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Managing Institutional, Industrial and Residential Waste Disposal System and Developing a Business Model for Empowering Lives in India

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***Abstract*— Due to population upsurge and urbanization, solid waste management is now one of the key issues to deal with as it affects quality of life. Urbanization contributes enhanced municipal solid waste (MSW) generation and unscientific handling of MSW degrades the urban environment and causes health hazards. This paper describes the various municipal solid waste conversion technologies for energy generation, in addition to a comprehensive review of MSW generation, its characterization, collection, and treatment options as practiced in India. Further, the two types of business models for handling municipal solid waste have been discussed. Finally, an attempt is made to review a Waste to Energy project in Delhi for the purpose of understanding its importance in addressing the problem of MSW in big cities like Delhi. The study concludes that installation of decentralized solid waste processing units in metropolitan cities/towns and development of formal recycling industry sector is the need of the hour in developing countries like India.**

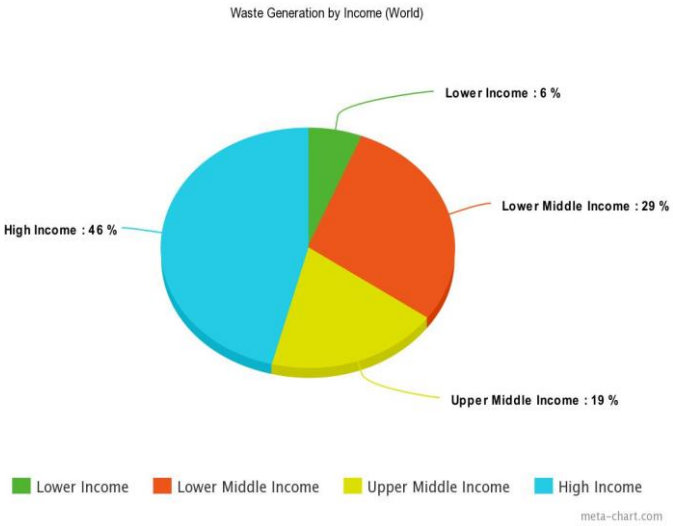
Keywords*— *Methane Production, Steam Generation, Electricity Production & Manure for organic farming.

I. INTRODUCTION

India is a fast growing country generating a huge amount of mixed waste including both biodegradable waste and non biodegradable waste. If we do not process the municipal bio waste & throw it outside directly then it will affect our atmosphere, soil, river and other environment related elements. There is an urgent need to treat the bio waste and use it for cooking, electricity generation & manure for organic farming. Thus, there is paramount importance to treat bio waste & derive useful energy for our residential & agricultural requirements.

A. Garbage generation in the world

Around the world, waste generation rates are rising. Current global Municipal Solid Waste (MSW) generation levels are approximately 1.3 billion tonnes per year, and are expected to increase to approximately 2.2 billion tonnes per year by 2025.
MSW generation rates are influenced by economic development, the degree of industrialization, public habits, and local climate. Generally, the higher the economic development and the rate of urbanization, the greater is the amount of solid waste produced. Urban residents produce about twice as much waste as their rural counterparts



B. Garbage generation in India

According to a latest Central Pollution Control Board (CPCB) report, in 2016, India produced some 52 million tonnes of waste each year, or roughly 0.144 million tonnes per day, of which roughly 23 per cent is processed—taken to landfills or disposed of using other technologies.
In 2011, a report by CPCB revealed that metro cities, economic hubs of the country, are the biggest waste generators—Delhi: 6,800 tonnes per day (TPD), Mumbai: 6,500 TPD, Chennai: 4,500 TPD, Hyderabad: 4,200 TPD, and Kolkata: 3,670 TPD.
In India, rapid urbanization and uncontrolled growth rate of population are main reasons for MSW to become an acute problem. In addition it has different geographic and climatic regions (tropical wet, tropical dry, subtropical humid climate, and mountain climate) and four seasons (winter, summer, rainy, and autumn) and accordingly residents living in these zones have different consumption and waste generation patterns.
MSW in India has approximate 40–60% compostable, 30–50% inert waste and 10% to 30% recyclable. Analysis carried out by The National Environmental Engineering Research Institute (NEERI) reveals that in totality Indian waste consists of Nitrogen content (0.64 ± 0.8) %, Phosphorus (0.67 ± 0.15)%, Potassium (0.68 ± 0.15)%, and C/N ration (26 ± 5) %.

