EVALUATION OF TWO METHODS FOR LIME STABILIZATION OF BIOSOLIDS

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In early 1993, the City of Cookeville, Tennessee began to consider various methods of compliance with the new 40CFR Part 503 regulations. After some deliberation, it was determined that the most desirable alternative for Cookeville would be to produce "EQ" biosolids using lime stabilization and to spread the final product on farm land using a manure spreader. Two methods of lime stabilization were considered: lime only pasteurization of biosolids and the RDP EnVessel PasteurizationÔ Process. Since the actual operating costs of these two methods could be determined only after the required lime feed rate was established, a pilot test was conducted in order to establish the lime feed rates.

The lime only pasteurization method utilizes a biosolids/lime mixer and an insulated pasteurization vessel which, in this case, were supplied by F. B. Leopold Company Inc. Pathogen reduction is accomplished by adding lime to the biosolids. The heat produced by the reaction of the lime with the water in the biosolids raises the temperature of the biosolids sufficiently to comply with the Class A Alternative 1 pathogen reduction requirement of the 503 regulations (temperature above 158° F for 30 minutes). Vector attraction reduction is accomplished at the same time, since the lime raises the pH of the biosolids to at least 12. The Leopold pilot unit consisted of a full size mixer, a lime feeder, and a batch type insulated container which approximated the pasteurization vessel.

The RDP EnVessel PasteurizationÔ Process utilizes an electrically heated biosolids/lime mixer and an electrically heated pasteurization vessel supplied by RDP Company. Sufficient quantity of lime is added to the biosolids to raise the pH above 12.0 which meets the vector attraction reduction requirements. Pathogen reduction is accomplished by adding electrical heat to further raise the temperature of the biosolids to comply with the Class A Alternative 1 pathogen reduction requirements. RDP's pilot unit consisted of a biosolids feeder, a lime feeder, an electrically heated mixer and an electrically heated pasteurization vessel which had a capacity of about 10 percent of the full size unit.

Before the pilot test, arrangements were made with Tenn Luttrell Company to provide quicklime for the pilot test for freight charges only. The lime was furnished in bulk bags weighing between 2500 and 3000 pounds each. Watt meters were set up to record the power usage of RDP's electric heaters, and laboratory testing methods were reviewed. A pilot test procedure was established for each manufacturer and reviewed with the manufacturer prior to transporting the equipment to the treatment plant site.

The manufacturers were allowed to set up their equipment several days early if they desired in order to determine the best treatment method for Cookeville's biosolids. Prior to the start of each day's testing, all biosolids wasting for the day was completed so that the biosolids feed from the biosolids holding tank to the belt press would be consistent throughout the test period. The belt press inlet and discharge solids were determined periodically throughout the day and at the beginning of each pilot test period. Each manufacturer ran two separate tests. During each test, output temperature was measured at least once every 15 minutes, output pH was measured at least once, and a sample was held for 24 hours to allow a 24-hour pH to be determined.

Leopold's pilot unit was a full size unit, so it was set up directly under the discharge hopper for the belt press. The biosolids feed rate was determined using the measured inlet solids and the revolution count from the plunger pump which feeds the belt press. The lime feed rate was determined by weighing a bulk bag of lime with truck scales prior to the start of the test and adjusting the time period of the test to use the entire bag of lime. Since the pasteurization vessel was a batch type, two separate batches were monitored for temperature during each test. Table 1 shows the results for Leopold's pilot tests.

RDP's pilot unit was set up outside in a paved area. The biosolids feed rate and the lime feed rate were determined by monitoring the screw feeder settings during the test and checking the weight of the contents of a bucket after a timed fill from each feeder after completion of the test. The temperature of the stabilized biosolids at the 30 minute detention point in the pasteurization vessel was monitored at least every 15 minutes. Watt meter readings were taken at the beginning and the end of each test period in order to determine the power requirements of the heating units. Table 2 shows the results for RDP's pilot tests.

The pilot test results along with the total connected horsepower of the proposed full size biosolids stabilization units were used during bidding to establish operating cost for each unit. The following data was used to determine the operating cost per ton of dry biosolids:

Electrical Cost: $0.055/kwh

Lime Cost: $75.00/ton

Motor Efficiency: 90%

Sludge Production: 2600 dry lb/hour, 40 hr/week, 52 weeks/year

Electrical Usage: power requirement of connected horsepower
at stated efficiency plus any power required for heat

From the pilot test results, it was determined that Leopold should use a lime feed rate of 106%, and RDP should use a lime feed rate of 25.3% plus 0.067 kwh per pound of biosolids treated for added heat.

TABLE 1

LIME ONLY BIOSOLIDS STABILIZATION PILOT TEST RESULTS

Test No. 1 - December 1, 1993

Total Sludge Treated = 2173 lbs.

