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ENERGY FROM WASTE TO ENERGY TECHNOLOGY USING RDF

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Abstract:

Municipal Solid Waste (MSW) management is a chronic environmental problem in most of the developing countries, including the India. The concept of Waste-to Energy (WTE) is known as one of the several technologies capable of benefiting a society, which desires to reduce fossil-fuel addiction. Currently, there is no WTE facility existing in the India. The MSW is collected and disposed in landfills untreated. A substantial increase in the population by 2.2 % per year over the last years coupled with urbanization and raised living standards have resulted in high generation rate of MSW. The food and plastic waste are the two main waste streams, which covers 70 % of the total MSW. The waste is highly organic (up to 72 %) in nature and food waste covers 50.6 % of it. The aim of this paper is to review the prospective WTE technologies in Jabalpur city in India. Three WTE scenarios were developed: complete incineration; incineration with recycling and Refused Derived Fuel (RDF) with Biomethanation. The results show that Jabalpur has the potential to produce about 197 MW of electricity based on incineration scenario; about 57 MW based on incineration with recycling scenario; and about 76 MW based RDF with biomethanation scenario in the year 2030.

1.0 Introduction:

The generation rate of Municipal Solid Waste is expected to increase to 2.2 billion tonnes per year by 2025 worldwide. However, in developing countries, collection, transport and disposing of waste is still challenging while, in developed countries, emerging technologies are used to produce different by-products such as heat, electricity, compost and bio-fuels. This study assesses the different waste-to-energy technologies developed to date. This work is divided into four groups: biological treatment of waste; thermal treatment of waste; landfill gas utilization; and biorefineries. Furthermore, integrated solid waste management systems with waste-to-energy technologies are studied and some worldwide examples are provided.

Municipal solid waste (MSW) management system aims to handle health, environment, aesthetic, land-use resources, and economic concerns related to improper disposal of waste [1-3]. Population, urbanization growth and the rise of standards of living have all dramatically accelerated the MSW generation in developing countries. Developing countries are not able to cope with the MSW generation growth and open landfills remain the dominant method of disposal. Waste-to-energy technologies (WTE-T) are promising technologies, especially for developing countries, to turn waste into a useable form of energy. In the developed world, WTW-T are being part of their Integrated Solid Waste Management Systems (ISWM-S) to not only produce other by-products but also to address global warming and climate change. Globally, WTE-T play a vital role for sustainable waste management and mitigation of environmental issues. These technologies are generally classified as biological treatment technologies (or Biochemical process) and thermal treatment technologies (or Thermochemical process).

There are many sources through which solid waste are generated, some of these are bio-medical waste, industrial waste, residential population, commercial establishments, public and private institutions and agriculture waste of heterogeneous in nature [1].

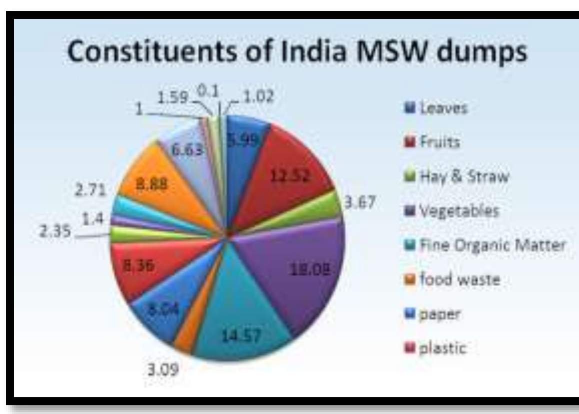


Figure 1: Composition of MSW in India [4]

1.1 Waste-To-Energy (WTE) Process

WTE is the process of generating energy in the form of electricity and/or heat from the incineration of waste. WTE is an energy recovery process. Most WTE processes produce electricity and/or heat directly through combustion, or produce a combustible fuel commodity through gasification/pyrolysis process, such as methane, ethanol or synthetic fuels. Waste feedstock can include municipal solid waste (MSW), agricultural waste, industrial waste and even the gases that are naturally produced within landfills.

