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EVALUATION OF MUNICIPAL SOLID WASTE AS A SOURCE OF ELECTRIC POWER GENERATION

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Abstract : Municipal solid waste (MSW) management has emerged as probably the most pressing issue many governments nowadays are facing. Traditionally, Waste to Energy (WTE) is mostly associated with incineration, but now, with the emergence of the bio economy, it embraces a broader definition comprising any processing techniques that can generate electricity/heat or produce a waste-derived fluid. Under the ambit of the circular economy many nations are looking for, additional effort must be made to be sure of acquiring the most updated information and paving a sustainable path for managing MSW in such a frame.
This work evaluates the techno - economic prefeasibility of waste to energy projects in Colombia using four different conversion technologies of incineration, gasification, anaerobic digestion and landfill gas. Three study cases were selected to represent typical urban centers in Colombia, which were namely Guayata, Andes and Pasto. After feasible technologies were identified for each case, their energy recovery potential was calculated based on the mathematical models and publicly available information about the composition of the wastes produced in these three municipalities

IndexTerms **– Solid Waste , Waste to Energy, Pressure Gauge , Boiler, Turbine**

I. INTRODUCTION

In developing countries like India waste generation is increasing day by day due to boom in industrialization, urbanization and population. This also causes greater amounts of socio – economic and environmental issues. India is the second leading nation in the world in terms of population with a nearly 1.2 billion population, has continue to raise population in India, gives a strong dip on the natural resources (Urban part of India generates approximately 0.136 million tonnes per day or 52 million tonnes per year of municipal solid waste (MSW), increases nearly 5% annually. The lifestyle of people in India is changing gradually which is the cause of waste generation.[2]

This creates continuous pressure on the government, local authority and the urban local bodies to manage the collection, segregation, treatment and disposal of wastes and make cost effective changes. Thus, there is an urgent need to improve planning of collection, segregation and disposal of wastes so that solid waste management process works significantly to create environmental sustainability[4]. The municipal solid waste management sector is governed by the Municipal Solid Waste Management Rules, 2016, Government of India. Most of the municipal solid wastes are disposed into land and water bodies without proper treatment, which produce severe water, land and air pollution. By adopting different eco-friendly waste to energy technologies, this severe lost to the environmental can be reduced. Waste to energy and heat from a renewable fuel sources, that eases dependency to greenhouse gas emissions. Waste to Energy (WTE) processes play an important role in the sustainable management of Municipal Solid Waste (MSW) worldwide. WTE involves the recovery of heat and electricity from waste, especially non-recyclable waste. The United States Environmental Protection Agency has listed MSW as a renewable energy source. Incineration is a high-quality treatment for Municipal Solid Waste (MSW), very useful in big or crowded cities, because it reduces the quantity and volume of waste to be land filled. It can be localized in an urbanized zone, and offers the opportunity of recovering energy[7]

Based on this property the MSW can be compared with the fresh wood or lignite, which is low grade coal. The amount of waste generated is still slightly rising over the years with some fluctuations, due to general economy reasons (at the time of writing – recession) and technical measures in waste management in recent years. The amount of deposited MSW at landfills is getting lower in recent year despite the rise of total generated MSW due to better separate collection and treatment technologies utilized. Mass burn is the combustion of unprocessed or minimally processed refuse after shredding MSW and removal of the non- combustible materials, bulky items and metal from refuse. The heat generated by burning MSW produces high temperature combustion can be converted to high temperature steam, which turns the steam turbine to generate electricity.[8] The energy crisis and environmental degradation are currently two vital issues for global sustainable development, rapid industrialization and

population explosion in world has lead to migration of people from villages to cities, to generate thousand tones of municipal waste daily which is one of the important contributors for environmental degradation with national level improper management of municipal solid waste causes hazardous to inhabitants. The management of MSW requires proper infrastructures, maintenance and upgrade for all activities, in this regards waste to energy provides a solution towards complying with government regulations, and achieving integrated solid waste management [9]. Wastes to energy facilities are not much different than other power plants [10]. They have generators that produce electricity. They just use garbage as the fuel. The heat produced from burning garbage turns water into steam. The force of the steam is directed at the rotors or blades of a turbine and causes it to spin. The turbine spins a shaft. At the end of that shaft is a magnet surrounded by copper wires. Electricity is generated from this movement.

Main Aim is to collect the waste from Municipalities and segregate the waste based on characteristics of dry waste and wet waste. To design a steam turbine, boiler and generator for incineration process. & To study the efficiency of electricity generation from municipal solid waste.

