Each day, 15,000 tons of sludge solids are removed from U.S. wastewater treatment plants. A combination of events has caused disposal of this sludge to build up to a major problem for an increasing number of communities.

Municipal sanitary wastewater contains about 0.35 pounds of dry solids per person per day. Added to this load are various commercial and industrial wastes. Ever-greater quantities of sludge are being produced as a result of increasing construction of wastewater treatment plants—and the fact that advanced wastewater plants produce more sludge than their predecessors.

In addition to presenting more and more sludge solids for disposal each year, wastewater treatment plants are energy-intensive. The more complex and advanced the plant, the more energy it consumes. The current problems of energy-intensive industries need not be explained.

Many conventional sludge disposal practices are becoming less available to municipalities. Spreading solid sludge on the land, and landfilling, are hampered by the lack of suitable sites. Ocean dumping is being phased out. Incineration has become unattractive because of its energy-intensive nature.

**The Problem is the Solution?**

But the energy required to run a wastewater treatment plant and incinerate its sludge may be available in every community—in municipal solid wastes. The possibility of integrating two disposal problems and producing energy at the same time is leading a number of U.S. and European municipalities to explore thermal processes with the generic name "co-disposal."

Municipal sludge has a heat value of approximately 10,000 BTUs per pound of dry solids and is autogenous (the ability to burn by itself without auxiliary fuel) at a ratio of moisture to solids of about 70/30 (30 per cent solids). As gravity thickening can only produce a sludge of about five percent solids, various mechanical and/or thermal processes are used to dewater the sludge. The co-disposal techniques discussed herein use energy produced from the combustion of the solid waste to dewater the sludge to its autogenous point.

There are two basic approaches in co-disposal. The first involves sewage sludge incinerators, in many cases already installed at the wastewater treatment plant, and uses the organic portion of solid waste as a fuel to dry, burn and reduce the volume of the sludge that must ultimately be disposed. The second approach uses a solid waste incinerator, solid waste fired steam generator or waterwall combustion unit to burn dewatered sludge. Both approaches have the capability of recovering the energy produced in the thermal process, and both are now being demonstrated or used.

**Sludge Incineration**

Thermal sludge disposal at wastewater treatment plants normally is carried out in multiple hearth or fluidized bed incinerators. The former is the more common, with roughly 200 of these units being used in the United States. Both devices have been used to co-dispose of solid waste and sewage sludge.

Co-disposal using sludge incinerator equipment was first demonstrated in this country in Franklin, Ohio, utilizing a fluidized bed furnace. The fuel used in this furnace consists of the rejected organic waste...
stream coming from the solid waste fiber recovery operation in this EPA-supported resource recovery demonstration. This plant recovers a low-grade paper-fiber (as well as ferrous and non-ferrous metals and glass) from the solid waste stream and uses the non-recoverable organic portions of the waste to fuel the sludge incinerator. The resource recovery plant is co-located and integrated with the wastewater treatment plant—but no energy is recovered. Organic residue from the fiber recovery system, a 20 per cent solids slurry, is mixed with 5 per cent solids sludge, dewatered to 45 per cent solids in a cone press and combusted in the fluidized bed incinerator.

The incinerator requires about 3000 BTUs per pound of as-received material to sustain combustion with no auxiliary fuel, and as the combination of solid waste and sludge contain about 3600 BTUs per pound, autogenous conditions are maintained. With only 600 BTUs per pound available as excess energy, however, the potential for energy recovery is low. The resource recovery technique demonstrated in Franklin is being replicated elsewhere, but not for fiber recovery. The recovered organic portion of the solid waste stream will be used as a fuel in a boiler. It is not known if replication of co-disposal in a fluidized bed furnace will be carried out, although it is technically feasible.

Co-disposal using a multiple hearth sludge incinerator has been tested in the United States and in Europe. Early testing in Europe, using raw solid waste, proved less than successful. 

