"TOHAR" – A TECHNIQUE FOR PRODUCING CLASS A SEWAGE SLUDGE USING AN ELECTRON BEAM

Ben Yaacov Nitzan

Maayanot 23, Shimshit, 17906, Israel, nitzancrm@walla.co.il

The Bar Idan Company is about to begin the construction of a pilot plant in the city of Beit Shemesh in Israel for treating raw sewage sludge. The pilot plant will process 800 tons of sewage sludge per month (18% dry solids).

The technology that will be used is based on our new patented technique for converting raw sewage to Class A sludge, and is based on the following:

1. Sterilizing the sludge by passing it under an electron beam;

2. Mixing the sludge with small amount of lime to initiate a stabilizing reaction.

This treatment is performed together with the dehydrating process. The process produces Class A sewage sludge, which is characterized by the following:

1. Total coliforms –under countable level;

2. PH above 12 in the first 2 hours and no lower than 11.5 after 22 hours;

3. Total odor control;

4. Total vector attraction control;

5. The process retains the value of the sludge as agricultural fertilizer.

I. Background

International pressure for environmental conservation and the increase in the world's population have resulted in stricter regulations and increased efforts to recycle waste materials (Agenda 21). In light of these developments, the importance of recycling sewage sludge from sewage installations is becoming increasingly important.

Israel has preceded other countries in the Western world in its requirements for treating sewage sludge. As a result, severe regulations have been instituted that require sewage sludge to be converted to Class A sludge before it can be used as agricultural fertilizer.

The city of Beit Shemesh operates a sewage purification facility with an output of 800 tons of raw sludge at a concentration of 16% dry material. During the past five years the facility has operated an installation for purifying sludge using N-Viro technology. Directors of the facility intend to halt the operation of the N-Viro plant because the sludge cannot be used for agricultural fertilizer.

Our company has been chosen to establish an alternative installation for treating sludge, based on "Tohar" technology.

I.A. A Review of Existing Competitive Technologies

- Using Sewage sludge as fertilizer

1. Compotation - continuing digestion of the sludge and converting it to fertilizer. This is a relatively inexpensive process based on a biological process that takes approximately three months. This process can take place in open air on asphalt surfaces or in containers or closed chambers. Its objective is to decrease hazards of odor or to maintain a proper temperature.

2. Sterilization and alkaline stabilization – Decontamination of the sludge while implementing a reaction with alkaline calcium (at a ratio of 1:1 or 100%) to increase the temperature of the sludge and stabilize it by increasing its PH. The product derived from this reaction is approved for use as fertilizer in agriculture, but is of relatively low value.

- Burial
- Incineration

This is the most complex technology to implement and is the most controversial, due to air pollution and the high cost of installation and operation.

Table 1 compares the nutrient value to plants for the various types of sludge.

TABLE I. Major Plant Nutrient Element Contents

Measurement	Secondary Un-stabilized Sludge	Digested Sludge	Composted Sludge	EcoSoil Beit Shemesh
DM (%)	20	20	70	70
OM (%)	-8560	76-41	49-34	7.9
C (%)	40-38	38-21	33-20	4.6
Ammonium NH4 (mg/kg)	6,253-1,383	4,704-315	3,115-106	20
Nitrate NO3 (mg/kg)	~	1,344-0	1,450-0	2
Total N (%)	5.77-7.84	5.87-1.86	3.21-1.59	0.54
Corg/Norg	5.4-8.2	5.9-16	11-19	9
Pot. Min. N (%)	70-80	30-40	5-15	50
Total P (%)	3.90-1.12	2.95-0.48	1.99-0.93	0.37
Ortho-P (%)	1.36-0.06	0.26-0.06	0.10-0.04	0.04
PO4 % of PTot	35-5.2	21-2.4	9.3-2.5	11
pH	6.64-5.95	8.11-6.06	8.11-6.06	12
EC (dS/m)	14-3.2	15-3.3	15-3.3	2.3

II. Description of the System Components

1. Inlet buffer tank;
2. Sterilization system using an electron beam that applies 10 kGy of dose to the sludge;
3. Stabilization blender - blendes 2-3% lime into the sludge;
4. Finished product storage tank;
5. Control system, automation, and odor control system.

