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Sound Practices
Incineration

1.5.2 System types

The two most widely used and technically proven incineration technologies are mass-burn incineration, and modular incineration. Fluidized-bed incineration has been employed to a lesser extent, although its use has been expanding and experience with this relatively new technology has increased. Refuse-derived-fuel production and incineration has also been used, primarily in Europe, but with limited success. These options are discussed further below.

Some facilities have also experimented with pyrolysis, gasification, and other related processes that convert solid waste to gaseous, liquid, or solid fuel through thermal processing. For example, in the past, some MSW facilities in Japan have used a two-stage process where pyrolysis is followed by thermal combustion. The vast majority of attempts to use these technologies have been unsuccessful and ceased, however, and most experts agree that they are not currently a reliable, cost-effective alternative, especially for developing countries.

Sound technical options

- Mass-burn
- Modular
- Fluidized-bed
- Refuse-derived fuel

Mass-burn systems

Mass-burn systems are the predominant form of MSW incineration. Mass-burn systems generally consist of either two or three incineration units ranging in capacity from 50 to 1,000 tons per day; thus, facility capacity ranges from about 100 to 3,000 tons per day. These facilities can accept refuse that has undergone little preprocessing other than the removal of oversized items, such as refrigerators and sofas. Although this versatility makes mass-burn facilities convenient and flexible, local programs to separate household hazardous wastes (e.g., cleaners and pesticides) and recover certain materials (e.g., iron scrap) are necessary to help ensure environmentally responsible incineration and resource conservation.



*This incinerator is in Gibraltar.
(credit: Warmer Bulletin)*

The waste intake area usually includes a tipping floor, a pit, a crane, and sometimes conveyors. Trucks enter the tipping floor and tip their wastes either onto the floor itself, or directly into the pit. When wastes are tipped onto the floor, a front-end loader or a bulldozer is used to push them into the pit or onto a conveyor. From a feed chute, MSW is continuously fed to a grate system, which moves the waste through a combustion chamber using a tumbling motion.

Modular incinerators

Modular incinerator units are usually prefabricated units with relatively small capacities of between 5 and 120 tons of solid waste per day. Typical facilities have between one and four units for a total plant capacity of about 15 to 400 tons per day. The majority of modular units produce steam as the sole energy product.

Brochure



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Due to their small capacity, modular incinerators are generally used in smaller communities or for commercial and industrial operations. Their prefabricated design gives modular facilities the advantage of shorter construction times. On average, capital costs per ton of capacity are lower for modular units than for other MSW incineration options.

Modular incinerators employ a somewhat different process than mass-burn incinerators, typically involving two combustion chambers. Gases generated in the primary chamber flow to an afterburner, which ensures more complete combustion and often serves as the primary means of pollution control. In addition, smaller-scale plants (i.e., less than 50 tons per day) sometimes operate using a batch process, rather than continuously, operating only 8 to 16 hours per day. The modular incineration option has become less common, however, in part due to concerns over the consistency and adequacy of air pollution controls.

Fluidized-bed incinerators

Fluidized-bed incineration of MSW has been used most extensively in Japan, where there are currently 167 such facilities. The Japanese plants are typically of medium scale, processing from 50 to 150 tons per day. Fluidized-bed incineration is also capturing an increasing portion of the European MSW incineration market, although mass-burn still dominates. Overall, there is less experience with fluidized-bed incineration than with mass burn.

In a fluidized-bed incinerator, the stoker grate is replaced by a bed of limestone or sand that can withstand high temperatures, fed by an air distribution system. The heating of the bed and the increasing of the air velocities cause the bed to bubble, which gives rise to the term "fluidized." There are two types of fluidized-bed technologies, a bubbling bed and a circulating bed. The differences are reflected in the relationship between air flow and bed material, and have implications for the type of wastes that can be burned, as well as the heat transfer to the energy recovery system.

Unlike mass-burn incinerators, fluidized-bed incinerators require front-end pre-processing, also called fuel preparation. They are generally also associated with source separation because glass and metals do not fare well in these systems. Also, fluidized-bed systems can successfully burn wastes of widely varying moisture and heat content, so that the inclusion of paper and wood, which are both recyclable and burnable, is not a crucial factor in their operation (and thus paper can be extracted for higher-value recycling). These factors would appear to indicate that fluidized-bed technologies are more compatible with high-recovery recycling systems, since there might be less competition for waste streams that are both burnable and recyclable. For this reason, fluidized-bed technology may be a sound choice for high-recycling cities in developing countries when they first move to incineration.

Fluidized-bed systems are more consistent in their operation than mass burn and can be controlled more effectively to achieve higher energy conversion efficiency, less residual ash, and lower air emissions. Cost comparisons with mass-burn are inconclusive. In general, however, fluidized-bed incinerators appear to operate efficiently on smaller scales than do mass-burn incinerators, which may make them attractive in some situations. As more such incinerators are installed in Europe over the next few years, and more experience is gained in Japan, fluidized-bed incineration of MSW could become a fully commercially proven practice.

Refuse-derived fuel

In a broad sense, refuse-derived fuel (RDF) refers to solid waste in any form that is used as fuel. The term RDF, however, is commonly used to refer to solid waste that has been mechanically processed to produce a storable, transportable, and more homogeneous fuel for combustion. Although their share has grown, RDF systems represent a much smaller share of incineration facilities than traditional mass-burn facilities. RDF systems have two basic components: RDF production and RDF incineration. RDF production facilities make RDF in various forms through materials separation, size reduction, and pelletizing. Although RDF processing has the advantage of removing recyclables and contaminants from the combustion stream, the complexity of this processing has increased the operating and maintenance costs and reduced the reliability of RDF production facilities. On average, capital costs per ton of capacity for incineration units that use RDF are higher than for other incineration options.

RDF production plants, like mass burn incinerators, typically have an indoor tipping floor. Instead of being pushed onto a pit, however, in an RDF plant the waste is typically fed onto a conveyor, which is either below grade or hopper fed. In some plants, the loader doing the feeding will separate corrugated and bulky items, like carpets. Once on the conveyor, the waste travels through a number of processing stages, usually beginning with magnetic separation. The processing steps are tailored to the desired products, and typically include one or more screening stages, using trommel or vibrating screens, shredding or hammermilling of waste with additional screening steps, pelletizing or baling of burnables, and, depending on the local recycling markets and the design of the facility, may include a manual separation line.

In Europe, a period of enthusiasm for mixed waste sorting in the early 1970s produced a number of materials recovery and RDF-producing installations, mostly of German or Italian design. Many of these facilities were initially designed to also feed the wet and putrescible wastes into composting systems. Although the ability of these installations to produce marketable recyclables has proved extremely limited, they have been able to produce refuse-derived fuel, usually in the form either of pellets or of baled paper and plastic, which can be marketed for use in electrical generating stations that use fluidized-bed technology. RDF in Europe is also burned for the purpose of generating heat needed in industrial processes, particularly papermaking, or it is co-combusted in utility generating stations designed for coal or wood.

