BIOSOLIDS Pasteurization: A NEW APPROACH IN CHERAW, S.C.

Guy E. Slagle, Jr., P. E.
Hayes, Seay, Mattern & Mattern, Inc.
181 East Evans St.
Florence, South Carolina, 29506

J. Ted Morris
Public Utility Director
Town of Cheraw, South Carolina

INTRODUCTION

The Town of Cheraw, South Carolina, like many other communities across the country, has historically disposed of wastewater treatment plant residual solids at a local landfill. With the implementation of more restrictive solid waste disposal requirements and the promulgation of the EPA sludge use and disposal regulations (40 CFR Part 503), the Town of Cheraw has had to pursue other means for treatment and disposal of residual solids.

The Town authorized engineering studies to be performed to investigate alternative solids treatment and disposal options. Special emphasis was placed on those options which would produce a biosolids product meeting the Exceptional Quality standards of the EPA's 503 regulations. Alternatives evaluated included aerated static pile composting, aerobic digestion, air drying, heat drying, and various lime stabilization processes. Studies were completed in early 1993 and the alternative selected for implementation proposed the treatment of wastewater solids by a relatively new lime stabilization process developed by the RDP Company called."EnVessel Pasteurization" with final disposal by land application. The treatment system has been in operation since June 1994 and has been effective in resolving the Town's biosolids dilemma.

SOLIDS PRODUCTION

Cheraw's extended aeration activated sludge wastewater treatment plant has a capacity of 175 L/s (4.0 MGD). Plant components include influent pumping, bar screen, flow measurement, grit removal, duel aeration basins, duel clarifiers, and disinfection. Excess solids removed from the treatment system are pumped to a holding tank where the solids are mixed, aerated, and thickened prior to dewatering utilizing a belt filter press.

The current wastewater flow to the treatment plant averages approximately 118 L/s (2.7 MGD) of which approximately 53 percent of this flow is from industrial users. The major industrial users are textile. The Town has an Industrial Pretreatment Program which regulates the discharge of toxic pollutants to the wastewater system. During the past year, the influent and effluent BOD averaged 335 mg/l and 22 mg/l respectively. Influent and effluent suspended solids have averaged 165 mg/l and 26 mg/l respectively. The plant's NPDES permit requires effluent BOD and TSS to be less than 30 mg/l.

During the past year, the plant staff removed from the treatment system approximately 726 Mg (800 dry tons) of solids. The solids were processed through the holding tank and belt filter press. After dewatering through the belt press the solids quantity was approximately 4354 Mg (4,800 wet tons) at an average solids content of approximately 16 percent.

LIME TREATMENT PROCESS DESCRIPTION

After dewatering, solids receive additional stabilization by the EnVessel Pasteurization lime treatment process. This continuous flow process utilizes quicklime and supplemental electrical heat to elevate the pH and temperature of the solids to that level needed to destroy pathogens and reduce vector attraction properties.

As the solids come off the belt press they are conveyed to a live bottom storage hopper then to a mixing chamber called a "Thermoblender" where quicklime is added. The mixing chamber contains duel mixing rotors that blend the solids and the quicklime. Within chamber the solids are heated to approximately 70°C (157°F) by reaction with the quicklime and by electrical heat tubes installed internal to the mixing rotors. The minimum amount of lime added is that quantity required to increase the solids pH to 12. The heated solids/lime mixture is then discharged to the pasteurization vessel where the entire mass of -material is allowed to essentially cook for approximately 30 minutes. This vessel provides an enclosed insulated environment that maintain the proper temperature to destroy pathogens contained in the solids. The vessel is equipped with heating elements to compensate for any heat losses during the processing period and to ensure that the solids maintains the proper temperature throughout. Vessel temperature and pH is monitored to provide documentation of compliance with state and federal regulations. After treatment the biosolids are conveyed from the pasteurization vessel to a concrete pad where they are windrowed to facilitate further dewatering after which the biosolids are moved into a covered storage area until final disposal by land application.

