Landfill Gas + Wastewater Residuals = Marketable Fertilizer Pellets

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The Solid Waste Authority of Palm Beach County (SWA), acting on behalf of the major utilities in Palm Beach, Martin, and St. Lucie counties, is in the process of developing a regional biosolids pelletization facility (BPF) to be operated by a private partner. The main purpose of the regional BPF is to provide a safe, environmentally friendly alternative to the practice of land applying biosolids, thereby reducing nutrient loading to the Okeechobee, Indian River Lagoon, and St. Lucie River watersheds.

Federal, state, and local governments are reviewing the potential impacts of land application, such as nutrient loadings to surface waters through run-off. The SWA is taking a leadership role in providing an alternative to the land application of biosolids.

The regulations governing wastewater residuals (biosolids) were established by the U.S. Environmental Protection Agency (EPA) in 1993 in the Code of Federal Regulations, Title 40 (Part 503). The regulations were promulgated to protect public health and the environment.

An alternative to land applying biosolids is to heat dry the sludge. Heat drying is defined in Appendix B to Part 503, in the processes to significantly reduce pathogens (PSRP) as:

> *2. Heat drying — Sewage sludge is dried by direct or indirect contact with hot gases to reduce the moisture content of the sewage sludge to 10 percent or lower. Either the temperature of the sewage sludge particles exceeds 80 degrees Celsius or the wet bulb temperature of the gas in contact with the sewage sludge as the sewage sludge leaves the dryer exceeds 80 degrees Celsius.*

In keeping with the new regulations, the technology to achieve the reduced moisture content stated in Appendix B has advanced over the past few years. Sludge leaving wastewater plants is often dewatered on site through either belt filter presses or centrifuges. This initial dewatering is vital to the heat-drying process in reducing the amount of energy and fuel required to drive off the remaining water. Heat-drying technologies vary from indirect drum dryers to direct drum dryers.

Heat Drying/Pelletization

Wastewater sludge heat drying/pelletization involves heating the feed sludge (15 to 20 percent solids) in a rotary dryer. The formed product typically ranges in size from 1 to 4 mm in diameter. Particles less than 10 microns in size are removed from the product stream and recycled back into the feed material. Product material in the desired size diameter range (1 to 4mm) is taken from the dryer outlet to the cooler, where it is cooled to 120° F.

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There are two main modes of biosolids drying that can be used in the heat drying/pelletization process:
- Direct dryers
- Indirect dryers

Direct Dryers

Direct dryers involve bringing the feed material into direct contact with the heated air stream. Of the three direct-drying systems most commonly used (flash dryers, rotary dryers, and fluid-bed dryers), rotary dryers are the most utilized. In this process, a rotating drum is paired with a high-velocity air stream to facilitate evaporation. A gas-fired burner produces 2,200° F gases, which are mixed with dilution air, resulting in an air stream at 750° F to 900° F.

The wet sludge (18 percent solids) is mixed with the recycle material produced during the drying process to form a feed material at 50 to 60 percent solids. The feed material is then carried through the dryer by the fast-moving air stream as the moisture evaporates. The temperature at the outlet of the dryer drops to approximately 185° F as the moisture in the sludge evaporates.

The dried sludge is approximately 93 percent solids at the outlet, which allows for easy handling and storage. The unit heat rate of the system is approximately 1,450 to 1,550 BTU/lb of water evaporated. Direct dryers typically produce a marketable product when the sludge is digested prior to the dewatering process.

Indirect Dryers

Indirect dryers utilize conduction drying to heat biosolids to temperatures of approximately 212°F. Paddle dryers, hollow-flight dryers, disc dryers, and multiple-effect evaporation dryers use a heat transfer medium (typically steam) to conduct heat through the shell. The paddle, hollow-flight, and disc dryers consist of a stationary horizontal dryer with a jacketed shell. These dryers contain a rotating agitator to move heat through the sludge.

In the indirect process, the outside of a rotating dehydration tube is heated. The biosolids never come into direct contact with the heat source; they are moved through the tube by a heated auger. No outside air enters the drying area in this system.

The absence of oxygen eliminates the chance of combustion within the system. The isolated system also allows for essentially no emissions. The moisture removed from the biosolids is collected as steam and removed from the dryer using a blower.

Regional Facility Concept

The SWA was approached by the regional wastewater utilities operators to take a leadership position in the formation of a regional BPF. The economy of scale of such a facility would require a minimum critical mass of participants to make the project viable. The producers of sludge for the tri-county area, consisting of Palm Beach, Martin, and St. Lucie counties, were encouraged to participate in the facility, and their sludge numbers were analyzed as part of the initial assessment of the project.

