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Transformation of waste to energy- Available technological options in India

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ABSTRACT

Urban, industrial, biomass and biomedical wastes are being generated in huge quantities world over causing significant environmental problems including human health. Such generation of waste is on increasing trend with the increase in population along with corresponding increase in industrialization and urbanization. In order to address such an alarming issue of such waste, it has become essential to transform this waste into usable product through technological development and innovation techniques which would not only take care of environmental problems but also act as economic tools to manage wastes. An effort has therefore been made by the authors of the present paper to discuss various technological options available to transform such wastes into energy, fuel pallets, compost, and methane gas etc.

Keywords: Solid waste, Energy conversion, technological options

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Introduction:

Generation of household waste Is increasing rapidly on a time scale particularly in urban areas surpassing the assimilation capacity of the ecosystem along with the insufficient capacity of disposed yards for its handling resulting into proliferation of open air dumps, with an increased threat to the public health, ecosystem, and quality of life. Based on the population estimates by the Population Division of the United Nations and the gross domestic product (GDP) predicted by the World Bank, it is likely to be expected that total solid waste will be increased to 27 billion tons in 2050 from 13 billion tons in the year 1990 (Beede and Bloom, 1995). The annual total solid waste generation is approximately 17 billion tons (Chattopadhyay et al., 2009). Global generation of MSW in 1997 was 0.49 billion tons with an estimated annual growth rate of 3.2–4.5% in developed nations and 2–3% in developing nations (Suocheng et al., 2001) (1).

It has been roughly estimated that around 70 million tones of municipal solid waste (MSW) is generated annually in urban areas in India out of which more than 80 percent is disposed off indiscriminately at dumping places in an unhygienic manner. Such a huge quantity of waste has the potentiality of generating 1.5 million cubic meter of biogas per day or 75 MW of electricity from biogas along with 5.7 million metric tons of compost. If such a huge quantity of waste is continued to be disposed off indiscriminately, it may need around 0.37 million cubic meter of landfill space every day or around 1300 hectares of land per year. Moreover, around 50 billion liters of sewage generated in urban areas in India and the sewage and solid waste is likely to be increased rapidly in future as more people migrate to urban areas (2). A typical waste dumping area is shown in figure 1 below:

Figure-1

Transformation of waste into usable products:

Composting:

Closed bins method:

Closed bins are usually square or cylindrical in shape and made from recycled plastic with lid to cover the container. These bins are classified as cold-composting method rather than hot composting because of not being able to maintain required temperature. These bins typically have no bottom and as a result the compost materials will drop out when the bin is lifted (3). A typical picture of closed bin is shown in figure 2 below

Figure-2 Showing closed bin method:

Pit composting method:

In this method, holes or trenches are dug to bury waste in pit where the organic materials

gradually break down over a period of six months to one year to produce compost as shown in figure 3. This method has no cost but requires extra labor for digging (3).

Advantages:

• Can be sited anywhere to make a new planting bed or garden

• Materials are out of sight

• Requires no construction and minimal labor

• No turning is necessary

• Holds as much organic matter as required

• Good for any area

Disadvantages:

• Takes six months to a year before matter breaks down

• cannot harvest the compost

• cannot do hot composting

Figure: 3 Showing pit compost method:

Open bins method:

Open bins are structured area using wire fencing or wood to store organic matter which enable perform hot or cold composting. Such bins facilitate easy turning and harvesting of materials and for air to enter and circulate leading to fast decomposition. These bins are easy to build and can accommodate large volumes. The three-bin system is approximately 12 feet long and 4 feet wide with each compartment being 4 feet square as shown in figure 4(4).

Advantages:

• Simple to construct

• Holds large amounts of organic matter

• Good for hot composting

• Materials are tidy and partially hidden

• Easy to turn materials and harvest compost

• One-bin system fits in most areas

Disadvantages:

• Can be expensive

• Compost isn't completely hidden

• Three-bin system requires a lot of space

Figure: 4 showing three bin composting system

Tumblers method:

Tumblers usually are made out of plastic and is a less labor-intensive method where closed tumbler is attached to a support structure as shown in figure 5 in which the unit is turned either with a handle or by hand. It is used for cold composting and some soil is added in the mix in order to breaking down of organic matter(5).

Advantages:

• Good for small spaces because of their size and appearance

• Easy to turn materials

Disadvantages:

• Harder to harvest compost

• Volume is limited

• Cannot do hot composting

Figure: 5 Showing tumbler method of compost

Piling method:

This method is good for hot and cold composting where a heap of mixed and compostable materials are used in a pile of around 5 ft height with open on top(6) as shown in figure 6.