The lime treatment system has been designed to process 3.18 Mg per hour (7000 lbs/hr) of cake solids having a solids content of 16 percent. The facility is located on a 38 m by 38 m (125' by 125') concrete pad which is covered. Space is available within this area for storage of 60 days of product production at design capacity. A similar size concrete pad was also included in the project to provided an area for product storage and air drying. The limited space required by the process was one of its attractive features. The plant is located on a relatively confined site and the Town was able to construct the facility on the site occupied by the plant's old sludge drying beds. Lime is stored in a 27,200 kilo (30 ton) silo which provides approximately 36 days of storage. All drainage from the facility is collected and returned to the head of the wastewater treatment plant.

SIGNIFICANT PROCESS FEATURES

The process of solids treatment by the addition of lime is not new and the technology is known and full, documented elsewhere. However, the process used in Cheraw represents a new approach to lime treatment and has several unique technical features worthy of discussion.

Lime Dosage: The Cheraw biosolids treatment system utilizes a combination of lime and electrical heat to meet the temperature and pH requirements for pathogen destruction and reduction in vector attraction. A lime only treatment system would require approximately 1 gram of lime per gram of dry solids to create sufficient chemical hydration to raise the solids temperature to 70°C. With the use of supplemental electrical heat, the Cheraw system has been able to reduce the lime required to approximately 0.38 gram of lime per gram of dry solids. With reduction in lime dosage, less ammonia gas is produced resulting in reduced on site process odors and less site dust. These features were especially critical to Cheraw since the treatment plant is located adjacent to a residential area. It has also resulted in preserving the nitrogen content of the final biosolids. The use of less lime also reduces the mass of product for final disposal.

Pathogen Reduction and Vector Attraction: Conventional lime treatment systems typically cure the lime and solids mixture on a concrete slab in piles exposed to the weather. This means that the outer portion of the mixture piles may be at a lower temperature than that required for complete pathogen destruction. The Cheraw system cures or cooks the solids in an enclosed insulated treatment vessel. This insures that the entire mass of solids and lime mixture is maintained at the required temperature for complete Pathogen destruction. As previously mentioned the vessel is equipped with electrical heating elements to compensate for any temperature loss during the treatment period. These features of the system provided Cheraw with additional assurance that the quality of the final product would meet expectations.

Land Application Rate: In the Cheraw area most farmland requires the application of lime to make up the calcium that is absorbed by the crops. Lime is typically applied at a rate of 2.24 Mg per hectare (2000 lbs/ac) to the fields to maintain a pH of 6.5 to 7.0. The rate of land application for biosolids in the Cheraw area is typically limited by its lime content. Therefore, reducing the lime content as previously described allows a greater biosolids application rate per acre thereby decreasing the total amount of land required for biosolids disposal. For example, the land application rate for Cheraw's biosolids using a conventional lime only system would be 14 Mg of biosolids per hectare (6.25 tons/ac). With the lime and electrical heat system the application rate is increased to approximately 32.5 Mg per hectare (14.5 tons/ac). Therefore, the Cheraw system has reduced land requirement by approximately 57 percent. This feature was attractive to plant staff since it meant that fewer farmers and sites would be required for final disposal of the product.

SYSTEM OPERATION

The lime treatment system has been in operation since June 1994. During the past year, 726 Mg (800 dry tons) of biosolids were processed by the facility. Lime dosage averaged 0.38 grams per gram (768 pounds per dry ton) of biosolids.

The solids content of the belt press cake averaged 16%. After lime treatment, solids content increased to approximately 30%. This increase in solids content is due to the addition of the lime, the extraction of water by the chemical reaction forming calcium hydroxide, and by evaporation. It has been observed that the calculated solids content is typically about five to eight percent less than the measured solids content. The product at this point has a paste consistency even though the moisture content has decreased significantly by weight. Further drying of the product is desirable to reduce haul cost and to facilitate land application. This is achieved by moving the product to an open concrete pad where it is spread and windrowed. The windrows are periodically turned to assist the drying process. When the solids content increases to approximately 40% the product is moved under covered storage awaiting final disposal.

Of particular concern to the product users is the chemical, lime, and nutrient content of the product. Samples are taken from each process batch and are analyzed for chemical content. In every instance the metal content has been less than the most restrictive standard of the EPA 503 regulations for land application. Presented in Table 1 is a data summary describing the agricultural lime equivalent and plant available nitrogen, phosphorus, and potassium per ton of product.