Most of the potential participants are currently lime stabilizing their sludge and transporting it off site in dump trailers for land application. The attractiveness of the SWA is the site location, its proximity to landfill gas, and the operational flexibility provided by the landfilling operation. The centralized location, which is west of the Florida Turnpike off 45th Street in Palm Beach County, allows for fairly short hauling distance for the participants.

The planned BPF will produce a biosolids pellet that can be marketed as fertilizer product for distribution in the southeastern United States. The wastewater residuals would be delivered to the facility after being dewatered by either belt filter presses or centrifuges at their place of origin. The 12-to-15-percent solids cake would be dried in a direct heat drum drying process using landfill gas as the fuel. Landfill gas would also be used to power a proposed lime recalcination kiln located on the same site.

The use of the methane gas produced by the nearby SWA landfill gives the project an economic advantage over facilities that use natural gas as the fuel source. Presently, the landfill gas is burned off using a flare system, so by using this excess gas as a fuel source, the biosolids pelletization and the lime recalcination facilities would create a beneficial use of this commodity and a major fuel savings for the SWA.

Funding

Funding for the proposed facility will originate with the SWA and the major stakeholders, who will be identified in interlocal agreements that are being developed. These entities will provide the initial capital cost required to construct the BPF.

Once the facility is in operation, the participating entities will be charged a tipping fee associated with each ton of sludge delivered to the site. This tipping fee, along with the sale of the finished product, will provide the revenue to pay off the debt services and fund the operational expenses of the facility.

Actual capital cost of the facility will depend on several factors, such as manufacturers' equipment to be used and the final size of the facility to be constructed. It is anticipated that the facility will be housed within a metal structure sized to contain all the equipment, as well as the electrical and control rooms.

The facility is to be constructed on SWA property, taking advantage of the close proximity of the SWA landfill. The use of landfill gas will play a major role in reducing operational cost of the facility.

Design Considerations

Permits

One of the primary issues in constructing the proposed BPF is the required air permit modification from the Environmental Protection Agency. Depending on maximum potential air emissions, a facility of this type could be permitted as a "major" air pollutant source or as a "minor" air pollutant source.

After completing a detailed evaluation of the potential air emissions from the proposed facility, along with several meetings with the SWA, it was decided that one consolidated PSD major modification permit application would be submitted. It is anticipated that the entire permitting process, including design calculations and drawings, air emission modeling, permit applications, and regulatory review period, could take up to a year to complete. Other permits that must be obtained prior to construction include:

- Stormwater permits from the South Florida Water Management District
- Florida Department of Environmental Protection permit to construct potable and sanitary pipelines as well as an on-site sanitary pump station
- Dewatering permit from the South Florida Water Management District
- Building permit from Palm Beach County

Landfill Gas

Since the BPF will use gas produced by the neighboring SWA landfill as a fuel source, an analysis of the gas production was performed to determine if sufficient quantities of gas would be available to operate the proposed facilities. Data collected on the Class 1 landfill gas and the SWA landfill indicate that gas flow and quality have substantially increased over time.

The collection efficiency in the period from 1996-2000 averaged approximately 61 percent of the predicted available gas generated within the landfill. In 2001, the collection efficiency rose to approximately 78 percent with the expansion of the landfill gas collection system.

Landfill gas quality has also varied somewhat over time. The five-year average methane content of the gas is approximately 55 percent, while the 2000 average was approximately 57 percent and the 2001 average was nearly 60 percent. These figures show a trend of increasing methane content as the landfill ages; however, a conservative approach was taken, with

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the long-term methane content held to 50 percent for forecasting purposes.

The average rate of 56 MMBtu/hr. will be required to accommodate the firing capacity for both facilities. To quantify the available gas, three different methods were considered:

- Using the calculated five-year average methane concentration of 55.2 percent, a total of 1,691 standard cubic feet per minute (scfm) of landfill gas would be required to meet the demand. By adding the calculated 2001 average capture efficiency of 78 percent to the calculation, sufficient landfill gas, on an average-flow basis, would have been available to the new facilities in January 2004.
- Using the calculated 2001 average methane concentration of 59.8 percent, a total of 1,561 scfm of landfill gas would be required to meet the demand. By adding the calculated 2001 average capture efficiency of 78 percent to the calculation, sufficient landfill gas, on an average-flow basis, would have been available to the new facilities in February 2003.
- Should the gas quality drop to a more typical 50-percent methane content, 1,867 scfm of landfill gas would be required to meet the demand. By adding a more typical 75 percent average capture efficiency to the calculation, sufficient landfill gas, on an average-flow basis, would not be available to the new facilities until July 2006. This shortfall would be made up using natural gas, which is readily available to the site.

