THERMAL CO-DISPOSAL FOR SLUDGE AND MUNICIPAL REFUSE

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ABSTRACT

Solid waste disposal (sludge and refuse) is perhaps the most persistent problem faced by many municipalities. Land disposal areas are rapidly disappearing and fuel costs for sludge incineration methods are continuing to escalate. Thermal co-disposal appears to be one solution to this vital problem.

This paper will describe the operation and control of the system currently in use at the City of Stamford, Connecticut. It will also include a discussion of the various problems, such as material handling and fires, as well as the solution to those problems.

INTRODUCTION

Solid waste disposal (sludge and refuse) is perhaps the most persistent problem faced by many municipalities. Land disposal areas are rapidly disappearing and fuel costs for sludge incineration processes are continuing to escalate. Alternate means of sludge disposal must be found which are both economical and environmentally sound. This paper will describe a thermal co-disposal system for sludge and municipal refuse which is one solution to this vital problem of solid waste disposal. Although, many operational problems have occurred with this system, most of them are now solved, thus allowing this process to run effectively and efficiently.

PROCESS DESCRIPTION

The City of Stamford, Water Pollution Control Facility, is a 20 MGD (7.57 x 10^4 m^3/day) conventional, activated sludge treatment plant with mechanical aeration. The sludge flow through the plant proceeds along the following pathway (Fig. 1):

The underflow of the primary clarifier is combined with waste activated sludge, degritted through hydrocyclonic degritters and thickened in gravity thickeners to approximately 2.5-3.5 percent solids. The thickened combined sludge, which is in a ratio of 60 percent primary to 40 percent waste activated, is then pumped to the sludge wells located outside of the incinerator building at which point the sludge disposal system begins. The equipment for the drying process was supplied by Combustion Engineering/Raymond, Chicago, Illinois.

Using progressive cavity pumps, the sludge is pumped to flocculation tanks. Calgon E-207 L polymer which is used to condition the sludge, is added approximately 25 ft (7.62 m) downstream of these tanks. The conditioned sludge is dewatered to a cake dryness of approximately 26 percent solids using Parkson belt filter presses. The cake is then discharged at a rate of 1,716 lb/hr (778 kg/hr) on a dry basis to the pug mill (Fig. 2). There the dewatered sludge is combined with previously dried sludge to produce a mixture which is approximately 62 percent solids. This mixture is discharged from the pug mill at a rate of 13,200 lb/hr (5,988 kg/hr)
and conveyed to the rotary dryer. A portion of the hot gas which would normally be wasted through the incinerator stack enters the dryer at the same area as the sludge mixture. As the dryer rotates (5 rpm), the sludge is cascaded through these hot gases thus evaporating approximately 5,000 lb/hr (2,268 kg/hr) of water. The dried sludge (90 percent solids) is discharged through a diverter gate and divided into two streams—one which goes back to the system as dry recycle and the other which goes to the incinerator and is burned. The heat value of the sludge is about 5,500 Btu/lb (12,793 kJ/kg).

**INCINERATOR FLOW**

The incinerator, manufactured by Urban Incinerators, is a 360 ton/day (3.27 X 10^4 kg/day) conventional, mass-burning refuse incinerator with rocking grates and has electrostatic precipitators for pollution control. Refuse enters the incinerator through a charging hopper at a rate of 280 tons/day and is deposited on the grates (Fig. 3). The refuse is as received with no pretreatment and has a heat value of 6,000 Btu/lb (13,956 kJ/kg). This high value is due to the large industrial contribution of
cardboard. At preset intervals, the grates rock thus moving the burning refuse through the furnace. The average temperature in the furnace is 1,600 F (870 C). At the end of the furnace bed, the ash drops into a wet sluice and is conveyed to a truck for landfill. Combustion is regulated using underfire, sidewall and overfire fans. The incinerator induced draft fan is rated at 125,000 cfm (59 m³/sec). The dried sludge enters the furnace through ports in the ceiling and burns in suspension within the first three feet of drop. The ratio of refuse to sludge is approximately 20:1. For the drying system, these hot gases which are drawn from the incinerator at a rate of 13,500 cfm (6.4 m³/sec) are tempered with ambient air (Fig. 4) to 400-600 F (204-315 C). This temperature is regulated by controlling the dryer exhaust gas temperature at $150 \pm 10^\circ$F (65°C).

As the hot air passes through the dryer, it picks up moisture and dust which is removed in a cyclone dust collector. These gases are then returned to the furnace for deodorization at approximately 1,200 F (648 C).

**OPERATIONAL AND CONTROL CONSIDERATIONS**

Soon after this system went into operation, it became very obvious that several modifications had to be made which would enable the process to proceed in an effective and efficient manner. These modifications were relatively simple and most were designed and installed by plant personnel.

This system is spread out over five different elevations in the incinerator building. Initially, the only way to control the process was to make continuous visual inspection of the sludge at the various stages in the process. This was not only tiring for the personnel involved in the operation, but also meant that the operator was unable to get an overview of the process at any one time. The solution to this problem was to install ammeters at the main control panel which monitored the amperage draw on the pug mill and on the screw conveyor which carried the material to the rotary dryer. By correlating the amperage with the material moisture content and the volume of the material, it is now possible for the operator to see at any point in time how the system is functioning. He can determine whether to increase or decrease the recycle rate or add additional dewatered cake without having to leave the main control center. He is still required to make visual inspection of the system, but at much less frequent intervals.