Advantages:

• Requires no construction

• Good for hot or cold composting

• Easy to turn materials

• Easy to harvest compost

• Can make varying amounts of compost

Disadvantages:

• Not desirable in small spaces because of its appearance

Figure: 6 Showing method of piling

Vermicomposting method:

In this method food waste is buried on moistened bedding which is made from shredded paper, dead leaves, or straw. It can also be done in a 15-gallon container kept under the kitchen sink in which Red wigglers (*Eisenia fetida*) are best suited for home composting. There are different options for harvesting the finished compost out of which the simplest methods is to move all of the contents to one side of the bin, adding fresh, moistened bedding material and fresh food waste to the empty side and the worms will migrate over to the newer bedding over a period of several weeks (7). The finished vermicompost is shown in figure 7.

Advantages:

• Materials are tidy

• Good indoors or for small spaces

• Easy to do in winter

Disadvantages:

• Bedding material needs to be kept moist

• Fruit flies can be a problem if food waste is not buried under the bedding or if feeding the worms more food

Figure: 7 showing vermicompost:

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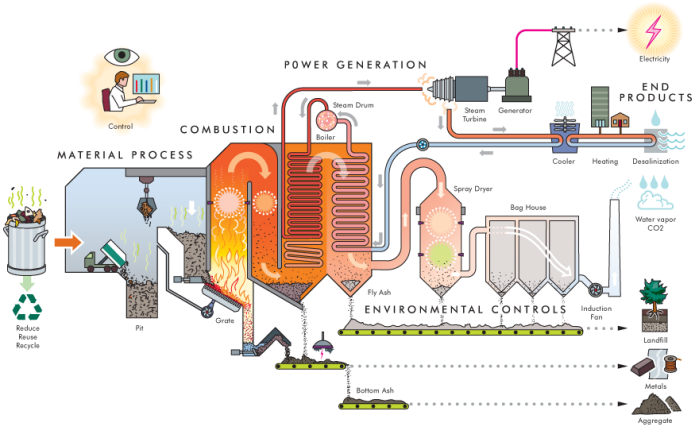
Waste-to-Energy:

Waste-to-energy is a method where waste is used as a fuel for generating power in which waste material is received in an enclosed receiving area where it is thoroughly mixed before combustion and then negative airflow is provided to carry dust and odor into the combustion chamber from the receiving area. Subsequently, mixed waste is then fed into the combustion chamber through a moving grate which enables to turns it over repeatedly to keep it exposed and burning where oxygen and fumes drawn from the receiving area are injected to allow complete burn. The burning fuel heats water into steam that drives a turbine to create electricity. This process can reduce a landfill volume up to 90 percent and prevent one ton of carbon dioxide release for every ton of waste burned (9). The complete process of converting waste to energy along with environmental control measures are shown in figure 8 below:

Figure:8 Shoring power generation from waste:



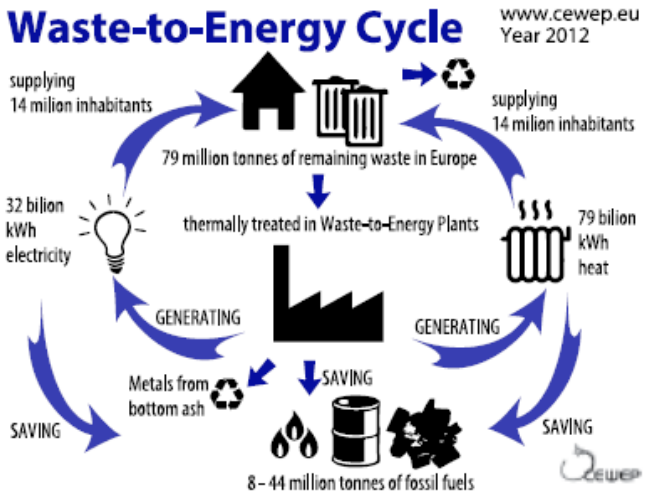
As would be seen from the above figure, the fly ash is generated .in the process which is in the form of fine airborne particle which is filtered and removed in the bag house. Moreover, the acidic combustion gasses are neutralized with an injection of lime or sodium hydroxide in the scrubber. Bottom Ash so generated is recycled and superheated steam produced is used run the steam turbine generator to produce power(10).

A typical waste to energy plant is shown in figure 9 below where solid food waste is collected and sent to food waste receiving and separation area and from where it is sent to anaerobic digester in which methane is produced. This methane is then sent to engine to produce electricity. Moreover, solids generated from anaerobic digester is applied to soil amendment (11).

Figure: 9 showing waste to energy generation plant

Moreover, a typical waste to energy cycle is reflected as shown in figure 10 below.

Figure 10: Showing waste to energy cycle:



Conclusions:

Increasing population and economic development along with increasing consumption pattern resulted into increased generation of municipal solid waste thereby causing significant environmental pollution, health effects, nuisance, and land degradation. In order to address such an alarming and emerging issue, sustainable solid waste management systems must be put in place by the local authorities and government. It should always be kept in mind that waste is a resource and should be transformed into usable products. In the present case , municipal solid waste should be used to transform into compost, fuel pallets and energy through technological options partly to address environmental threats and partly to provide economic sustainability. However, adequate research needs to be undertaken and encouraged in this area with different dimensions

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