Chapter 18 – Ash Management

While incineration provides significant volume reduction, there is still a significant quantity of material to be managed. Over a million dry tons of biosolids are incinerated each year. Incineration reduces these biosolids to approximately 400,000 tons of ash, which is either used or disposed (USEPA 1979).

The type of incineration process selected unit will impact the characteristics of ash and, to some extent, the quantity of ash. Combustion of grit, screening, and scum will also affect the characteristics and quantity of ash.

18.1 Critical Control Points / Operational Controls

There are a number of controls associated with ash management. They include:

- Quantity of ash
- Ash Characteristics
- Ash Collection

18.2 Quantity of Ash

The quantity of ash produced will essentially be equal to the inert fraction of the biosolids being incinerated. Strict air pollution control regulations allow very little particulate material to escape with the exhaust gas. Generally, the quantity of ash produced by a biosolids incinerator will range from 20 to 40 percent of the dry weight of the biosolids fed to the incinerator.

The quantity of ash may vary seasonally as a result of infiltration/inflow in the wastewater collection system or seasonal additions of chemicals to the wastewater treatment process for nutrient removal. Wastewater treatment facilities receiving heavy industrial discharges may also see fluctuations that correlate to production schedules for the given industries.

18.3 Ash Collection

The type of incinerator used impacts the physical characteristics of the ash generated. As a result, a basic understanding of the operating principles of Multiple Hearth Furnaces (MHFs) and Fluidized Bed Incinerators (FBIs) and the way each collects ash is essential to defining the physical characteristics of the ash generated by each technology.

18.3.1 Ash Generation and Collection in a MHF

As discussed in Chapter 15 or 16, the MHF can be divided into four zones. The upper zone evaporates water from the biosolids. The second and third zones, proceeding down the incinerator, combust the volatile solids and fixed carbon contained within the biosolids. Ash is collected in the fourth zone of the incinerator, located in the lowest hearth of the MHF, where it accumulates in a layer several inches thick. Air for biosolids combustion is often introduced into the lower hearths of the incinerator. This contact

serves to cool the ash before discharge and warm the combustion air before it reaches the upper hearths.

Ash is discharged from the bottom of the MHF each time a rabble arm on the bottom hearth passes the port at the outer edge of the furnace. Normally this occurs two times per rotation or once every ten to 90 seconds depending on the speed of the center shaft. Because of the intermittent nature of the discharge, a small surge hopper is normally provided beneath the furnace. The three main methods of handling ash from the surge hopper are:

- Slurrying the ash with scrubber drain water and depositing it in a lagoon,
- Lifting the ash with a bucket elevator to a hopper from which it is loaded into a truck for disposal.
- Conveying the ash pneumatically to a hopper for transfer to a truck.

The first method, where the ash is mixed with water to form a slurry, is only appropriate where there is significant land area available. Its principal advantage is that there is little dust. Disadvantages include the heavy wear on slurry pumping systems, the potential for steam at the slurry tank, and the need to at least partially re-dry the ash for ultimate disposal.

Bucket elevators are normally employed at moderate size facilities to lift the ash to the elevation required to load a truck. Lateral movement is normally provided with either flat belt or screw conveyors. The ash is normally wetted to a sufficient degree to control dust. Pneumatic conveyance systems are typically employed at larger facilities. The pneumatic system must be equipped with a bag house or some kind of filter at the discharge point to control dust.

Ash taken from the bottom of the incinerator tends to have a coarse grain and a bulk density of 24 to 40 pounds per cubic foot. If handled with a wet collection system, the bulk density will be in the range of 90 to 120 pounds per cubic foot.

The volatile solids concentration will typically range from 0.5 to 1.5 percent with an average of slightly less than one percent. Studies of ash from numerous MHFs have shown a wide range of volatile solids concentrations, ranging from nearly zero to almost six percent. The average volatile solids content is normally slightly over one percent.

18.3.2 Ash Generation and Collection in a FBI

Unlike a MHF, most if not all of the ash from a FBI is carried out of the top of the furnace and removed from the air stream by the air pollution control system. The exception occurs when large amounts of grit are incinerated. In that case, it may be necessary to periodically remove the coarser portion of the bed from the bottom.

A venturi scrubber is the most common means of removing particulate matter from the exhaust of a FBI. The collection mechanism in a venturi is impaction. As the exhaust air from the FBI is forced through the throat of the venturi at velocities ranging from 12,000 to 24,000 fpm, the particulates come into contact with water injected either into or just

ahead of the venturi throat. The venturi is followed by a centrifugal separator, which removes the ash slurry from the air stream.

The discharge from the venturi/collector system is typically a slurry with a total suspended solids concentration of about 10,000 to 15,000 mg/l and a particle size ranging from 0.2 to 0.25 mm. This slurry must be concentrated and often dewatered before the ash can be disposed or beneficially used.