1.2 Refuse Derived Fuel (RDF)

The purpose of the waste to RDF facilities is to produce improved solid fuel or pellets from waste which can be used for energy production by thermal combustion of RDF or as a cheap and efficient fuel in Industries and it can also be fired along with the conventional fuels such as coal.

RDF facilities can relieve the pressure on the landfills [3]. But operation of such thermal treatment systems involves higher cost and expertise [2]. High metal concentration in the RDF is a major problem which is encountered, which makes it essential to pretreat the waste. The RDF generation involves dehydration, shredding and palletization, which require a separate site, increasing the operational cost of the RDF facility.

Figure 2: RDF Making Machine

India has experience with the RDF facilities, like the RDF facility installed in Hyderabad, Jaipur, Rajkot, Vijayawada and Chandigarh. All these five facilities experienced severe problems and public opposition which resulted in the closure of these facilities. But nevertheless, attempts to setup RDF plants in India are still going on. And there are already some other RDF plants which are in operation.

2.0 Total Potential of MSW in Jabalpur City

Jabalpur is one of the four major cities in Madhya Pradesh (India) with a population of approximately above 24 lacks produces 1, 59,826 tons per annum and 600 tons per day of MSW. This waste is disposed by open dumping site at the Ranital dumping site MSW problem is a major concern in major cities Jabalpur. The organic fraction of solid waste composition comprised about 71%. The waste generation rate has increased from 0.23kg/capita/day in 2004-05 to 0.50 kg/capita/day (500 g/c/d) in 2015 indicating an increase rate of 3.8% per year. MSW is the waste generated in a community with the exception of industrial and agricultural wastes. Hence MSW includes residential waste (e.g., households), commercial (e.g., from stores, markets, shops, hotels etc), and institutional waste (e.g., schools, hospitals etc). Paper, paperboard, garden and food waste can be classified in a broad category known as organic or biodegradable waste.

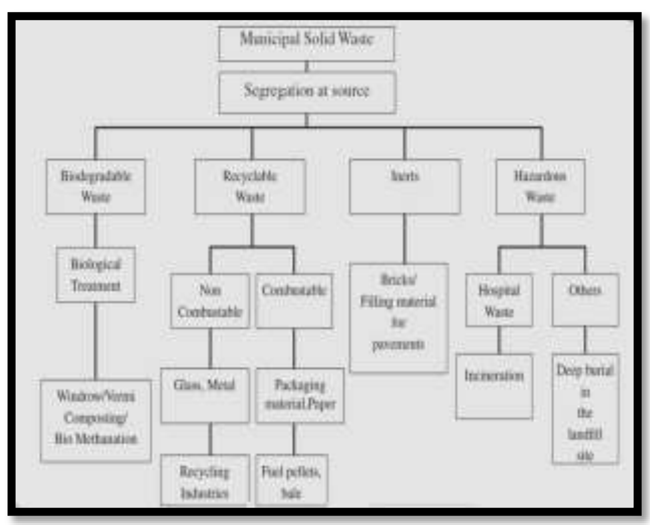


Figure 3: Schematic of solid waste segregation at source at Jabalpur

3.0 Current MSW Methodology

a) Collection and Transportation by the Jabalpur Municipal Corporation (JMC)

Jabalpur is one of the four major cities in Madhya Pradesh (India) with a population of approximately above 24 lacks produces 2, 19,000 tons per annum and 600 tons per day of MSW. This waste is disposed by open dumping site at the Ranital dumping site MSW problem is a major concern in major cities Jabalpur. The organic fraction of solid waste composition comprised about 71%. The waste generation rate has increased from 0.23kg/capita/day in 2004-05 to 0.50 kg/capita/day (500 g/c/d) in 2016 indicating an increase rate of 3.8% per year. MSW is the waste generated in a community with the exception of industrial and agricultural wastes. Hence MSW includes residential waste (e.g., households), commercial (e.g., from stores, markets, shops, hotels etc), and institutional waste (e.g., schools, hospitals etc). Paper, paperboard, garden and food waste can be classified in a broad category known as organic or biodegradable waste [3]

In Jabalpur mostly MSW management, i.e. its collection, transportation, segregation and disposal, is done by the municipal agencies who work under the state government as per MSW management and handling rules, 2000 which is under the Environment Protection Act, 1986. And in some urban areas it is handled by the private agencies as well, such as non-governmental organizations (NGO's).