The RDF Connection

Converting the organic portion of solid waste into a fluff refuse-derived fuel (RDF) and using the RDF to fuel the multiple hearth proved technically viable. Operating the incinerator in a pyrolysis mode (starved air) with an afterburner improved the system performance greatly.

This technique was demonstrated at a wastewater treatment plant in Concord (central Contra Costa County), CA, in an EPA-supported demonstration. An existing multiple hearth sludge incinerator was modified to accept RDF as a fuel and to operate in either an incineration or pyrolysis mode. An afterburner was added to the device to burn the gas produced during pyrolytic operation. The RDF could be mixed with the sludge which had a solids content of 16 per cent and introduced into the top hearth, or fed directly into the third hearth. The latter method proved more efficient. The system operated best under starved oxygen conditions. Air flow was adjusted to maintain 1400 degrees F off-gas temperature and these 130 BTU/DSCF gases burned to completion in the afterburner. The pyrolysis gas could be combusted at temperatures as high as 2500 degrees F in the afterburner with no additional fuel. RDF could be fed into the furnace at a much higher rate than necessary for sludge disposal only, thereby producing exportable energy that could be recovered in a waste heat boiler.

The demonstration ran for two months at eight hours per day and was considered a success. Design is now underway to replicate this technique at another plant in Contra Costa County. The integrated facility will receive 1000 tons of solid waste and 45 MG of wastewater each day. The solid waste will be processed into a fluff RDF and burned in the multiple hearth incinerators. The pyrolytic gas will be burned and the energy released will be used to power the advanced wastewater treatment plant.

Attempts at Volume Reduction

The second approach to co-disposal, that of using a solid waste incinerator as the volume reduction unit, has been tried many times—usually with poor results. In the past 50 years, many municipal incinerators were used for rudimentary co-disposal. Although basically a simple concept, the problems of material handling, feeding, and firing were never successfully addressed. As a result the concept has generally been abandoned. Sludge, with a typical solids content of from five to 25 per cent, was dumped into the refuse pit and mixed with the solid waste in the charging chute by feeding a bucket load of sludge along with several bucket loads of solid waste. Since the furnace lacked the flexibility to respond to this drastically different feed material, the frequent result was a dosing of the fire. As the technology of municipal solid waste incineration matured into efficient, sophisticated devices, co-disposal was again considered and great strides were made. A number of incinerators and waterwall combustion units have been tested as co-disposal devices. Various new techniques have been demonstrated, and some plants are operating on a day-to-day bases. All of these techniques use the heat released from the solid waste combustion to dry or the sludge to its autogenous point. The form of the heat is either hot flue gas, steam from the waterwall combustion unit or waste heat boiler, or heat from the fire itself. Mechanical dewatering devices in the co-disposal plants can be driven by steam or electricity generated within the plant itself. The drying can take place in the furnace or in a separate vessel, depending on the technique.

Two plants in this country use flue gas to dry the sludge and then burn the sludge solids in the furnace. Ansonia, CT, has a 200 TPD (design) refractory incinerator. About 55 TPD of refuse are disposed of in an eight-hour shift. Sludge from the integrated wastewater treatment plant at about four per cent solids is dried in a high speed disk co-current spray dryer. Hot flue gases from the secondary combustion chamber at 1200 degrees F are introduced into the spray dryer. Vapors and dry solids are blown into the furnace above the second grate where the solids burn in suspension. At present, the dried sludge is not burned but used for a fertilizer by local residents.

Another small refractory incinerator, 50 ton-per-day average throughout, in Holyoke, MA, uses the same general technique but the sludge, after mechanical
dewatering to 28 per cent solids, is dried in a rotary dryer. Hot flue gas from the incinerator is used to directly heat the sludge in the dryer. The dried solids are then burned in suspension above the refuse grates. No exportable energy is recovered in either of these plants.

