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1. Introduction

Disposal of sewage sludge is the subject of much controversial and emotional discussion. On the one hand, there is a clear preference for an agriculture-based approach to sewage sludge treatment, involving the return of nutrients and humus to the land or use of the sludge in landscaping. On the other hand, however, regulations with more stringent limit values are being promoted to protect the general public, and these regulations mean that an agriculture-based approach is no longer possible.

Sewage sludge consists of 50 – 70 % carbon, approx. 7 % hydrogen, 21 – 24 % oxygen, 15 – 18 % nitrogen, 1 – 1.5 % phosphorus and up to 2 % sulphur, i.e. by all means valuable substances for soils, such as nitrates, phosphates and potassium. As waste water treatment has become increasingly complex and fewer pollutants are permitted in cleaned waste water, these materials can be found in concentrated form in sewage sludge after the cleaning process. In particular, heavy metals such as mercury, cadmium, and lead, as well as halogen compounds, organic substances, medication residues and hormones are critical.
Nevertheless, agriculture-oriented sewage sludge treatment continues to be common practice because the relevant directives and ordinances essentially permit the application of sewage sludge on agriculturally or horticulturally used soils as long as specified concentration limits for heavy metals are adhered to (Sewage Sludge Ordinance – Council Directive 86/278/EEC). However, the trend in many countries is to restrict the use of sewage sludges as fertilizers because the effects of introducing the specified pollutants into the soil and groundwater is seen as an extremely critical issue.

Valuable materials such as phosphate and nitrate can already be separated in the waste water treatment plant and returned to the cycle as raw materials. The remaining sewage sludge can be treated thermally.

This paper outlines the options for treating sewage sludge from municipal sewage treatment plants in the grate-based combustion systems of waste-to-energy plants.

2. Thermal treatment

The options for thermal treatment of sewage sludge are:

- Mono-combustion in fluidized bed combustion systems and multiple hearth furnaces;
- Co-combustion in fluidized-bed combustion systems;
- Co-combustion in coal-fired power stations (mostly just mechanically dewatered sludge) or cement plants (mostly dried sludge);
- Co-combustion in waste-to-energy plants with grate-based combustion systems.

The sewage sludge to be treated is essentially available in two forms:

- Mechanically dewatered; TS ~ 20 – 40 %; water content 60 – 80 %; heating value ~ 0 – 2 MJ/kg;
- Dried; TS ~ 90 %; water content 10 %; heating value ~ 8 – 10 MJ/kg.

3. Co-combustion in grate-based systems

There are basically three options for feeding the sewage sludge.

1. Feeding of sludge into the refuse pit
2. Feeding of sludge into the furnace/onto the grate
3. Feeding of sludge into the waste chute (chute shaft)

3.1. Feeding of sludge into the refuse pit

Technically, the easiest approach is to feed the sewage sludge into the refuse pit. When tipped over the pit's gates, the sludge is fed and distributed onto the waste stored in the pit. The grapple is used to redistribute and mix the waste in the pit, thereby further spreading the sludge.

To minimize odour nuisance, lime is sometimes simultaneously spread when feeding mechanically dewatered sewage sludge. However, this is not common practice.

It is mostly dried sewage sludge that is fed directly into the refuse pit.
Co-Combustion of Sewage Sludge in Grate-Based Combustion Plants

The following advantages and disadvantages are associated with the feeding of sludge into the refuse pit:

**Advantages**
- Very low outlay/costs.

**Disadvantages**
- Open system with the danger of odour and dust nuisance.
- High dust input (in particular with dried sewage sludge).
- Sewage sludge may build up and accumulate at the bottom of the refuse pit.
- The amount of sewage sludge to be co-combusted cannot be precisely determined and controlled (only as a long-term average).

3.2. Feeding of sludge into the furnace/onto the grate

3.2.1. Martin sewage sludge spreader

In this system, solids pumps convey mechanically dewatered sewage sludge from a silo to a movable sewage sludge spreader (spreading unit) developed by Martin. The spreader is installed at an opening in the boiler wall at the height of the furnace.

