Energy from waste: Intriguing necessity in Indian sub-continent

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Abstract

Background/Objectives - Disposal of waste was never taken seriously in urban/rural areas. The recent Swachh Bharat Abhiyan initiated by the Hon'ble Prime Minister Shri Narendra Modiji has offered an immense opportunity to revolutionise the waste management practices being adopted in the country into a golden opportunity for producing energy from waste.

Methods/Statistical Analyses - This paper discusses in detail the various prevailing systems for converting the waste into productive energy.

Results - In a developing economy like India with huge gulf between electricity demand and supply, schemes for converting waste to energy needs to be rigorously pursued.

Key words : biogas, clean energy, incineration, municipal wastes.

1. Introduction

The municipal solid waste (MSW) is generated in very large amounts and dumped in open landfill without proper precautions and sorting out the recyclable wastes. As waste decomposes in a landfill, it produces methane which depletes ozone layer increasing the risk of skin cancer. Apart from air pollution, when rainfall or surface water passes through these open landfills, toxic wastes percolates into the groundwater causing contamination and consequent health hazards [1].

Energy-from-Waste (EfW) or Waste-to-Energy (WtE) is the process of generating electricity and at the same time disposing the wastes in a safe manner. While these concepts were put to practice in the developed west way back in the last quarter of the nineteenth century and even Asian countries such as China, Japan & Indonesia joining the bandwagon though two to three decades back, no efforts were seen in this direction in the Indian subcontinent which has a huge potential. As per State-of-the-Art-Report Statistics, 5th Edition published by International Solid Waste Association in August 2006, Germany topped amongst the EU countries with about 15 million tonnes waste treated per year and producing 12 MWh energy from waste[4]. Lee County Solid Waste Resource Recovery Facility, operating as Covanta Lee, Inc., located in Fort Myers, Florida (USA) which began commercial operation in December 1994 processes about 1,836 tons-per-day of solid waste while generating up to 60 megawatts of clean, renewable energy.

2. EfW/WtE Technologies

A number of new EfW or WtE technologies are emerging for tapping energy from waste obviating incineration or direct combustion. Moreover, these technologies are quite efficient too compared to mere incineration. This is mainly due to the separation of corrosive components (ash) from the converted fuel, thereby allowing higher combustion temperatures in e.g. boilers, gas turbines, internal combustion engines, fuel cells[2]. Some are able to efficiently convert the energy into liquid or gaseous fuels as discussed below.

2.1. Incineration

Incineration entails burning of the solid wastes to boil water and generate steam so as to power steam generators for generating electricity. Adequate filtration/screening equipments such as lime scrubbers and electro-static precipitators on chimneys are required to be erected in order to overcome the problem associated with the pollutants of incineration to enter the atmosphere causing environmental damage by turning rain into acid rain.

2.2. Thermal technologies

2.2.1. Gasification

The biomass waste is converted into carbon monoxide, hydrogen and carbon dioxide by subjecting the material to temperatures as high as 700 °C without combustion, with a controlled amount of oxygen and/or steam. Syngas (short form of synthesis gas or synthetic gas) produced from gasification serves as a fuel.

2.2.2. Thermal depolymerization

It is analogous to the natural geological processes which produce fossil fuels. Under pressure and heat by using super heated water, long chain polymers of hydrogen, oxygen, and carbon decompose into short-chain petroleum hydrocarbons. The advantage with this method is that water need not be removed from the organic matter at the time of processing.

2.2.3. Pyrolysis

An irreversible thermochemical reaction of organic material at elevated temperatures involving simultaneous changes to physical as well as chemical composition under anaerobic conditions is the essence of pyrolysis. The word is coined from the Greek-derived elements *pyro* "fire" and *lysis* "separating".