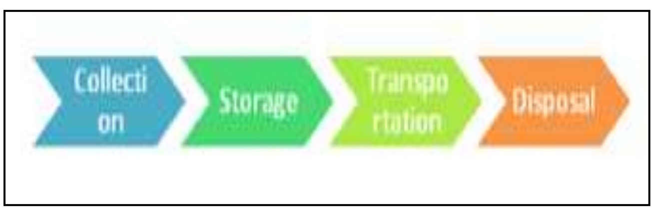


Figure 4: MSW Methodology used in Jabalpur City

4.0 Materials and Methods

(i) Waste-to-Energy (WTE) generation process Through RDF

WTE is the process of generating energy in the form of electricity and/or heat from the incineration of waste. WTE is an energy recovery process. Most WTE processes produce electricity and/or heat directly through combustion, or produce a combustible fuel commodity through gasification/pyrolysis process, such as methane, ethanol or synthetic fuels. Waste feedstock can include municipal solid waste (MSW), agricultural waste, industrial waste and even the gases that are naturally produced within landfills.

In this technology the waste is mechanically processed to produce forms more suitable for use as fuel, producing refuse-derived fuel (RDF) or solid recovered fuel (SRF). RDF is a fuel produced by either shredding solid waste or treating it with steam pressure in an autoclave. RDF consists largely of organic materials taken from solid waste streams, such as plastics and biodegradable waste. Burning RDF is more clean and efficient than incinerating MSW or other solid waste directly.

(ii) Structure of collection and transportation

The collection and transportation of the waste is made in two different ways depending on how the waste is generated. Household waste is collected through door-to-door collection with tricycles. Waste thrown on the streets is collected through street bin collection with compactors. The collection efficiency in Jabalpur is 73 percent, which means that 73 percent of all the MSW in Jabalpur is collected and transported to a final disposal [6].

4.1Steps for process methodology

a) Identified Location and Organisation of Primary Collection

Primary collection of segregated MSW from individual households and establishments (door-to-door collection) is accomplished through the use of containerised pushcarts, tricycles or small mechanised vehicles, compactors, or tipping vehicles depending on the terrain of the locality, width of streets, and building density. Spacious and well-lit safe neighbourhoods allow collection systems with compactor vehicles and tipping equipment which are more efficient. Narrow streets do not allow for the use of conventional primary collection vehicles.

a) Door-to-door collection (primary collection)

At the household level, dry waste, wet waste, and domestic hazardous waste should be stored in separate garbage bins, of appropriate capacity and colour (Figure). The colour of the garbage bins should be in accordance with the SWM Rules, 2016; wet waste is to be placed in a covered green bin and dry waste in a covered white bin. Because the rule does not specify the colour of the bins for storage of domestic hazardous waste, urban local bodies (ULBs) should decide on an appropriately coloured bin.

i) Process MSW to RDF Conversion

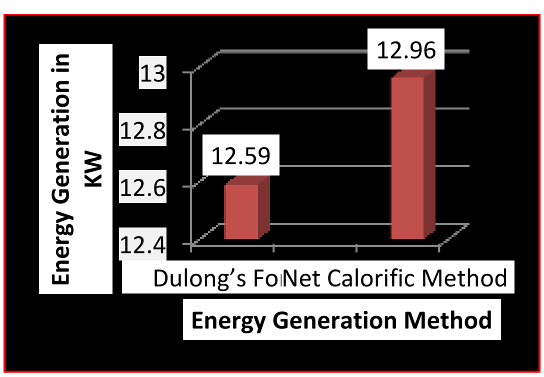
There are a number of different processes for preparing RDF from MSW. However, all the technologies can be summarized into the following generalized process steps:

- Acceptance of segregated (separation at source) or unsegregated waste at the processing plant
- Sorting by different rotating drum or plain sieves into main fractions (biodegradable, combustible, mineral)
- Mechanical separation of recyclables like metals
- Size reduction (shredding, chipping and milling)
- Separation and screening of main fractions into products
- Blending
- Drying and pelletizing
- Packaging and
- Storage

5.0 Result & Discussion

Analysis of power generation potential and environment effects after the RDF production are defined below through Dolong's Formula for steam generation method and net calorific method for direct combustion method. The current operating Plant capacity is 11.5 MW under construction using direct dry MSW.

