. The raw sludge produced at Blue Plains is conditioned with ferric chloride and lime, then dewatered using vacuum filters. At the Blue Plains plant, hydrated lime slurry is added in a batch process before the sludge is dewatered. As noted, this process generally requires a greater lime addition to provide both adequate dewatering and disinfection. The lime content of the Blue Plains sludge is generally about one third higher than that of the sludges produced in Anne Arundel County.

Sludge from Blue Plains is managed either as a cake or as a liquid. Cake sludge is transported in covered dump type trailers and offloaded at the field application site. A front end loader is then used to pick up the sludge and place it in a high flotation tire spreader box similar to a manure spreader. This spreader breaks up the sludge with beater bars to provide an even application.

Blue Plains sludge is also applied as a liquid as much the same way that the Anne Arundel County sludges are handled. This method also uses some additional water in order to allow the sludge to be pumped. At the field it can then be transferred to liquid applicator vehicles and injected or surface applied as appropriate.

Public Acceptance of Land Application

One of the greatest challenges facing any sludge management program is to gain and maintain community acceptance of the project. While sludge is a waste product that can be used beneficially, it also has aspects that must be addressed if it is to be successfully utilized.

While all sludge land application projects require some attention to public acceptance issues, the Blue Plains project has been particularly challenging in this regard. Since there is no available farm land within the boundaries of the District of Columbia where the plant is located, all of the sludge which is land applied must be transported across county and state boundaries.

Fortunately, the Blue Plains sludge is both a "clean" sludge (in terms of its industrial component) and has been extensively analyzed and reported in scientific research since the early 1970's. This high sludge quality has been very valuable in achieving public acceptance for the Blue Plains land application program.

We have developed information packets which are handed out to potential sludge users, citizens groups, county officials, and any other interested parties. These packets include the data available on the Blue Plains sludge; State and Federal publications that promote the use of sludge as a resource; and newspaper articles reporting on the successful land application of sludge. We have also developed slide presentations to explain the regulatory process and the health and environmental safeguards which are required for all managed land application programs. We regularly conduct field tours and demonstrations, appear at public information meetings, meet with local officials and citizens groups, and provide information to the media to sustain the acceptability of the Blue Plains land application program. As a measure of the success of this effort, we now have permitted sites for the Blue Plains sludge in 20 counties in Maryland and Virginia, totalling more than 70,000 acres of privately owned farmland.

While the Anne Arundel County project involves much smaller amounts of sludge (about 30 DT/day as compared to about 200 DT/day for the Blue Plains project), the project is operated in a rapidly developing county where residential areas are immediately adjacent to our farm sites. It was this development pattern which led to our selection of the liquid handling method for the Anne Arundel County sludge. The ability to inject sludge beneath the surface of the soil can greatly reduce, or eliminate, the potential for complaints from adjacent landowners. In more rural areas, subsurface injection may not be necessary and the application of cake sludge will generally be acceptable in the farming communities. It is important to design the sludge management program to take into account the overall acceptability of both the sludge itself and the application methods used.

While environmental and health concerns are commonly voiced when land application is proposed, the issues which have the greatest potential for jeopardizing the program have nothing to do with environmental or health risks. Our experience has been that the appearance, and even more importantly, any odor associated with the application of sludge is far more likely to create public opposition than any perceived risks (which have always been greater than any real risks associated with the practice). To decrease the potential for odor, we add dry lime to the digested sludge from the Blue Plains treatment plant which is land-applied. Since we are operating in several heavily populated areas, adding lime to the digested sludge has provided increased public acceptance. This lime addition is not required by any federal or state regulations since the sludge is already stabilized. However, it does serve to address the aesthetic concerns which are so critical to maintaining acceptability for a land application program. In addition, of course, the sludge's agricultural value is enhanced by the addition of lime.

Conclusion

As sludge handling becomes a larger and larger portion of treatment plant costs, the potential for improved sludge treatment and management technologies will likewise increase. The U.S. EPA actively promotes the beneficial use of sludge and most states have developed detailed regulatory programs for the management of land application projects. We believe the use of lime for stabilization and/or odor control has the potential to be a major component in land application beneficial use programs. It is important to address the specific considerations for each treatment facility and land application area in order to develop successful programs. While there is no single method that works for all sludges and in all places, a good understanding of the treatment processes, the equipment, and the methods of handling different types of sludges can help to insure a successful program.

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