Another serious operational consideration was clogged conveyors. This was caused by such conditions as broken drive belts, build up of rags at the bearings of the conveyors and changes in the ma-
The solution to this problem was to install speed sensors on all critical conveyors and the bucket elevator. The sensors are located on the drive shaft of the speed reducers and are adjusted to an experimentally, predetermined shaft speed. As soon as the speed decreases below this level, the electrical interlock system shuts down the material feed going to that conveyor and an alarm rings at the main control panel alerting the operator and allowing him to take action before any serious equipment blockages occur. Because of this, down-time is reduced by a considerable factor and also, the operator is no longer faced with the frustration of having to remove impacted sludge from the conveyor.

Initially, when the presses were installed, a 65 ft (19.8 mm) screw conveyor was installed to convey the dewatered cake to the pug mill. However, after the first few hours of operation, problems were encountered. The physical characteristics of the cake changed dramatically as the sludge proceeded through the conveyor. This was due to the thixotropic nature of sludge—a change in viscosity as the material is mixed. In actuality, the sludge was becoming sticky as it proceeded along the length of the conveyor making it difficult to move and
causing excessive torque on the drive motor. The screw conveyor had to be replaced with a belt conveyor which did not alter the physical state of the material. It appears that sludge conveyed in shorter lengths of screw conveyor does not exhibit this property, but as the length of the conveyor increases and the sludge is mixed to a greater extent, this thixotropic property creates a serious material handling problem.

Dewatered cake dryness and polymer concentration in the cake also appear to have considerable effect on the ability of the system to function. Instead of the normal fluffy material (somewhat like vacuum cleaner fluff), the sludge begins to form balls about the size of a pea. These balls are dry on the outside and moist in the inside. As these balls circulate through the system, they get larger and larger approaching 0.25 in. (6.4 mm) in diameter. Surface area is reduced considerably, relative to the surface area of the fluff, resulting in a greater recycle ratio which, at times, would make it virtually impossible to operate the system. High polymer dosages also tend to make the sludge sticky, creating drag on the conveyors and an amperage draw much greater than the motor rating thus shutting down the conveyor due to electrical overload. Experiments have been run which show that these changes occur as the cake solids drop below 21 percent and/or the polymer dosage increases beyond 20 lb (9 kg) of dry polymer/ton (907 kg) of dry sludge.

One of the most serious and reoccurring problems is fires. Originally, there was no way of controlling a fire inside of the dryer which is where the majority tend to occur. An automatic spray was developed by plant personnel which was installed across the diameter of the feed end of the dryer. In addition, two sprays were located at the discharge end of the dryer. It was critical that the spray system be such that a stream of water would not impinge on the periphery of the dryer since thermal shock can possibly cause damage to the dryer. Five stainless steel fogging nozzles are spaced evenly along a 0.5 in. (12.7 mm) diameter stainless steel pipe. Three nozzles are adjusted to spray the length of the dryer and two are adjusted to spray downward. A solenoid, controlled by a thermocouple with a preset temperature alarm, allows water to flow automatically in case of fire. They are set for intervals of 10 sec on and 5 sec off or can be run continuously in a manual mode. The nozzles at the discharge end are also connected into this system. The combination of the sprays has effectively controlled most fires. Causes of fires are possibly too dry a feed material to the dryer, a large concentration of dust in the dryer or possibly the incinerator going from the normal negative pressure to a positive pressure. However, it has been
virtually impossible to exactly identify the cause or causes of all of the fires.

**ADDITIONAL PROBLEMS**

Additional minor problems included spalling of metal from the riding rings and hot spots in the live-bottom bin. The problem of spalling of the metal from the riding rings and trunion rolls was corrected by installation of graphite blocks on each of the four trunion rolls. This small amount of continuous lubrication has prevented serious wear on the rings and rolls. The hot spots in the corners of the live-bottom bin which were a source of smoldering sludge were corrected by welding sheet metal inside the bin to round the corners preventing a build-up of hot recycled sludge.

Additional problems also result from wet refuse. If the refuse is too wet due to rain for example, not enough heat is produced. This results in having to decrease sludge feed to the system. Sludge feed rates are determined on the basis of the amount of heat available from the incinerator, as well as cake moisture. If there is not enough heat to maintain adequate sludge production, extra work hours beyond the 5 day/week, 16 hr/day schedule must be added.

**CONCLUSION**

Although many operational problems have occurred with this system, most of them are now solved and the system runs efficiently and effectively.

When the plant was built, the co-disposal system was the only means of sludge disposal. An alternative method was added so as to provide back-up for the co-disposal system. This alternative method is a post-lime stabilization system which costs approximately $1,000,000/year to operate purely because of the cost of trucking the sludge to the only available landfill site 40 miles away. However, because of the design of the plant, this was the only alternative available to the City.

The sludge drying and incineration system is extremely economical and energy conservative since it does not require any external fuel source and utilizes energy which otherwise would be wasted through the incinerator stack. It has not added any additional ash-handling problems nor is it a source of air pollution. Additionally, the dried sludge could be used as a soil conditioner where a market is available thus creating a source of revenue for the municipality. Furthermore, excess waste incinerator heat could generate steam or electricity which could supply the municipally owned buildings, with excess being sold to the public.

This drying and incineration system is a very viable alternative to the problem of solid wastes disposal for any community which has both a wastewater treatment plant and incinerator located fairly close to each other.

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**Key Words**

Co-disposal
Drying
Incineration
Municipality
Refuse
Sewage
Sludge