In general, 600 tons of raw MSW can generate about 11.5 Mega Watt power, depending upon the waste characteristics. So, if we follow this thumb rule and calculate the power generation on assumption that 1.25 MW per 100 tons, then it will be 11.5 MW which is almost nearer the calculated value on considering Calorific Value. The above calculation show total power generation potential in average 1 2 MW per day using RDF.



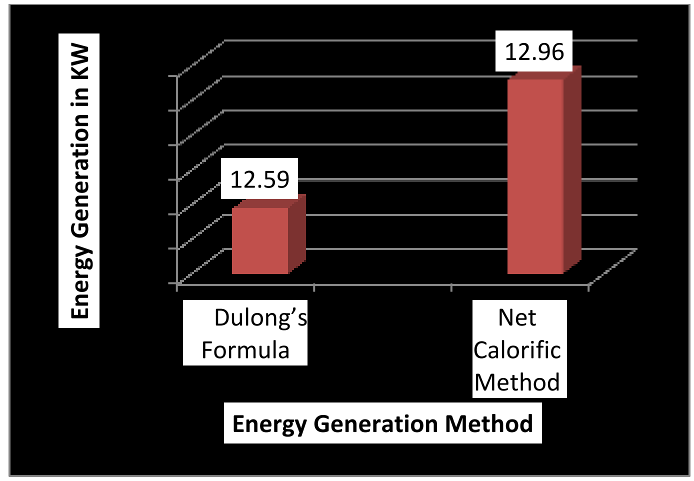


Figure 5: Graph show Power generation Potentials of two methods

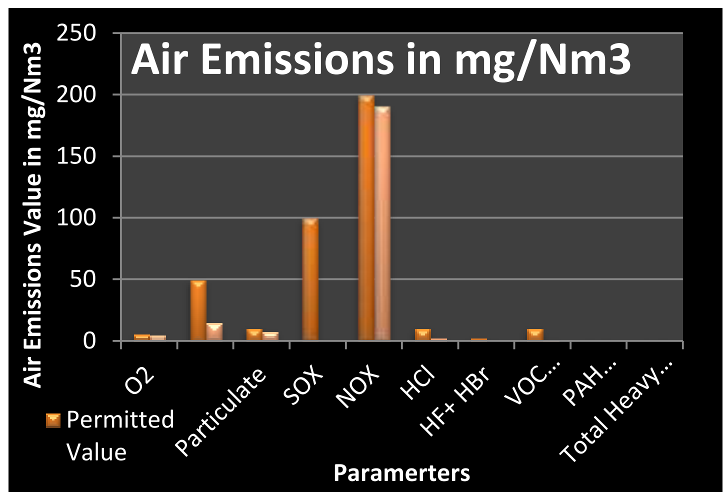


Figure 6: Graphs shows the air emission between permitted value and Expected Value

6.0 Conclusion

An extensive economic analysis of an MSW management option has been carried out to evaluate the feasibility of integrating RDF production to RDF-to-energy facilities under current MSW generation in Jabalpur (M.P.). The economic feasibility of RDF-to-energy plant has been investigated by carrying out a capacity analysis as well as evaluating energy generation and also reduces the environmental impact. Sensitivity analysis of total air emissions in environments. The analysis showed that, with technological option considered, up to 12 MW power plant has attractive return on investment.

Under this scenario, majority of MSW will still be disposed of in landfills. Hence, environmental benefit is not realized to the full. To gain considerable environmental, social and economic benefits such as reduction of need for new landfill sites, prolonged existing landfill sites, clean air and less underground contamination, lower chance of disease spreading, new business and employment for recycling, government subsidies for the RDF to-energy project may be offered. These can be in terms of subsidized credits, partial public funding, etc. considering its social relevance in the framework of government waste management policy.

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