

Sludge incineration applications and processes

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KEYWORDS: Combustion, paper mills, pulp mills, sludge, sludge disposal.

Incineration has been used for the disposal of paper mill treatment plant sludges at many plants in the United States and Canada. Many of these installations have been less than satisfactory. The reputation of the difficulty of incineration is unfortunate because the incinerator does have a place in the treatment and disposal of these troublesome wastes.

As with any other technology, there are proper and improper applications. The right kind of system or equipment is not always selected.

Pulp and paper mill sludges invariably contain a relatively high silica fraction. They will likely also contain sodium salts. In general, inorganic salts and many silica compounds have relatively low melting points (melting temperatures). When combined or found together in a sludge, the melting point of the total mixture, or eutectic, is almost always lower than the melting temperatures of the individual compounds, as illustrated in Fig. 1. Although sodium sulfate will begin to melt at 1623°F and sodium chloride will melt at 1562°F, a 50% mixture of both will melt at a temperature less than 1200°F. Similarly, a mixture of sodium chloride and sodium carbonate can also melt at a temperature less than 1200°F.

It is important to note that while it is unlikely that the salt content of a waste charge will ever even approach numbers like 50% or even 15%, the presence of any salt in a bed will produce a eutectic with a lower melting point than if the salt were not present.

Incineration will destroy the organic content of a waste, which is the ultimate purpose of this process. The temperature at which this destruction will occur is generally above 1400°F. Unfortunately, raising the temperature of a waste to the temperature at which organics will be destroyed will likely result in the melting of salts and other low melting point materials within the waste.

Incineration processes involve the introduction of air into a heated chamber. Even if preheated, the air introduced into an incinerator will necessarily be at a lower temperature than the incinerator operating temperature. When a molten salt passes into a zone of the incinerator that is at a lower temperature, and if that temperature is lower than the

eutectic temperature, this melt will harden or freeze. This results in the formation of a slag—a gray, fused, and hardened clinker of unwanted and damaging solid matter.

Incineration systems

Two types of furnaces are generally used for incinerating sludges: multiple hearth and fluid bed systems. With a multiple hearth furnace, waste is continually wiped through the furnace, from one hearth to another, and continually discharged from a bottom drop or gate. If the salt content is sufficiently low, this potential slagging problem may not be debilitating. If there is a fractional salt content—above 2% of the solids content of the sludge, for instance—the operation can be disastrous. Uncontrollable slagging will occur throughout the burning portion of the furnace, and molten particulate will be carried through the gas stream, depositing as a slag on furnace and flue walls.

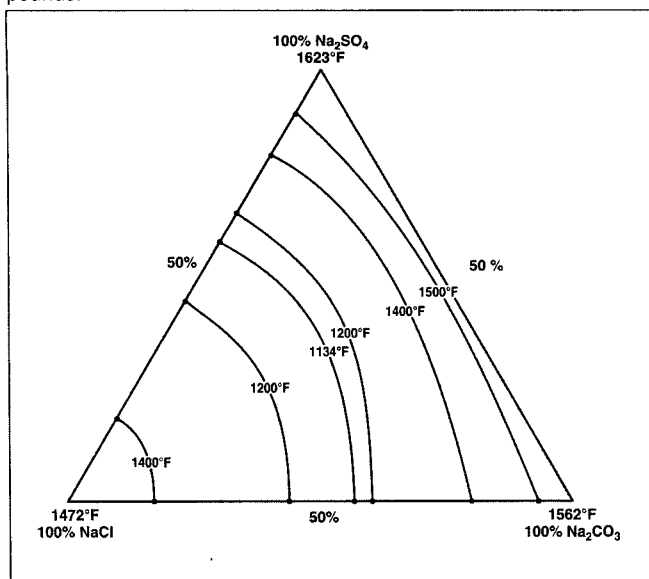
A fluid bed incinerator is a completely different system. Waste is held in the furnace as air bubbles through a bed of sand and waste (and fuel, when supplemental fuel is required). When slag develops, air circulation to and within the bed is hampered. As slag formation increases, bed fluidization will cease. With bed defluidization, the incineration process will no longer be possible and the bed will freeze into a large solid, fused mass. This requires a significant effort and an accordingly long period of time to remove.