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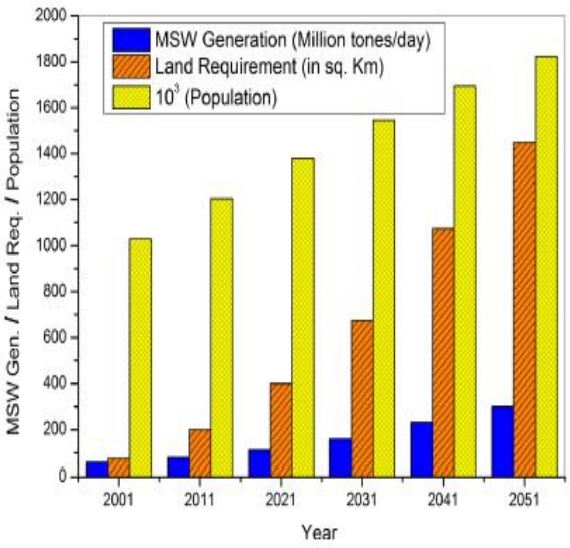

II. REVIEW OF LITERATURE

A. *Initiatives taken by Indian Government*

The Indian Government has taken Initiatives like –

- Environment Protection Act – 1986
- Hazardous Waste Management and Handling Rules – 1989
- Manufacturing, Storage and Transportation of Hazardous Waste Rules – 1989
- Bio-Medical Waste Management and Handling Rules – 1998
- Municipal Solid Waste Management and Handling Rules – 2000
- Plastic Waste (Management and Handling) Rules – 2011
- E-Waste (Management and Handling) Rules – 2011
- Municipal Solid Waste Management and Handling Rules – 2016

The National Solid Waste Association of India (NSWAI) with the help of Ministry of Environment and Forest (MoEF), New Delhi makes policies and action plans for Solid Waste Management and is responsible for collecting information and various data related to solid waste management from the municipalities of Urban Class-I cities (population more than 1Lakh) and Urban Class-II cities (population above 50,000), collate and disseminate the information to website which is linked to national and international organizations. It is also a member of the International Solid Waste Association (ISWA), Copenhagen, Denmark providing forum for exchange of information and expertise in the field of Solid Waste Management at the national and international level.
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B. *Initiatives taken by private companies*

Subhash Projects and Marketing Limited (SPML) Enviro is an integrated environment solution provider arm of Subhash Projects and Marketing Limited (SPML) provides complete solution in relation to collection, transportation & disposal of municipal / hazardous waste, segregation and recycling of municipal waste, construction & management of sanitary landfill, construction & operation of compost plant and waste to energy plant at the Delhi airport and Hyderabad Airport. SPML Enviro in collaboration with PEAT International, North Illinois, and USA uses its proprietary Plasma Thermal Destruction Recovery (PTDR) Technology in Okhala Treatment Sewage Plant.

SPLML Enviro is in joint venture with the US based Company INSITUFORM Technologies which eliminates the replacement of old sewers. In this, pipe within a pipe concept is used in which a liner is inserted into the sewer, which makes it as good as new.

C. *Initiatives taken by Indian Corporate*

Indian Corporate like HCL info System supports the ongoing initiative for separation of e-waste in India. HCL has created the online process of e-waste recycling request registration, where customers (both individual and corporate) can register their requests for disposal of their e-waste.

Nokia India launched a 'Take Back' campaign where customers can drop their old handset in the company's stores and win gifts. The take-back campaign is aimed at educating mobile phone users on the importance of recycling e-waste. As a part of this initiative, Nokia encouraged mobile phone users to dispose their used handsets and accessories such as charges and handsets, regardless of the brand, at any of the recycling bins set up across Nokia Priority Dealers and Nokia Care Centre.

D. *Initiatives taken by individuals*

Vani Murthy also known as Queen of Composting is the extraordinary story of an inspirer, who has transformed over the last three years to practice, guide and inspire many to pioneer with her the cause of waste management, home composting and terrace gardening. She started with SWM in 2008 where she worked with ITC on the project titled Wealth out of Waste (WOW). She has also initiated projects like Solid Waste Management Round Table (SWMRT) to convince that the only way to manage waste is to decentralise the system and Swachagraha to promote home composting.