In order to document compliance with the EPA 503 Regulation's Class A sludge pathogen reductions requirements and vector attraction requirements, continuous measurements are made of solids temperature and pH within the "Thermoblender" and pasteurization vessel. The pH of the biosolids is also monitored at the end of the 24 hour treatment period to verify compliance with the EPA regulations. Since the process has been in operation, there has been no instance where temperature and pH requirements of EPA have not been met. Even after 6 months of storage, product pH has not dropped less than 12. Prior to hauling any biosolids off-site fecal coliform samples are taken. This sampling has indicated no evidence of feral coliform regrowth.

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n early 1995 the Town obtained authorization from the State of South Carolina to discharge solids from the Town's water plant to the wastewater system. The water plant utilizes conventional water treatment technology with alum as its primary coagulant. Solids production from this plant has averaged 18.1 to 27.2 Mg (20 to 30 dry tons) per month. The wastewater plant staff have observed no change in plant performance other than increased solids quantity. Likewise there has been no observable impact upon the solids dewatering and lime treatment system. Product appearance and chemical content has not changed other than for aluminum concentration. Incorporation of the water plant solids into the wastewater treatment system has saved the Town the effort and expense of operating duel solids treatment and disposal systems.

BIOSOLIDS DISPOSAL

The Town of Cheraw is actively marketing the biosolids to farmers. Marketing efforts have been by personal contacts with local farmers. After about of year of operation local farmers were invited to tour the treatment facility and attend a presentation to introduce them to how biosolids were produced, its characteristics, and potential uses. Assistance has been also provided by the Soil Conservation District, Clemson University, and the Agricultural Extension Service in disseminating information regarding the product to potential users.

During the first 18 months of operation the demand for the product did not equal production and product inventory grew. This is believed to be due to several factors. First, the Town recognized the lime and nutrient value in the biosolids and insisted that the farmers assume responsibility for hauling and land applying the biosolids. Second, many farmers did not have the capability to haul and land apply the biosolids, and it is believed that the farmers were hoping the Town would get desperate enough to assume responsibility for hauling and spreading. Lastly, the use of biosolids was a new concept to the farmers and its use is perceived to include risk. This Spring the demand for the biosolids product by farmers has increased. Currently, demand equals biosolids production. Several farmers are coming to the treatment plant to get the product for application to their fields. The Town is optimistic that as these farmers see first hand the benefit associated with use of biosolids on their land that the demand will increase. It is the hope of the Town that the demand will eventually increase to the point were the cost of the lime used in the treatment process can be recovered.

Each recipient of biosolids is given a copy of a label which describes the quality of the biosolids ant provides assistance as to its proper use. This label was developed with the assistance of the South Carolina DHEC and the Clemson University Agricultural Department.

A research project was initiated in 1995 by the State Forestry Commission and Clemson University to study the effect of Cheraw biosolids on loblolly and longleaf pine tree growth at the Sandhills State Forest near Cheraw. Other studies by Clemson University have demonstrated increased forest productivity with the application of biosolids. The Sandhills State Forest includes approximately 18,616 hectares (46,000 acres) of forest land, roads, and wildlife food plots. The soils in the Forest have generally poor nutrient status. The objectives of the research project will be to: (1) measure the magnitude and duration of a one time biosolids and inorganic fertilizer application on forest wood production; (2) determine micronutrient and element fate; and (3) measure the change in straw production as effected by inorganic fertilizer and biosolids. This study will be ongoing for a 10 year period. After one year it has been reported that those trees receiving biosolids are showing signs of increased yield. All are confident that the results of this study will provide Cheraw with a land disposal site for its biosolids, and the Sandhills State Forest will realize increased soil fertility, wood volume yields and pine straw production.

In order to further demonstrate the beneficial use of biosolids the Town has constructed at the wastewater treatment plant 10 test plots which grass will be grown. Each test plot has received biosolids at a different application rate. Grass yield from each test plot will be quantified. Those potential users will be able to see at the treatment plant the beneficial use of the biosolids.