Total Test Time = 88 minutes

Total Lime Fed = 2560 lbs.

Lime Dosage = 118%, dry weight basis

Minimum Temperature Pasteurization Vessel = 198° F

Maximum Temperature Pasteurization Vessel = 210° F

Test Results: Belt Press Output Solids = 21.5% average

Stabilized Biosolids Solids = 54.7% average

pH = 12.1

Test No. 2 - December 1, 1993

Total Sludge Treated = 2676 lbs.

Total Test Time = 112 minutes

Total Lime Fed = 2840 lbs.

Lime Dosage = 106%, dry weight basis

Minimum Temperature Pasteurization Vessel = 170° F

Maximum Temperature Pasteurization Vessel = 197° F

Test Results: Belt Press Output Solids = 20.0% average

Stabilized Biosolids Solids = 44.6% average

pH = 12.0

TABLE 2

LIME/ENVESSEL BIOSOLIDS STABILIZATION PILOT TEST RESULTS

Test No. 1 - November 30, 1993

Total Sludge Treated = 286 lbs.

Total Test Time = 95 minutes

Total Lime Fed = 101 lbs.

Lime Dosage = 35.3%, dry weight basis

Minimum Temperature Pasteurization Vessel = 158° F

Maximum Temperature Pasteurization Vessel = 176° F

Electrical Usage for Heat = 18 kwh

Test Results: Belt Press Output Solids = 20.1% average

Stabilized Biosolids Solids = 30.1% average

pH = 12.1

Test No. 2 - December 1, 1993

Total Sludge Treated = 194 lbs.

Total Test Time = 61 minutes

Total Lime Fed = 49 lbs.

Lime Dosage = 25.3%, dry weight basis

Minimum Temperature Pasteurization Vessel = 158° F

Maximum Temperature Pasteurization Vessel = 165° F

Electrical Usage for Heat = 13 kwh

Test Results: Belt Press Output Solids = 19.9% average

Stabilized Biosolids Solids = 28.1% average

pH = 12.0

Using an annual biosolids production rate of 5,408,000 pounds, the cost of Leopold's lime only pasteurization process was calculated as follows:

Lime Cost - 106% feed rate	$ 214,968
Electrical Cost - 38.5 connected hp	$ 3,651
Total Annual Operating Cost	$ 218,619
Present Worth at 6-5/8% over 10 years	$ 1,562,470
Capital Cost	$ 690,000
Total Cost	$ 2,252,470

The cost of RDP's lime/EnVessel PasteurizationÔ Process was calculated as follows:

Lime Cost - 25.3% feed rate	$ 51,308
Electrical Cost - 60 connected hp	$ 5,689
Electrical Cost - heat @ 0.067 kwh/lb	$ 19,928
Total Annual Operating Cost	$ 76,925
Present Worth at 6-5/8% over 10 years	$ 549,783
Capital Cost	$ 1,032,875
Total Cost	$ 1,582,658

her factors considered during evaluation of the equipment included the general appearance of the finished product, fertilizer and lime content of the finished product, and land area requirements for land application. In general, the lime only biosolids had a more acceptable appearance in the opinion of most of the test observers. The lime only biosolids were very light in color which may be more appealing to farmers and the general public. The RDP EnVessel PasteurizationÔ processed biosolids were darker in color and closer in appearance to biosolids.

An analysis of each type of biosolids was made to determine its lime and fertilizer content. The results of this test are shown in Table 3. Land area required was calculated for each type of biosolids assuming an annual nitrogen utilization rate of 130 lb/acre and a lime loading rate of 2000lb/acre/year. Calculations show that the lime only biosolids require 693 acres per year at fertilization rates and 2114 acres per year at lime application rates. The RDP EnVessel PasteurizationÔ processed biosolids require 1288 acres per year at fertilization rates and 1005 acres per year at lime application rates.

Cookeville made the decision to utilize the RDP EnVessel PasteurizationÔ method after consider all of the data. Table 4 shows a summary of the results of the pilot test.

Parameter	**RDP EnVessel Pastuerization**	**Lime Only Pastuerization**
Solids	30.87	41.78
Nitrogen	3.14	1.72
Ammonia Nitrogen	0.10	0.07
Nitrate Nitrogen	0.03	0.03
Calcium Carbonate Eq	37.12	78.18
Organic Nitrogen	3.04	1.65
Nitrite Nitrogen	<0.01	<0.1

Parameter	**RDP EnVessel Pastuerization**	**Lime Only Pastuerization**
Lime Cost Per Dry Ton Sludge	$18.97	$79.50
Power Cost per Dry Ton Sludge	$9.47	$1.35
Total	$28.44	$80.85
Land Required per Dry Ton Sludge	0.48 acres	0.78 acres