Ashish Jain, Director of Indian Pollution Control Association (IPCA) has implemented a number of projects on SMW in India since 2001. IPCA has initiated various projects like Garbage Recycling Program, Garbyhog Home Builder Project, Primary Education For Rag Picker's Children, Doh Bin, Champ, Tetra Pack Packages Recycling and Tendrella And Her First Aid Box with the aim of creating environmental awareness and Implementing integrated solid waste management system.

III. MUNICIPAL SOLID WASTE CONVERSION TECHNOLOGIES FOR ENERGY GENERATION

A. *Composting*

Composting is a biological process which involves the decomposition and stabilization of organic solid waste by microbes also known as methanogens either in the presence or absence of oxygen.

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Classification of Composting

1. Depending on the availability of oxygen
   - Aerobic composting (Aerobic digestion)
   - Anaerobic composting (Bio methanation)
2. Depending on the operating conditions & design of the plant
   - Open (Window),
   - Closed (Mechanical)

B. Briquetting Process

Biomass briquettes are made up of green waste and organic materials, and are commonly used for electricity generation, heat, and cooking fuel. It is mainly used in developing countries where there is a shortage of availability of cooking fuel. The briquettes are formed by compressing various organic materials, including rice husk, bagasse, ground nut shells, MSW and agricultural waste. The compression of the organic raw material into briquettes results in longer burning time, high calorific value and easy transportation.

The briquettes are a very good substitution of coal and charcoal and differ from the later because of low concentrations of carbonaceous substances and added materials. In comparison to fossil fuels they produce low net total greenhouse gas emission because the utilized material is already a part of carbon cycle.

The drying of biomass briquettes can be done by various processes like torrefaction, carbonization or Pyrolysis, but the use of the briquette determines which method should be used.

Compaction is a major factor affecting the production of briquettes as material like corn Stover grind burns more efficiently if compacted at low pressures and materials such as wheat and barley-straw require high amount of pressure to produce heat. Compaction can be done by using a variety of press technologies depending on the requirement like a piston press can be used to create solid briquettes for a wide array of purposes and screw extrusion can be used to compact biomass into loose, homogeneous briquettes that are substituted for coal in co firing.

C. Thermal Gasification Process

Thermal gasification also known as Pyrolysis involves destructive distillation of solid waste to recover its constituents and energy. It involves thermal degradation of solid waste in the absence of air. It is generally used for the treatment of waste which is low in moisture content like paper, cloth, plastic, yard wastes etc. as waste which is high in moisture content requires more heat supply.

In this process, a Pyrolysis reactor is used to heat the solid waste at 600-1000 °C which yields the following products -

1. Liquid phase - Methanol, Acetone, Acetic acid
2. Gaseous phase - Hydrogen, Methane, Carbon monoxide, Carbon dioxide
3. Solid phase - Carbon char and inert materials

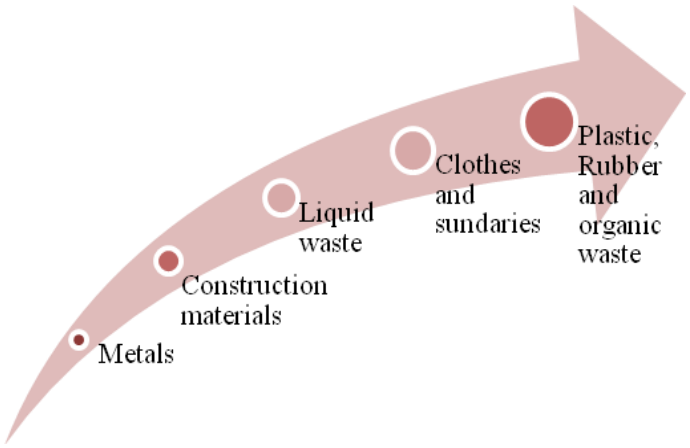
Reactors such as fixed bed reactor, rotary kiln & fluidized bed reactor can be employed for the Pyrolysis process. The total heat utilized in the process depends on various factors such as temperature, heating rate, residence time in reactor zone & material size and it can be divided into three types according to its consumption -

1. Q1 - Amount of heat required for moisture vaporization
2. Q2 - Refers to calorific requirement of Pyrolysis process
3. Q3 - Radiation loss during the process

The Advantage of this process is the very little effect on environment in terms of air pollution. Though, high initial cost and operation cost make this process difficult to be accepted as commercially sound practice.