PRODUCTION COST

The construction of the biosolids treatment facility was completed in June 1994 at a cost of $1,108,000 of which $575,000 represented the process equipment value.

Operational cost of the Cheraw biosolids treatment system is documented in Table 2. Primary operations cost are labor and lime. The estimated operational cost for the lime treatment system is approximately $116 per Mg ($105 per dry ton) of solids treated.

For purposes of comparison, a treatment system employing lime only would have a similar construction cost. The electrical heating elements would be eliminated, however a larger capacity lime feeding system would be needed. Operationally, the electrical cost would be essentially eliminated, however the lime cost would increase due to the higher lime dosage required. It is estimated the operational cost for a lime only system would be approximately $194 per Mg ($176 per dry ton) of solids treated not considering the increase quantity of biosolids that would have to land applied.

Based upon the above operational cost comparison and a solids production rate of 726 Mg (800 dry tons) per year, the annual cost savings realized by the Cheraw lime treatment system would be at least $56,600 per year.

A significant benefit resulting from Cheraw's new biosolids treatment system is that it produces a biosolids product that farmers are now coming to the treatment plant to pick up. This eliminates the substantial cost the Town previously paid for hauling the solids to the landfill.

CONCLUSION

The Town of Cheraw has successfully implemented a solids treatment process that utilizes lime to elevate the solids pH and electrical heat with lime to raise solids temperature. This new approach in solid treatment has several features worthy of consideration which include:

* With the use of electrical heat, the lime dosage has been reduce as compared to a lime only treatment system.
* Reduced lime dosage decreases ammonia gas production and associated odors while preserving biosolids nitrogen content.
* Reduced lime dosage results in less biosolids mass for final disposal.
* Acreage required for land application is reduced.
* With the use of an electrically heated treatment vessel, pasteurization temperature is reliably maintained throughout sludge mass resulting is superior biosolids quality.
* Biosolids product exceeds state and federal quality standards for land application
* The use of electrical heat and lime is economical.
* The production of a superior quality biosolids product has resulted in users coming to the plan to Get the biosolids.

REFERENCES

1. Miller, T.C., et al., “A Study of the Reaction Between Calcium Oxide and Water”, National Lime Association.
2. Christy, Robert W., “Sludge Disposal Using Lime”, Water Environment & Technology, April,1990
3. “Process Design Manual for Sludge Treatment and Disposals, U.S. EPA 625/1-79-011 (1979)
4. Dickens, David, “Study Proposal for Lime Stabilized Biosolids Application on the Sandhills State Forest”, May 1995.

TABLE 1: BIOSOLIDS LIME AND NUTRIENT CONTENT

Batch Number	Ag Lime lbs/ton	Nitrogen lbs/ton	Phosphorus lbs/ton	Potassium lbs/ton
1	514	10.2	12.5	1.3
2	354	13.6	14.3	1.3
3	412	13.8	10.7	1.3
4	473	21.1	9.6	1.6
5	515	12.9	8.6	1.1
6	360	13.6	19.3	1.9
7	416	18.3	16.5	1.5
8	515	12.2	9	1.8
AVG	445	13.3	12.6	1.5
MIN	354	10.2	8.6	1.1
MAX	615	18.3	19.3	1.9

TABLE 2: BIOSOLIDS PRODUCTION COST

SOLIDS DEWATERING

ITEM	COST PER DRY Mg OF SOLIDS	COST PER DRY TON OF SOLIDS
Labor	$28.30	$25.67
Belts	$3.16	$2.87
Parts, Repair, and Lubricants	$10.77	$9.77
Electricity	$12.92	$11.72
Polymer	$21.50	$19.50
TOTAL	$76.65	$69.53

LIME TREATMENT

ITEM	COST PER DRY Mg OF SOLIDS	COST PER DRY TON OF SOLIDS
Labor	$26.31	$23.87
Parts, Repair, and Lubricants	$17.47	$15.85
Loader Operation	$5.05	$4.58
Analytical Testing	$2.02	$1.83
Electricity	$10.26	$9.31
Lime	$54.92	$49.82
TOTAL	$116.03	$105.26