2. MATERIAL AND METHODOLOGY

The municipal waste is collected and then it is separated all the solid waste is removed and collected. The waste is collected manually or by trucks based on the area and volume of waste generated. And the waste is segregated based on dry and wet waste and it also depends on its composition.

Source : https://www.shutterstock.com/search/waste+segregation

Figure 2.1 Collections of Waste & Segregation of Waste

2.1 FUNCTIONAL ELEMENTS OF SOLID WASTE MANAGEMENT[5]

- **Waste generation**: waste generation encompasses activities in which materials are identified as no longer being of value and are either thrown away or gathered together for disposal. Wastes are generated at the start of any process, and thereafter, at every stage as raw materials are converted into goods for consumption. For example, wastes are generated from households, commercial areas, industries, institutions, street cleaning and other municipal services. The most important aspect of this part of the SWM system is the identification of waste.[4]
- **Waste handling, storage, sorting, storage and processing at the source:** Waste handling and sorting involves the activities associated with the management of waste until they are placed in storage for collection. Handling also encompasses the movement of loaded container to the point of collection. Sorting of waste components is an important step in handling and storage of solid waste at the source. For example, the best place to separate waste materials for reuse and recycling is at the source of generation. Households are becoming more aware of the importance of separating newspaper and cardboard, bottle/glass, kitchen wastes and ferrous and non ferrous materials. Onsite storage is of primary importance because of public concerns and aesthetic consideration. Unsightly makeshift containers and even open ground storage, both of which are undesirable, are often seen are any residential and commercial sites. Processing at the source involves activities such as backyard waste composting..[4]
- **Waste collection:** The functional element of collection includes not only the gathering of solid waste and recycling materials, but also the transport of these materials, after collection, to the location where the collection vehicle is emptied. This location may be materials processing facility, a transfer station or a landfill disposal site. .[4]
- **Sorting, Processing and transportation of solid waste:** The sorting, processing and transformation of solid waste materials is the fourth of the functional elements. The recovery of sorted materials, processing of solid waste and transformation of solid waste that occurs primarily in the locations away from the source of waste generation are encompassed by this functional element.
- **Transfer and transport:** The transfer of wastes from smaller collection vehicles to the larger transport equipment. The subsequent transport of waste usually over long distances o a processing or disposal site. The transfer usually takes place at a transfer station.
- **Waste disposal:** Today the Disposal of waste by land filling or uncontrolled dumping is the ultimate fate of all solid wastes, whether they are residential wastes collected and transported directly to a landfill site, residual materials from material recovery facilities, residue from the combustion of solid wastes. Thus, land use planning becomes a primary determinant in the selection, design and operation of landfill operations. A modern sanitary landfill is a method of disposing solid waste without creating a nuisance and hazard to public health. [4].

2.2 ELECTRICITY GENERATION:

Dry waste pass through the boiler to burn the waste, the boiler consists of water inside it after the boiler is heated the water and the high-pressure steam is produced in the boiler that steam is then passed through turbine from the nozzle of the boiler. Then due to the high pressure of the steam the blades of the turbine will rotate the shaft of the turbine is coupled to the shaft of the generator due to rotation of the turbine the generator will also rotate due to which electricity will be produced. [Figure 3.3] shows the flow chart of electricity generation.

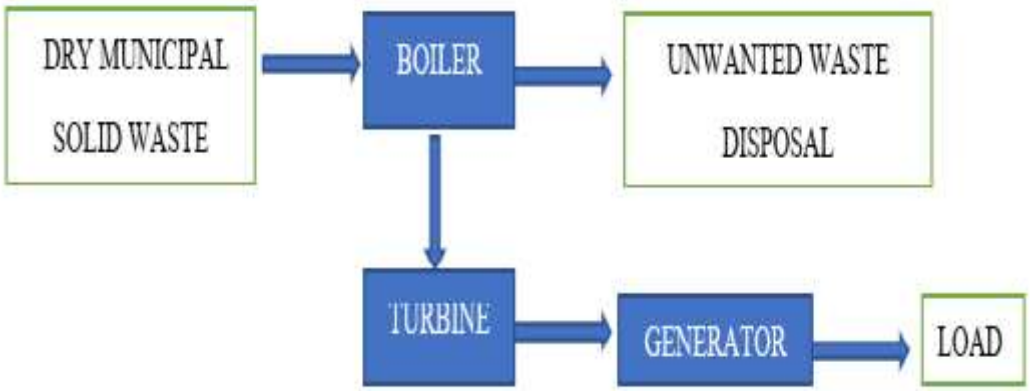


Figure 3.3: Flow chart of Electricity Generation

2.3 MATERIALS USED FOR FABRICATION OF ELECTRICITY GENERATION

Materials: Various materials are used for the fabrication of electricity Generation were as follows:

1. For Boiler – High Galvanized iron steel – 8mm think
2. For Turbine - High Galvanized iron steel – 1mm think
3. Gear arrangement- Copper wire
4. Axial flux generator- magnets neodymium
5. Nuts, closets

2.4 EXPERIMENTAL SETUP

The experimental setup consists of boiler, turbine and gear arrangements. Schematic sketch shows the arrangements Fig 2.4

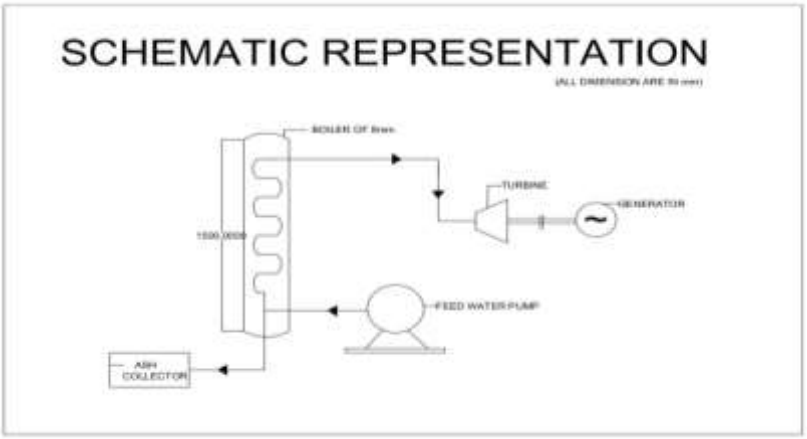


Figure 2.4: Schematic Representation

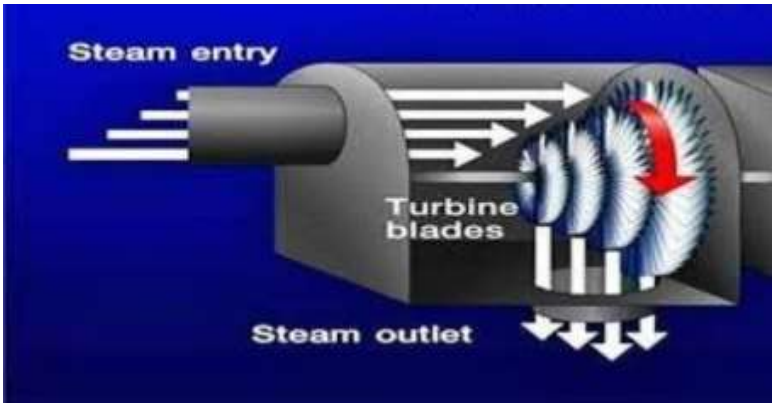
- **Boiler**

A boiler is a closed vessel in which waste is burned or heated. They are used to produce steam. The following points are the design part of the boiler is as follows,

1. Boilers are pressure vessels designed to heat water or produce steam, which can then be used to provide space heating and/or service water heating to a building.
2. The material used for the boiler design is hard GI steel.
3. The thickness of the steel material used is 10 mm so that it can withstand the high pressure produced in the boiler.
4. The length of boiler is 6 feet and the breadth of boiler is 1feet.
5. The nozzle of the boiler is such design that it will produce high pressure.

- **Turbine design**

A turbine converts the potential and kinetic energy of moving gas to mechanical energy. In a turbine generator, a moving gas pushes a series of blades mounted on a shaft, connected to a generator. Steam turbine generates 61% of electricity compared with other turbines.



Source: https://www.mindomo.com/da/mindmap/steam-turbines

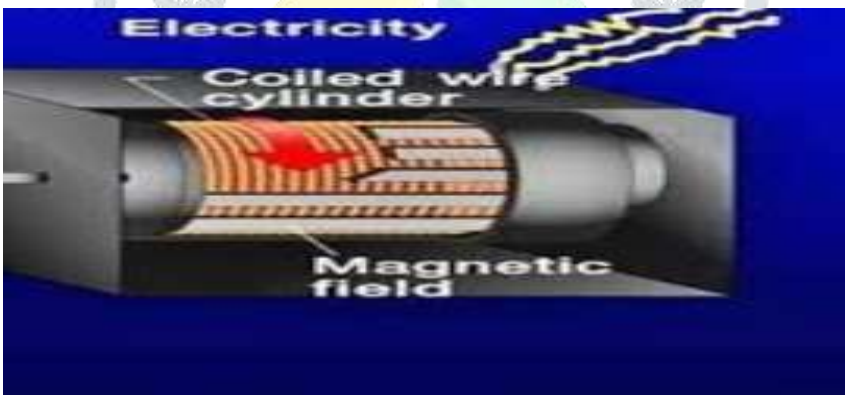
Figure: Steam Turbine

The following are the properties of generator regarding our project.