IV. MUNICIPAL GARPAGE DISPOSAL SYSTEM IN INDIA

A. Types of MSW Generated in India



B. Steps undertaken to treat MSW in India

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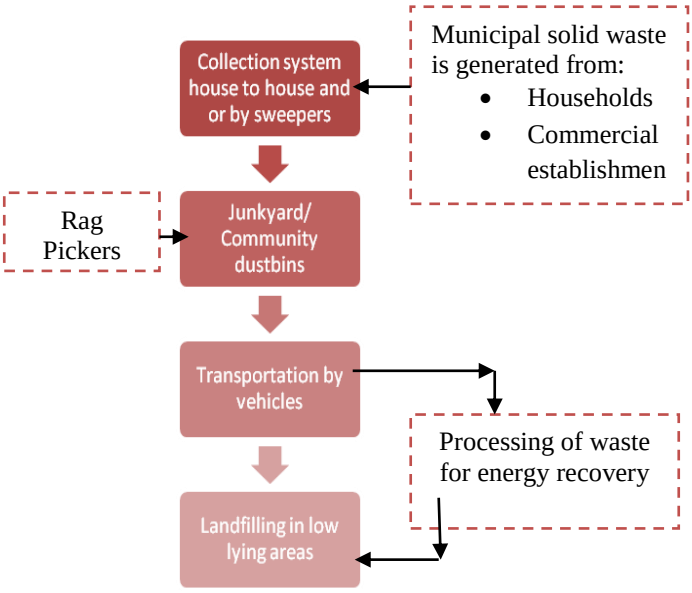
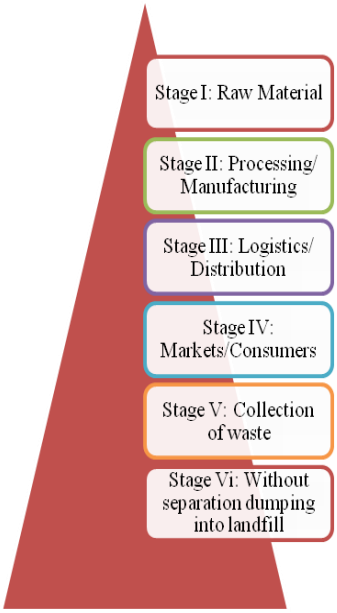


V. BUSINESS MODEL

The Municipal solid waste can be handled by either of the two models. The Model – I works on linear economy and have the basic limitation of methane capturing which is a greenhouse gas. On the other hand the Model – II works on circular economy and is based on zero waste strategy and also creates employment opportunities.
The two models are as follows –

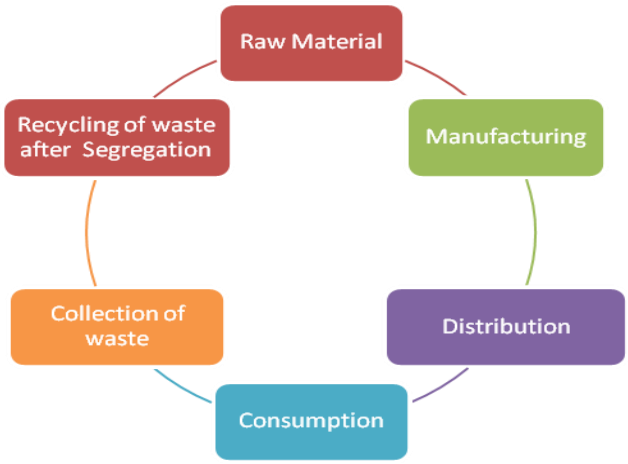
A. Model I - The Linear Economy

India produces 62 million tons of solid waste annually of which 31 million ton is directly dumped into the landfill without segregation and processing/treatment. The waste in the landfill produces a potential amount of methane which is very hard to capture and thus contributes to greenhouse effect.
Presently India follows the Linear Economy for model for handling and disposal of Municipal Solid Waste.



