Technology: MSW Gasification with Electricity Generation

Definition and Description

Unlike incineration, where the useful end product is high-temperature heat, the thermal gasification of the organic component (anything containing carbon) of municipal solid waste (MSW) produces a synthesis gas. The composition of the syngas will vary depending on the feedstock and the type of gasification process but is typically 30 to 60% carbon monoxide (CO), 25 to 30% hydrogen (H_2), 0 to 5% methane (CH_4), 5 to 15% carbon dioxide (CO_2), with some traces of ammonia, and hydrogen sulphide[6].

To produce this syngas, two processes occur. Firstly, at temperatures less than 600^oC, through pyrolysis, the volatile components of the waste stream are released. A char is produced as a by-product. After pyrolysis, the volatile components are either reacted with steam or hydrogen (reforming) or combusted in oxygen rich air at high temperatures and pressures to form the syngas. Reactors can be fixed bed (< 1 MW) or fluidized. Fluidized beds are more suitable for larger scale plants. The heterogeneity of the MSW poses significant challenges for this technology. Some form of pre-treatment to homogenise the waste (e.g. produce refuse-derived pellets) prior to gasification is preferable.

Another form of gasification is plasma arc technology, which uses extreme heat to produce plasma which converts the waste into a synthesis gas. This technology has been used successfully to treat some forms of hazardous waste. However, the variable composition of MSW has proven to be challenging.

The syngas is then cleaned (e.g. particulates removed) and used in a gas turbine for electricity production or for combined heat and power.

Potential in Grenada

Grenada produces approximately 100 tonnes of MSW per day. This is a relatively small quantity and there would be significant economy of scale penalties. Gasification of MSW (unlike gasification of coal) is in its infancy. There is limited potential for the use of this technology on a national scale to produce electricity. Barbados' recent experience with proposed developers of plasma arc gasification technology is instructive[7].

[6] https://www.netl.doe.gov/research/coal/energy-systems/gasification/gasifipedia/syngas-composition
[7] https://www.barbadostoday.bb/2016/05/13/cahill-project-dead-confirms-lowe/

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 MSW gasification WTE facility would displace 10% of the diesel used for electricity generation, would equate to an annual mitigation potential of ~ 12,500 tonnes of CO_{2eq}

Advantages

- Extends the life of the landfill
- Provides baseload electrical energy
- Has the potential to be more efficient than conventional mass burn technology
- Slag by-product is a useful construction material

Disadvantages

- High upfront capital costs
- Economics may rely upon a tipping fee or government subsidy
- May require pre-treatment of the waste (homogenisation)

Costs and other financial requirements

As with mass burn, the economics of MSW gasification and energy recovery are dependent upon the type of gasification technology, the size of the plant, the tipping fee that is imposed, and the selling price of the baseload energy. The capital costs may be slightly lower for gasification plants because less flue gases are produced and there is less need for air pollution technology. However, there may be higher upstream costs associated with having to produce a homogenous refuse-derived fuel. A study in the USA estimated the processing costs of gasification at US$36/tonne as compared to conventional mass burn at US$51/tonne[8].

Status of the Technology in Grenada

There is currently no MSW gasification technology with energy recovery in Grenada.

[8] Jenkins, S.D., 2007. Conversion technologies: A new alternative for MSW management, Earthscan.