Technology: MSW Mass Burn Incineration with Electricity Generation

Definition and Description

Incineration is the thermal decomposition of the organic component of the municipal solid waste (MSW). The end product of incineration is high-temperature heat, which can be used to produce steam in a heat exchanger and the energy in the steam converted into electrical energy in a turbine or can be used in combined heat and power systems (with the heat used primarily for space heating). About 12% of the MSW in the USA is incinerated to produce energy, whereas in Sweden and other European countries close to half the MSW is incinerated in waste-to-energy (WTE) plants[18].There are several types of mass burn (combustion of the waste without significant prior sorting or treatment) technologies:

- Fixed grate – a simple, brick-lined cell, with a fixed metal grate and an ash pit below.
- Moving grate – the most commonly used technology in modern incinerators, the waste is introduced by a crane at the "throat" of the grate and then moves down the descending grate to the ash pit at the end.
- Fluidized bed – a powerful air current is used to churn sand particles, and then the waste and fuel are added. The violent churning ensures full circulation in the furnace.
- Rotary kiln – has two chambers. In the primary chamber, the solid fraction of the waste is converted to gas (volatilization, partial combustion), the gases are combusted in the second chamber

MSW incinerators (moving grate) produce:

- A bottom ash (collected in the ash pit)
- A fly ash (collected from cleaning the flue gases)
- Flue gases

Incinerators reduce the mass of the original waste by 80-85% and the volume by 85 - 90%. In some countries both the fly ash and bottom ash are considered hazardous, and the disposal of the ash is regulated. The flue gases may contain particulates, sulphur oxides, nitrogen oxides, carbon monoxide, carbon dioxide, hydrochloric acid, heavy metals, dioxins and benzofurans. Up to 50% of the capital costs of mass burn incinerators is the pollution control technology, which may include:

- Baghouse filters
- Electrostatic precipitators
- Afterburners
- Wet and dry scrubbers

Potential in Grenada

[18] https://www.wsj.com/articles/does-burning-garbage-for-electricity-make-sense-1447643515

According to Danish researchers, one tonne of MSW can produce 0.66 MWh of electricity and 2 MWh of district heating[19]. Therefore, 100 tonnes of MSW/day (Grenada's current solid waste generation rate) could produce approximately 66 MWh of electricity and 200 MWh of district heating (or district cooling if combined with a heat pump). According to the USEPA[20], one short ton of MSW (0.9 metric tonnes) can produce 550 kWh of electrical energy. Using the EPA figures, 100 metric tonnes could produce ~ 61 MWh of electrical energy (equivalent to a 2.5 MW plant running 24 hours).

According to the 2016 GRENLEC Annual Report, the utility company generated 217 GWh of electricity that year. Using the more conservative EPA figures, a 100-tonne /per day Waste-to-Energy plant could produce approximately 22 GWh per year or ~ 10% of the national supply. However, incinerators suffer significant economy of scale penalties. 100 tonnes per day may not be enough waste to make the technology competitive.

Mitigation to Climate

Assuming annual national emissions of ~ 250,000 tonnes of CO_2 equivalent, with approximately half coming from the electricity sector, and that a mass burn WTE facility would displace 10% of the diesel used for electricity generation, would equate to a annual mitigation potential of ~ 12,500 tonnes of CO_{2eq}

Advantages

- Extends the life of the landfill
- Provides baseload electrical energy
- Is the most common WTE technology for MSW

Disadvantages

- High upfront capital costs
- Economics may rely upon a tipping fee or government subsidy
- May compete with some recycling programmes (e.g. plastics)
- Complex mechanical systems that require maintenance
- Ash considered hazardous

Costs and other financial requirements

The costs of a mass burn incinerator with energy recovery vary depending on the size of the plant. According to the World Bank[21], the technology is not suitable for waste streams less than

[19] *Waste to Energy in Denmark". Ramboll. 2006.*

[20] https://www.epa.gov/smm/energy-recovery-combustion-municipal-solid-waste-msw

[21] World Bank, 2000. A Decision Maker's Guide to Municipal Solid Waste Incineration

50,000 tonnes/year. Grenada is currently at ~37,000 tonne/year. Unlike other energy systems, operators of WTE systems usually get two sources of revenue- a tipping fee for receiving the waste (e.g. US$ 20 - 40/tonne) and a sale price for the electricity produced (e.g. US$0.05 – 0.2/kWh). The World Energy Council[22] has estimated the capital costs of mass burn incineration with WTE at US$7,000 – 10,000/kW. A 3MW plant would therefore cost ~ US$21 – 30 million assuming no economy of scale penalties.

Status of the Technology in Grenada

There is currently no mass burn incineration technology with energy recovery in Grenada.

[22]World Energy Council, 2016. World Energy Resources. Waste to Energy