B. Model II – The Circular Economy

The circular economy model is based on zero waste strategy. It creates employment opportunities by involving the recycling and processing of municipal solid waste. It is based on various waste conversion technologies like composting, Pyrolysis, briquetting etc.
The use of circular economy type model is a smarter choice for handling municipal solid waste as it works in harmony with the environment.



VI. A CASE STUDY IN DELHI

An attempt is made in this paper to review a Waste to Energy project in Delhi for the purpose of understanding its importance in addressing the problem of MSW in Big cities like Delhi.

The detail of the project whose case has been presented in this paper is as given under:-

A. Case - Biomethanation plant of Delhi Technological University (DTU) campus

Biomethanation technology offers an excellent alternative for decentralized processing of solid biodegradable waste and avoids the contamination of land-fill sites.

Delhi Technological University (DTU) and Bhabha Atomic Research Centre jointly took up the project of installation of Nisargruna biogas Plant at the backyard of college canteen having Capacity of 500Kg of kitchen waste/day.

The Nisargruna technology is environmental friendly and differs from the anaerobic digester as it can accept a variety of raw materials while the anaerobic system developed in India mainly accepts animal dung. It also has a high rate of Biomethanation. The technology uses a mixer to homogenize waste with water into free flowing slurry. The free flowing slurry is pre treated in an aerobic digester for a limited period of about 3-4 days. The overall process produces two valuable products i.e. Biogas & Manure.

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The 500Kg of kitchen waste fed to the digester per day produces 50Kg of manure and 20Kg of

Biogas. Biogas so generated from the plant is supplied to the University's canteen and the organic manure is used for horticultural requirements of the University.

The biogas generated from this plant has high calorific value and it is used for cooking purpose in the Mechanical canteen. The manure generated in the process is weed free and rich in organic carbon contents. Hence it is a soil conditioner & results in soil enrichment and nitrogen fixation.

B. Type of waste material that can be used in Nisargruna biogas Plant

The waste material that can be processed in the decentralised unit includes Kitchen (Food) waste, Vegetable waste, Abattoir waste, Cattle dung, Poultry manure etc.

C. Decentralised Application of the Nisargruna technology

Nisargruna technology offers great opportunity for decentralized processing of solid biodegradable waste generated by various sources like; residential sector, vegetable and fruit mandies/markets, hotels and restaurants, and also by other processing industrial units which generate biodegradable/organic MSW, This way the problem of handling MSW of this nature be minimized and contribute to environmental sustainability of Urban areas.

CONCLUSION

The Bio methanation is a very effective technology for converting bio mass into useful energy and thus reducing the greenhouse effect on environment. It can be made successful by installing a decentralised bio methanation plant in every locality, hotels, colleges, hospitals & schools. The process produces two valuable products i.e. biogas and manure which can be used for cooking and organic farming.

ACKNOWLEDGMENT

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REFERENCES

[1] Abhishek Nandan, Bikarama Prasad Yadav, Soumyadeep Baksi, Debajyoti Bose “Recent Scenario of Solid Waste Management in India”, WSN 66 (2017) 56-74.

[2] Environmental Protection Agency “Municipal Solid Waste Generation, Recycling and Disposal in United States: Facts and Figures for 2012.”

[3] Aftab Anjum, Mohit Gupta, Aadish Jain “Economic Analysis of the Nisargruna Based Bio-Methanation Plant” International Journal of Advance Research and Innovation (Volume 3, Issue 4 (2015) 611-614) ISSN 2347 – 3258.

[4] Dr. Ravinder Palakurthy and Dr. J.P. Kesari “ Solid Waste Management in Urban Areas: Review of Some Case Studies in Delhi.”

[5] Jayashree Mahajan and Asoo J Vakharia “Waste Management: A Reverse Supply Chain Perspective” The Journal for Decision Makers 41(3) 197–208.

[6] Vipul Vaid and Shivangi Garg “Food as Fuel: Prospects of Biogas Generation from Food Waste” International Journal of Agriculture and Food Science Technology (IJAFST)(Volume 4 No. 2 (2013)) ISSN No. 2249-3050.

[7] CPCB-2013: Report of Central Pollution Control Board on “Status of Compliance by CPCB with Municipal Solid Wastes (Management and Handling Rules, 2000”, Ministry of Environment and Forests (GOI), 2013.