When sewage sludge is to be fed, a valve to the combustion chamber is opened, the spreading unit is moved to the boiler wall and the sludge is supplied to the spreader’s rotary chopper wheel. A toothed slat in the spreading unit breaks up and shreds the sewage sludge into flaky pieces and distributes it uniformly over the hot fuel bed (1,000 °C) in the front third of the reverse-acting grate. The shredded sewage sludge particles are integrated into the red-hot fuel bed through the mixing and agitating motion of the grate and are combusted together with the waste.

Figure 1: Martin system for introducing sewage sludge onto the grate

Source: Martin GmbH für Umwelt- und Energietechnik GmbH, München
If the supply of sewage sludge is interrupted or if co-combustion is no longer desired for other reasons, the spreader is retracted from the furnace and the furnace opening is closed by a valve.

The following advantages and disadvantages are associated with the system:

**Advantages**
- Completely closed system (no odour or dust nuisance) and no direct contact between operating staff and sludge.
- Good distribution of the sewage sludge in the fuel bed.
- Good control, easy metering of the sewage sludge flow possible.
- Relatively high sewage sludge flows possible (up to 20%).
- The technology has been tested in various plants in CH, DE, IT.
- High levels of operational reliability.

**Disadvantages**
- High investment costs.
- High maintenance and service costs.
- Additional, larger opening in the boiler side wall.

### 3.2.2. Pyromix

In Veolia’s Pyromix system, solids pumps transport the mechanically dewatered sewage sludge to lances arranged in the furnace over and at the sides of the first grate zone (front arch). The lances are preferably arranged in such a way that the sewage sludge is fed into the drying zone at the front grate area before actual combustion begins.
The injection lances consist of a main central tube, through which the sewage sludge is transported, and an outer sheath, to which compressed air (atomizing air) is directed. At the nozzle tube's outlet, the sewage sludge is broken up into small particles with a grain size of 5 – 15 mm and injected into the drying zone at the point directly before combustion begins.

The following advantages and disadvantages are associated with the system:

**Advantages**
- Completely closed system (no odour or dust nuisance) and no direct contact between operating staff and sludge.
- High levels of operational reliability.

**Disadvantages**
- Sludge distribution in the waste bed is not uniform.
- Small particles can dry relatively fast during combustion. They combust in the flue gas, which leads to an increase in the amount of raw gas dust.
- The nozzles installed in the furnace area tend to become fouled.
- High service costs.
- Additional costs for the provision of compressed air.

3.3. Feeding of sludge into the waste chute/chute shaft

3.3.1. Saxlund

In Saxlund's system, solids pumps convey the mechanically dewatered sewage sludge to what is known as a rotary distributor, which is located in the refuse pit above the waste chute's feed hopper. The rotary distributor has several outlets (discharge tubes) to the feed hopper. Each discharge tube is equipped with valve and pneumatic driving cylinder with which the sewage sludge flow can be sequentially regulated and controlled across the entire width of the chute. Valves are opened and closed at intervals according to a specific program. Only one of these valves is opened at any one time for sludge distribution. The sewage sludge flow can be controlled by means of the opening duration and the cycle, and is largely automated.

![Schematic diagram of the Saxlund rotary distributor](source: Saxlund)
The following advantages and disadvantages are associated with the system:

**Advantages**
- Relatively low costs.
- Uncomplicated technology that has already been proven in several plants.
- High levels of availability and operational reliability.

**Disadvantages**
- The system is located directly in the refuse pit as an open system, which can result in odour and dust nuisance.
- Service work may be performed only during scheduled overhauls. Operating staff may come into contact with sewage sludge when working in the refuse pit.
- Because sewage sludge and waste are not fed simultaneously (bunker crane), layers may form (the fuel is not well mixed).

### 3.3.2. Ingtec

The Ingtec system feeds the mechanically dewatered sewage sludge into the chute. Solids pumps convey the sewage sludge to a spreading unit installed in the refuse pit beside the waste chute's feed hopper. There, the sewage sludge is shredded into particles < 40 mm and distributed across the waste layer in the waste chute's feed hopper.