Many of the furnaces used for the incineration of pulp and paper mill sludge have been fluid bed units. A significant number of these systems have slagged up, just as described above, and have been abandoned.

In some of these instances, the slagging potential of the sludge was just too great to allow the use of a multiple hearth or a fluid bed furnace. Multiple hearth furnaces are not amenable to low melting point temperature materials, as noted above, and too high a salt load will eliminate this furnace from consideration.

In many of the fluid bed systems, however, relatively simple design modifications could make operation of these furnaces effective and efficient under low temperature eutectic materials service. For instance, if a bottom conveyor of hot service design were provided for the bed of the furnace, the bed could be tapped of material on a continuous basis. At the same time, makeup sand would be injected into

1. Sodium salts eutectic diagram indicates how varying percentages of compounds in sludge affect melting temperatures of individual compounds.



the bed to make up the bed volume to keep the volume of bed sand within the incinerator constant. Most fluid bed incinerator systems include sand injection equipment to replace the relatively small amount of sand which is normally elutriated into the exhaust gas stream.

The tapping volume would be adjusted to maintain an equilibrium particle size. For this system to work, a conscientious operations effort is required. Bed particle size must be measured at least once a day. This measurement is simple but is not the kind of measurement normally made by incinerator operating personnel or their support teams: an examination of bed sand particle dimensions under a microscope.

Agglomeration and erosion

As salts begin to melt, the sand particle size will increase, a condition termed "agglomeration." With increased melting, particles will tend to fuse. Essentially the presence of low melting temperature materials will first be observed through a deposition on sand particles, e.g., the sand particle will appear to increase in size. By tapping the bed, agglomeration can be controlled to the extent that particle size is constant from one day to another. At some rate of sand evacuation, the length of time for the new sand injected into the furnace to increase in size from the agglomerative effect of waste will be controlled. This process is empirical, adjustable once the furnace is on-line firing the intended waste stream.

Another process affecting agglomeration is erosion. The high turbulence developed within the bed will have the effect of decreasing particle size. As sand particles come in contact with each other within the bed, this will have the effect of wearing down the increase in particle size from agglomera-

tion. Erosion (abrasion), however, will not necessarily be exactly equal to this agglomerative effect, and there likely will be a net increase in particle size with these low melting temperature materials.

If the chemical constituents of the waste are known, it may be possible to find an additive that can be introduced into the bed which will increase the melting temperature of the bed materials. If the melting (eutectic) temperature can be increased above the maximum temperature within the incinerator, melting will not occur and slagging will not be a problem.

Clays, with their alumina constituent, have been found to increase bed eutectic temperatures with certain wastes. The melting point of aluminum oxide, the major constituent of most clays, is high, in excess of 3500°F, and the presence of this material tends to increase bed eutectic temperatures.

For additives to be successful, the constituents of the feed must be consistent and unvarying. This is unlikely. Even in a plant manufacturing a single product, the sludge waste will not be constant but will vary from day to day from process anomalies, which are always present. The selection of an additive depends upon the nature of the bed material and the waste, and when either of these materials change, the additive requirements will change.

It is important to know the constituents of the waste feed. To assure the adequacy of an incineration process, particularly when a fluid bed incinerator is being considered, materials testing should be mandatory. A determination of the melting characteristics of the bed materials or bed eutectic is crucial.

Where relatively low melting point wastes are found, a decision must be made as to the adequacy of incineration, and then a selection must be made of an applicable incineration system and associated equipment. There are advantages and disadvantages of both multiple hearth and fluid bed incineration systems beside susceptibility to slagging.

When a fluid bed incinerator is selected, it should always include a hot bed tapping system and a means of readily adding bed sand (makeup sand) while the bed is hot. This system should always include microscopic examination of bed particle size as a normal and frequent operations requirement.

As with any other process equipment, a depth of analysis is required in the selection and design of waste disposal systems. All of these systems are not equal, and they require care in their selection, design, and operation. ▮

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