2.2.4. Plasma gasification

Plasma gasification converts organic matter into synthetic gas, electricity, and slag using plasma. Plasma is one of the four fundamental states of matter, the others being solid, liquid, and gas. A plasma can be created by heating a gas or subjecting it to a strong electromagnetic field applied with a plasma torch powered by an electric arc, thus catalyzing the organic matter into synthetic gas and solid waste (slag).

2.3. Non-thermal technologies

2.3.1. Anaerobic digestion

Anaerobic digestion breaks down biodegradable material with the help of microorganisms in the absence of oxygen producing biogas consisting mainly methane, which can be used in running the power gas engines. The nutrient-rich digestate produced has a great use as a fertilizer. Due to abundant availability of biomass resources such as cattle dung, kitchen waste, agricultural waste etc in the rural India, the decentralized bio-gas units offer greater viability & sustainability.

2.3.2. Fermentation

Fermentation is also used more broadly to refer to the bulk growth of microorganisms on a growth medium. Fermentation products are ethanol, lactic acid, hydrogen which can be used as a fuel.

2.3.3. Mechanical biological treatment (MBT)

This includes mechanical sorting facility as well as biological treatments such as composting or anaerobic digestion. MBT removes metals, plastics, glass and paper from the MSW and recycles them. The mechanical element comprising conveyors, shredders etc is similar to materials recovery facility (MRF). Anaerobic digestion, composting or biodrying are adopted under biological processes. Renewable fuel (biogas) is produced and waste materials such as metals, paper, plastics, glass etc, are sent for recycling. Digestate viz., organic fertiliser and residual unusable materials are completely burnt in incinerators thereby reducing the volume by about 90% which can be used in filling of low lying lands.

3. Indian experience

Timarpur Okhla WtE plant is the first and largest integrated waste management project operating since December 2011 based on zero waste concept through an environmentally friendly process to generate clean and renewable energy from MSW. Existing project site at Okhla was an open dump and Jindal Urban Infrastructure won the bid to develop the project on a Built Own Operate and Transfer (BOOT) basis in a public private partnership (PPP) with the Government of Delhi. The Okhla Waste to Energy (WtE) plant process about 1/3rd of the Delhi garbage (1300 tonnes MSW per day) generating 16 MW clean and renewable energy serving 6 lakh homes[3]. The working process of Timarpur Okhla WtE facility is shown as under :

(a) The trucks carrying Municipal Solid Waste (MSW) will be allowed into a fully covered enclosure where negative pressure is maintained to prevent bad smell/odour spreading in the plant site.
(b) Thereafter, reusable materials such as metals etc are removed for the purposes of recycling.
(c) The Refuse Derived Fuel (RDF) or solid/specified recovered fuel (SRF) comprising of combustible biodegradable materials is burnt in a combustion chamber with a pre drying zone, where self-sustaining combustion is maintained at extremely high temperatures.
(d) The heat generated from the combustion process is used in generating the steam which further runs the turbine for ultimate electricity production.
(e) Ash from combustion is used for filling of low lying lands or manufacturing flyash bricks etc.
f) All gases are emitted into the atmosphere after proper filtration.

4. Conclusion

WtE plants generate energy using household waste as fuel and helps solve some of society's biggest challenges such as

- Population growth – Safe & reliable waste disposal
- Climate change - Greenhouse gas reduction
- Dependence on fossil fuels – Clean & renewable electricity

The Government should explore the target of "Zero Waste" atleast by 2022 under the Swachh Bharat Mission which not only cleanse the nook & corner of the country but also helps in overcoming the power shortage particularly in remote & far flung rural areas through decentralised bio-gas plants. MBT plants with fully equipped filters to avoid pollution not only to be built in all cities & medium sized towns and at the same time should be made mandatory for all smart cities to be developed by the Union Government. Incinerators with electrostatic precipitators should be promoted for all town municipalities and the present practice of open garbage fills should be totally banned. Clean India not only enhances the prestige of the country in the comity of nations but also help in promoting the Prime Minister's pet project Make in India.

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