- A steam turbine is a mechanical device that converts thermal energy in pressurized steam into useful rotator mechanical energy.
- The material used for the turbine design is GI Steel.
- The thickness of the steel is 2 mm.
- The size of the turbine height 18 cm and the blades of the turbine are bent at an angle of 30 degree.

- **Generator design:**

A machine that converts one form of energy into another, especially mechanical energy into electrical energy. Generators produce electrical power based on principle of FARADAYS law of electromagnetic induction. This law states that when a conductor moves in a magnetic field it cuts magnetic lines of force, which induces an electromagnetic force in the conductor.



Source: https://www.linquip.com/blog/dc-motor-parts/

Figure: DC Generator

2.5 Design:

In the Depends upon coil and and magnet will be produce more flux and the RPM's of your alternator less the number of turns needed thereby allowing a heavier gauge of wire that can be used giving higher amperage output with tesla

V= -N*change in ((Tesla* area meter squared)/ seconds)

This gives number of turns

N=-1*(-V/change in ((Tesla*area meter squared)/seconds))

For V=10V lets figure 5 turns per second, that gives us 150RPM. If we do a good blade design we might be able to get 180rpm

N=-1*(-10/((1.35*(2*Π*20*E-3)(20*E-3+4*E-3)/0.5)

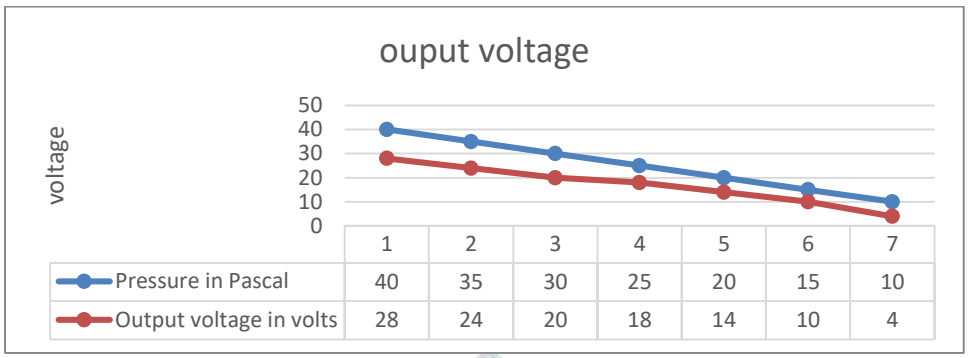
The wire used for the making of the coil is copper gauge wire of 40swg and made 8 coils of 1228 turns as per the calculation shown above. The magnets used are neodymium magnets because it has more conductivity compare to other magnets. The diameter of magnet is 20mmand Thickness of the magnet is 4.5mm.the magnetic flux density is of the magnet is 1.35 Tesla.

3. PROPOSED RESULTS AND DISCUSSIONS: Waste to energy solves the problem of municipal solid waste disposal while recovering the energy from waste material with the benefits of environmental quality, increasingly accepted as a clean source of energy. Waste presents a source of energy. The energy utilization is possible with the appropriate integrated waste management

system and utilization of appropriate technologies within the legally permissible environmental impact. Such system can create power, which is distributed to the citizens or industry. The municipal solid waste is used as fuel for the production of electricity.

The municipal solid waste should be considered as alternate source of energy and every municipal corporation should use this technology to reduced pollution, preserve coal, limited space for waste disposal and reduce production of greenhouse gases protection the ozone layer. By using municipal solid waste as fuel the pollution will be reduced and we will get the power which can be used in the poor village were electricity is less. Despite of its high initial cost we are successful to generate a voltage up to 28 to 30 volts at 40 Pascal of pressure.

OBSERVATIONS TABLE AND GRAPH



	1	2	3	4	5	6	7
Pressure in Pascal	40	35	30	25	20	15	10
Output voltage in volts	28	24	20	18	14	10	4

CONCLUSION: The conclusion is based on the results and discussions from the previous study. The aim of this project is to generate the waste to energy to solves the problem of municipal solid waste disposal while recovering the energy from waste material with the benefits of environmental quality, increasingly accepted as a clean source of energy. The municipal solid waste is used as fuel for the production of electricity. The municipal solid waste should be considered as alternate source of energy and every municipal corporation should use this technology to reduced pollution, preserve coal, and reduce production of greenhouse gases and protection of the ozone layer. By using municipal solid waste as fuel, the pollution will be reduced as well as the power which can be used for electrifying the poor villages were electricity is less.

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