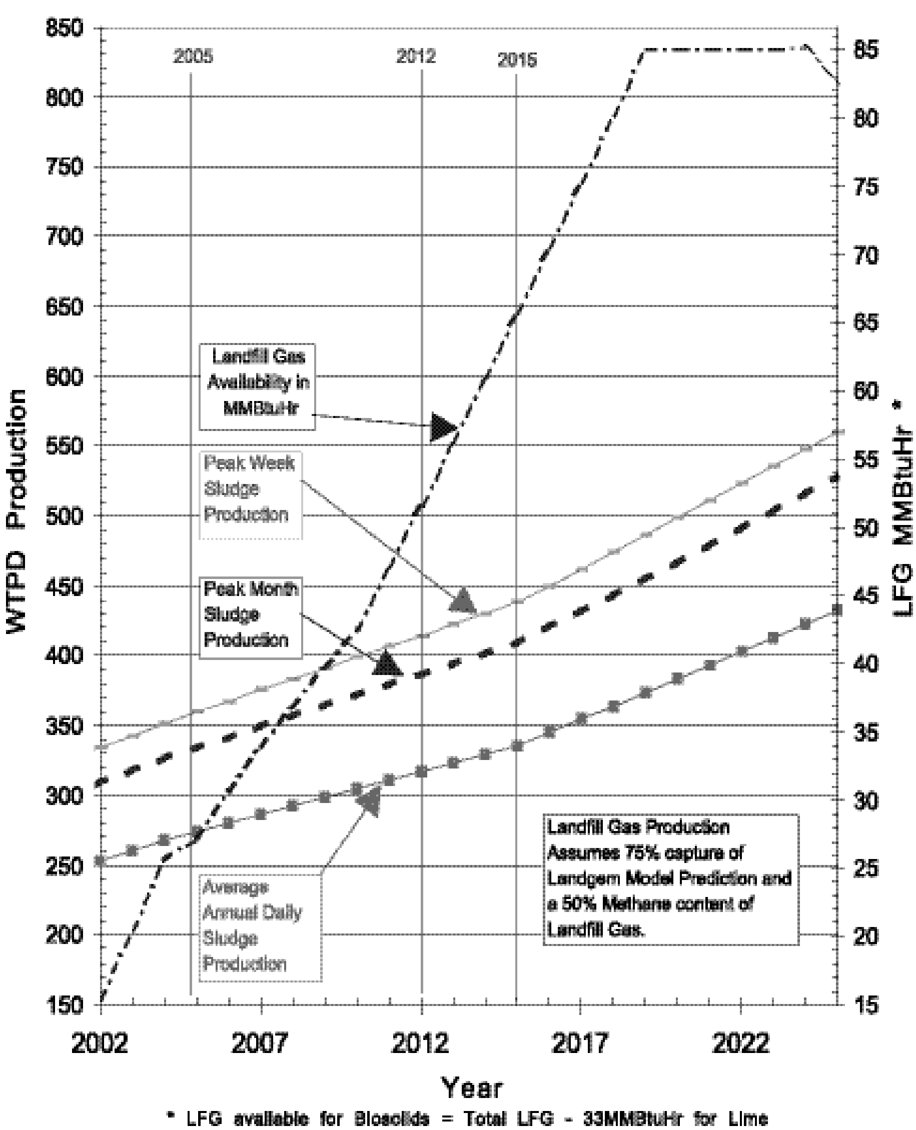
Sludge (Wastewater Residuals) Quantities

In order to properly size the BPF, it was necessary to conduct a sludge survey of the entities that may participate in the sludge pelletizing facility program. Using the sludge-production volumes gathered in the surveys, it was necessary to develop a peaking factor, not only for the average daily amount of sludge to be delivered, but also peak sludge quantities that could be delivered to the BPF.

The peaking factor is extremely important, since it will probably dictate the size of the facility to be constructed during the initial phase of the program. Should the designer choose too large a peaking factor, the facility could sit idle many hours of the day during the earlier years of operation. Discussions with the different entities and a review of record sludge-production data seem to indicate the use of a weekly peaking factor of 1.2 to 1.4 may be in order.