Ash slurry from FBI can be discharged to lagoons for settling. Lagoon storage requires a relatively large land area requirements, and the need to eventually dewater the ash for disposal or use.

A common ash management system consists of sending the slurry to a gravity thickener where gravity separates the ash from the water. In some cases, a polymer is used to assist settling. The supernatant is recycled to the wastewater treatment facility and the thickened ash slurry is mechanically dewatered.

Ash from a FBI will typically have a bulk density in the range of 90 to 120 pounds per cubic foot. The volatile solids concentration will typically range from 0.5 to 1.5 percent with an average of slightly less than one percent.

18.4 Chemical Characteristics of Ash

As might be expected, the chemical properties of ash exhibit a wide range of constituents. Historical data for ash is often a poor indicator of existing characteristics due to improvements in biosolids characteristics as a result of pretreatment.

Essentially, the total quantity of metals in the ash will equal the quantity of metals in the biosolids being incinerated. Because incineration has the effect of reducing the total mass of material, the concentration of metals in the ash is greater.

Some metals will vaporize at the temperatures found in an incinerator and exit with the exhaust gas. Metals that are expected to partially vaporize during incineration are cadmium, lead, mercury and zinc. As discussed in Chapter 17, the emission control equipment available today will recover most metals volatilized during incineration with the exception of mercury. Typical characteristics of ash are summarized in Table 18.1

Table 18.1 - Typical Characteristics of Biosolids Ash

Constituent	Range of Composition, %
Silica (SiO_2)	20-60
Alumina (Al_2O_3)	5-20
Iron oxides	2-25
Phosphoric pentoxide (P_2O_5)	3-15
Magnesia (MgO)	1-3
Quicklime (CaO)	10-30
Sodium oxide (Na_2O)	0.1-1
Potassium oxide (K_2O)	0.1-1
Titanium dioxide (TiO_2)	1-3
Zinc oxide (ZnO)	0.1-0.5

18.5 Ash Disposal

Fusing ash using heat and chemicals or concrete is considered to be the best long-term solution to control the heavy metal content. It is a permanent solution for even the most prohibitive of standards.

A number of means could be engineered to implement the use of cement-stabilized ash. Perhaps the easiest would be to mix the cement and the ash with water at the plant site in a concrete mixer/hauler and transport the liquid mixture to the landfill or other suitable sites. Landfilling is normally the least costly method of disposal.

Interest in slagging combustion processes for municipal biosolids is strong in Europe and Japan, because high temperatures ensure volatile organic compound destruction and glassified ash stabilizes heavy metals so that they can not be leached. This technology is in the developing phase, and the available database is inadequate to define if whether there is metal fuming at elevated temperatures.

The majority of ash generated by biosolids incineration is disposed of in either Municipal Solid Waste (MSW) landfills or ash monofills. Due to the solids concentration within the ash, dust control is a significant issue. The requirements of 40 CFR Part 258 must be met if ash is placed in a MSW landfill. Any ash that meets the definition of a hazardous waste must comply with regulations in 40 CFR Parts 261 and 268.

18.6 Beneficial Use of Ash

Beneficial uses have been identified for biosolids ash. Many of these alternatives have been implemented on a full scale, while other alternatives have been used on a trial or pilot basis. As has been used in agricultural land application programs and in the production of building materials.

18.6.1 Land Application

Ash has been described as a good fertilizer because of its phosphorus and lime content. In addition, it may contain valuable micro-nutrients. A study of ten incinerators in the United States (Furr and Parkinson) found the following fertilizer values.

Nitrogen 0.06 to 0.1 % dry weight
Phosphorus 1.0 to 5.2 % dry weight
Potassium 0.23 to 1.05 % dry weight

Limited research on the use of biosolids ash as a fertilizer has been conducted. The manner in which ash land application would be regulated also requires clarification. While not specific, it is anticipated the criteria contained in the Part 503 Rule would apply.

18.6.2 Structural Additive to Building Materials

Biosolids ash has been used in the production of building materials. The ash has gained limited popularity. A barrier to using biosolids ash as an additive to structural materials such as concrete or asphalt is the fact that it is produced in relatively small quantities by most incinerators. As a result, it is not cost effective for many manufacturers to develop standards and quality control procedures to incorporate biosolids ash into their products. Biosolids ash can be used as filler in asphalt road mix. The ash serves as the fine material that fills the small voids among the pieces of gravel and increases the strength of the material. This also leaves a smaller void for water penetration and helps prevent freeze-out in the winter. Another use of ash is in building products. Although the iron will often color a concrete or cinder block a dull red, the ash will act as filler that allows the formation of sharp corners in the cinder blocks and concrete blocks.

References

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