II.A. The Sewage Sludge Treatment Plant

Area of the Facility: 200 square meters.

Description of the system components:

1. A 20-Cubic meter intermediary tank for storing unprocessed sludge. This ensures that the system operates within four hours and stabilizes the process without being dependent upon the rate of water removal.

2. Sludge Sterilization facility – This structure contains the electron beam emitter. The sludge enters this part of the facility through a nozzle that spreads it in a thin layer. The sludge then passes under the electron beam. The sludge absorbs at least one mega-rad of energy, ensuring complete sterilization.

3. Facility for stabilizing the sludge – The sludge is mixed with 20 kg. of lime for each ton of wet sludge at a concentration of 16% dry material. The sludge and lime are mixed in a mixer designated for this purpose.

4. Storage tanks for the finished product – Six tanks are located in an accessible area where they can be loaded and unloaded.

5. All system components are located in a closed structure with a central facility for treating odors and a central system for control and supervision of the production process.

Facility design guidelines and monthly fluent operational expenses are shown in tables 2 and 3.

TABLE II. Facility Design Guidelines

Quantity Of Wet Sludge Per Month (18%)	**800 Ton**
Electron Beam Type	**1.5 MeV, 50 kWh**
Electrical Efficiency	**70%**
Applying Doze	**10 kGy**
Number Of Shifts	**1**
Dry Materials Content	**18%**
Kilowatt Costs	**$0.08**
Average Monthly Wages	**$3,571**
Number Of Workers	**1**
Interest Level	**9**
Number Of Years For Reductions	**10**
Details of Establishment Costs	
Electron Beam	**750,000**
Civilian Engineering	**205,000**
Lime equipment	**80,000**
Groundwork and electricity	**167,000**
Conveyors	**60,000**
Pumps	**38,500**
Establishment and Licensing	**365,000**
unexpected expenditures	**227,325**
Total Establishment Costs	**2,059,600**

TABLE III. Monthly Fluent Operational Expenses

Capital (depreciation for 10 years at 9% interest)	**25,444**
Electricity (estimated cost $1.50 per ton)	**1,200**
Wages	**3,571**
Lime - 2% Doze, $95.00 per ton + transport costs	**1,520**
Maintaining sterilization facility	**1,750**
Other maintenance costs	**5,714**
Quality, Insurance, Misc.	**4,000**
Total monthly fluent costs	**43,200**

Unexpected Fluent Expenditures	**6,480**
Total monthly fluent costs + unexpected expenditures	**49,680**
Class A processing cost per ton. (USD)	**345**
Transport costs	**5,714**
Spreading and applying	**2,476**
Total cost for transport and applying.	**8,190**
Class A total processing costs. (USD) (Processing, Transport and applying)	**57,870**

III. RESULTS and DISCUSSIONS

At the beginning of the project it was decided to establish the first plant that would serve as a facility for proving the success of the Tohar technology and applying it as a basis for commercial operation of our company, based on this technology.

The "Tohar" technology is an elaboration of a previously known EPA-approved technology for sterilization of sludge and converting Class B sludge to Class A sludge. (The technology is referred to in EPA Code (7) (A) 503 32).

The plant will be built as a pilot plant and will operate for 25 years depending upon its success.

Criteria for Success:

The demonstration process will be accompanied by daily examinations to monitor the various parameters. These examinations will determine if the processed sludge meets regulations requirements regarding elimination of water and its use.

The following parameters will be examined:

1. PH 2 hours and 24 hours following the processing time;

2. The concentration of *Coliforms* feces - type bacteria and/or *Salmonella* and/or intestinal viruses and/or live parasite eggs.

The success of the demonstration will be determined by whether or not the measurements meet the code requirements.

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