An example of the importance of the sludge-production peaking factor is shown in Figure 1, which was developed for the SWA project to reflect the relationships between sludge-production, dryer sizes (capacity in wet tons per day (wtpd)), projected landfill gas availability, and the peaking factors for peak week and peak month. As demonstrated by the graph, facility design considerations are drastically affected, depending on what peaking factor is used to pick the size of the initial dryer installation.

Figure 1
Sludge Production, Dryer Size, and LFG Availability



A review of **Figure 1** shows the relationship of the average annual daily sludge production (AADSP) and the size of the dryer needed to process the incoming sludge, based on a 20-year design tract. Using the AADSP, the unit should be sized large enough to process approximately 430 wtpd, but if the peak-week sludge production is considered in sizing the facility, the increase in capacity results in 560 wtpd. The peaking factor used for the peak week in this case was 1.4 to 1.0 and clearly demonstrates that this criterion can make a significant impact on the size of the pelletization facility—especially in the initial operating years.

The use of a high peaking factor increases the initial capital cost, but using offsite storage during more critical times can lower the peaking factor. If the sludge can be stored at the place of origin, its delivery to the BPF can be regulated to lessen the impact of peak times at the plant. This allows for smaller dryers to be installed and lowers the capital costs. The proximity to the SWA landfill also allows for the sludge to be land filled under extreme conditions.

Facility and Site Layout

The facility layout will vary, depending on the manufacturers' equipment specified. Typically the dryer(s) and the associated ancillary equipment will be housed in a structure, along with the electrical and control rooms. The structure will be a metal or masonry building designed to provide sufficient height and space for the dryer equipment. The design of this structure must allow for the transfer of incoming sludge to hoppers and must be capable of receiving dump trucks.

During preliminary design for the facility, it was decided that two sludge hoppers would be provided to allow for redundancy and operational reliability. The hoppers will be located below grade to allow faster unloading of trucks. The sludge-receiving area will be housed in a separate portion of the facility to segregate the odors from the main operations floor. Odor control is viewed as a major component of a successful plant. The design of the sludge-receiving area will provide for a high ceiling clearance to accommodate the semi-truck dump trailers.

Corrosion Prevention

Wastewater sludges tend to give off ammonia and hydrogen sulfide gasses, which can be very high in odors as well as corrosive. The corrosive nature of the off gasses leads to careful consideration in the selection of the building materials, piping, electrical components, and miscellaneous metals to be used in the sludge-receiving area.

Material Handling

Material handling is a vital concern for the facility. The raw sludge will be received in the hoppers from dump trucks brought in from the various participants' wastewater treatment plants. The sludge will be transported through screw conveyors located in the bottom of the hoppers to a vertical lift conveyor, which will bring the material up to overhead horizontal screw conveyors. These conveyors will dump into a feed hopper that will ultimately feed the dryers.

The dried product will then be transported into two storage silos, where it will be loaded into semi-trailers for transport off site. All conveyors will be covered to limit fugitive dust emissions. The dust is captured using a bag house and the fines are returned to the feed hopper and mixed with the raw feed material to increase the solids content of the feed material.

The storage silos will be located over truck weigh scales to assist in loading the proper amount of material onto the trucks. The silos will be equipped with a nitrogen cooling system, which lowers the risk of explosion through cooling and oxygen deprivation.

Site Layout

Site layout is another critical element in the design of the completed facility. The site will experience heavy truck traffic on a continuous basis each day, so the road network on site must allow for not only maintenance vehicles but also ingress and egress to the site. In most cases, sludge trucks will be required to weigh in and out with each visit. Trucks leaving with the finished product will be weighed while loading under the silos. The site layout takes future expansion into consideration with room for the addition of more dryers and ancillary equipment.

Marketable Product

The use of wastewater residual biosolids as a marketable product is what drives the economic benefit of the facility. The dried product will be classified as Class AA sludge because of pathogen destruction and low heavy metal content.

The heavy metal content is low because of the limited number of heavy industrial customers served by the various wastewater utilities. The pelletized sludge is an excellent source of nitrogen, which can be used to augment the phosphate industry in Florida for the production of commercial fertilizer.

The production of a marketable product defrays the overall operating cost of the facility; therefore, making a marketable product lowers the tipping fees required of the participants to deliver their sludge to the plant.

Conclusion

The construction of a regional BPF provides a viable solution to the question of wastewater residual management in the Palm Beach County region.

The solution incorporates the beneficial reuse of both biosolids and landfill gas. The participants enjoy a safe, reliable, environmentally friendly solution for their residuals disposal problem.

It is envisioned that a private contractor would operate the facility and would be responsible for marketing the product, releasing a public entity from the hassles of selling a product.