The following advantages and disadvantages are associated with the system:

**Advantages**
- Relatively low costs.
- Simple technology.
- High level of availability.

**Disadvantages**
- The system is located in the refuse pit as an open system from the spreader up to the point at which the material is spread onto the waste layer (odour and dust nuisance).
• Service work may be performed only during scheduled overhauls.
• Operating staff may come into contact with the sewage sludge when working in the refuse pit.
• The sewage sludge is not mixed with waste. There is a danger of layers forming in the feed hopper.
• The grapple may collide with the spreading unit.

3.3.3. CNIM

The system was developed by CNIM (France) and is based on a CNIM patent. A solids pump is used to transport the dewatered sewage sludge to a sludge feeding device on the rear wall of the chute. The feeding device consists of a distributor tube and supply tubes arranged along the entire width of the chute. Sludge is fed and distributed by means of the supply tubes, in which injection nozzles are located. The nozzles are used to inject sludge into the chute.
The following advantages and disadvantages are associated with the system:

**Advantages**
- Simple technology.
- Completely closed system (no odour and dust nuisance).
- Operating staff does not come into direct contact with the sewage sludge.
- Low acquisition costs.
- High levels of operational reliability.

**Disadvantages**
- Sludge distribution in the chute is not uniform. Where waste densities are low, more sludge is injected and, where waste densities are high, less sludge is injected.

### 3.3.4. SATOM/Monthey

In the SATOM/Monthey WTE plant, a system for introducing mechanically dewatered sewage sludge to a sludge feeding device on the chute was also developed and installed together with the plant operator. A solids pump similarly conveys sludge from a silo to a distributor tube located on the rear wall of the chute. Here too, several outlet or supply tubes are used to introduce the sludge into the chute across the entire width of the waste chute. Each supply tube is equipped with a control valve with which the sewage sludge flow can be sequentially regulated and controlled across the entire width of the chute. Only one of these valves is opened at any one time for sludge distribution. A sequential supply results in easy metering and uniform distribution of the sludge in the chute's waste column. Identical amounts are metered even when waste density varies.

![Figure 8: Distributor of the sewage sludge feeding facility in the Monthey WTE plant](image)

Source: Martin GmbH für Umwelt- und Energietechnik GmbH, München

The following advantages and disadvantages are associated with the system:

**Advantages**
- Completely closed system (no odour or dust nuisance).
- Very good, uniform distribution of the sewage sludge (no layers form), sewage sludge and waste are very thoroughly mixed.
• Maintenance work can be performed easily (no direct contact between operating staff and sludge).
• Uncomplicated technology that has already been proven in several plants.
• High levels of availability and operational reliability

Disadvantages
• Higher expenditure for installation.

4. Summary

Various feeding systems are available for co-combusting municipal sewage sludge in thermal waste-to-energy plants using grate-based systems.

Dried sewage sludge can be fed directly into the refuse pit. Mechanically dewatered sewage sludge is intermediately stored in silos and then conveyed by means of solids pumps to the specific feeding system in the waste chute of the grate-based combustion system or furnace.

Based on long-term and varied experience, the amount of co-combusted sewage sludge should not exceed a proportion of 10 – 20 % to avoid having a negative influence on the combustion conditions and bottom ash burnout.

The following points are key to the integration of a system for co-combusting sewage sludges in waste-to-energy systems:
• Odour and dust nuisance caused by the delivery and introduction of sewage sludge should be avoided.
• The system should be easy to maintain. Contact between operating staff and sludge should be avoided.
• To achieve optimum combustion conditions and good bottom ash burnout, it must be possible to meter the sludge as appropriate, and to distribute and mix it with the waste in the best possible manner.
• Proven systems with low acquisition costs and offering high levels of availability and operational reliability should be used to minimize disposal costs.

Taking these points into consideration and based on previous experiences, closed feeding systems with a facility for metering the sewage sludge directly into the waste chute are preferred.

In particular, the SATOM/Monthey system (section 3.3.4), which has meanwhile proven itself in several Martin plants (for example Giubiasco, Trieste) stands out.

5. References

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