**Direct Sludge Drying**

A different technique was tested in Norwalk, CT. The tests proved the feasibility of the idea and it is being replicated in Glen Cove, NY. In this approach, the heat of the burning solid waste dries the sludge directly and the dried solids burn along with the waste. The sludge is spread as a thin film on the top of the solid waste. This is accomplished by spraying the sludge at about five per cent solids onto the front wall of the charging chute forming a layer of sludge on the solid waste. As the solid waste flows into the furnace from the charging chute, the sludge layer remains on top of the solid waste. In the furnace, the heat from the burning solid waste first drives off the moisture from the sludge, and then the dry sludge solids burn along with the solid waste on the grates. The plant at Glen Cove will have waste heat boilers installed and the steam will be used to generate electricity for use in the incinerator and the wastewater treatment plant.

Two co-disposal plants are currently operating in Europe. One is at Dieppe, France; the other at Krefeld, West Germany. Both use a waterwall combustion unit to burn the solid waste and sewage sludge.

**At Dieppe, France**

At Dieppe, a coastal town with a population of 60,000, 54 tons of solid waste and 21 tons of 55 per cent solids sludge are disposed of each day. The digested sludge, at four per cent solids, is pumped from the treatment plant to the waterwall combustion unit and dewatered in two thin-film evaporators heated with 350 degrees F steam from the waterwall unit. The vapors released in the sludge drying enter the furnace area with the underfire air to the burn-out grate and are combusted. The sludge solids are continuously conveyed to the charging chutes of the furnace and are mixed with the solid waste from the receiving pit. No energy is exported from this plant.

**At Krefeld, West Germany**

The Krefeld plant is located in the Rühr industrial area near Guesseldorf. Serving a population area of about 270,000 it is the largest integrated solid waste disposal/wastewater treatment facility operating in the world today. The waterwall combustion unit disposes of approximately 600 tons of solid waste and 45 tons of raw sewage solids every day, generates electricity for the generator and treatment plant, and exports hot water for use in the community. Undigested sludge, at five per cent solids, is pumped from the wastewater treatment section of the facility to the waterwall combustion unit where it is first dewatered in centrifuges to 25 per cent solids. A polymer is added to and in dewatering. The 25 per cent sludge is then flash dried in a vertical chamber using 1500 degrees F flue gas taken from the top of the radiation zone of the boiler. Most of the drying takes place in the mill and fan combination at the lower end of the drying chamber. The dry, powdered solids, vapors and flue gas (now at 750 degrees F) are blown back into the furnace close to the top of the flame in the radiation zone of the boiler. The solids burn in suspension. As the flue gases recirculate, little energy is lost in the system and the calorific content of the sludge itself more than offsets the energy lost in the dewatering and drying steps. The steam generated by combusting the solid waste and sludge is used to generate electricity with a back-pressure turbine, and the back-pressure steam is used to produce exportable hot water. This integrated facility has been on line for almost two years with, apparent, good results.

**Non-Thermal Approaches**

Several non-thermal co-disposal techniques are also being demonstrated. They include composting sludge and solid waste for soil conditioner and fertilizer; anaerobic digestion of solid waste and sludge for the purpose of generating methane; combining solid waste and sludge into bricks that can be used as a fuel; and the combination of the organic portions of both as an animal feed.

**Conclusions**

In conclusion, the disposals of solid waste and sewage sludge are now often being considered together rather than separately, and the possibility of integrating a community's two disposal problems shows promise. There are a number of perceived advantages to this approach. Among them: the use of existing sludge disposal facilities with a new fuel source; the possibility of deriving wastewater treatment plant power from a new energy source; and the probable capital and operating cost savings by using the same device to dispose of both solid waste and sludge.

Some of the techniques mentioned in this article are experimental. Continued study and evaluation by EPA should shed light on the extent of their practical value. More experience in this relatively new field of co-disposal must be gained before judgments on its technologies and economics can be passed.

Many communities are now considering the construction of solid waste/ resource/recovery facilities. These systems may have the potential to dispose of sludge in addition to the solid waste with only a small increase in facility complexity, and as an integrated facility could reduce the communities' overall disposal costs.

In the future the trend towards integrated waste facilities should increase, and the recovery of the intrinsic energy in solid waste will be seen as a much more attractive disposal option.

Reprinted from Waste Age - July 1977