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MUNICIPAL WASTE TO ENERGY

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ABSTRACT

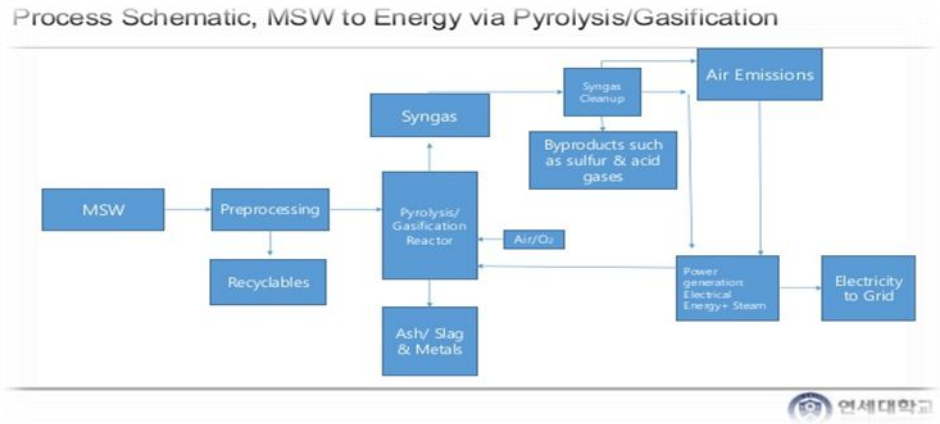
Municipal Waste management is a necessity wherever people live ,but traditionally waste is viewed as a problem something that pollutes and needs reducing or mitiating.If this mindset could be changed such that we value our waste as a source of Bio energy? Waste contain significant type of energy and if we could harness this close to where the waste is generated and convert it to a useful form, it could provide both a distributed source of electricity contribute to solving the global problem of waste management. The natural resources in the form of fossil fuels are the raw material for electrical energy generation. The daily life of the people of the world is solely depend on electrical energy. The electricity sector in india supplies the world's 6th largest energy consumer, accounting for 3.4% of global energy consumption by more than 17% of global population. A rapidly growing economy, increasing household incomes, limited domestic reserves of fossil fuel and the adverse impact on the environment of rapid development in urban and regional areas, While the rural areas are struggling for supply of electrical power. In order to manage the changing conditions, knowledge and estimation of the available resources and applying their relation with the population is most important. This paper deal with estimations of amount of solid waste generated in Ranchi area by using spatial techniques.

Keywords- Municipal waste, Bio-Energy, Power generation, Spatial technique

1. CURRENT TECHNOLOGIES

Waste to energy conversion

Municipal solid waste is combustion in presence of oxygen. Heat produced and utilized to produce steam which rotates the turbine and alternator to produce electricity. Harmful flue gases are treated and released in atmosphere.



Landfill Gas Recovery

Landfill gas is a complex mix of different gases created by the action of microorganisms within a landfill. Landfill gas is approximately forty to sixty percent methane, with the remainder being mostly carbon dioxide. Trace amounts of other volatile organic compounds comprise the remainder (<1%). These trace gases include a large array of species, mainly simple hydrocarbons.

Landfill gases are the result of three processes:

- evaporation of volatile organic compounds (e.g., solvents)
- chemical reactions between waste components
- microbial action, especially methanogenesis.
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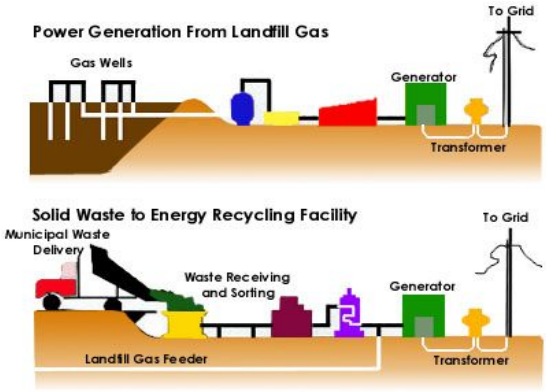
The first two depend strongly on the nature of the waste. The dominant process in most landfills is the third process whereby anaerobic bacteria decompose organic waste to produce biogas, which consists of methane and carbon dioxide together with traces of other compounds. Despite the heterogeneity of waste, the evolution of gases follows well

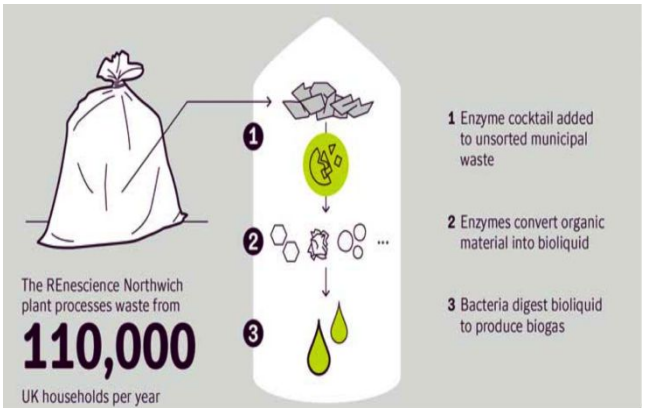
defined kinetic pattern. Formation of methane and CO_2 commences about six months after depositing the landfill material. The evolution of gas reaches a maximum at about 20 years, then declines over the course of decades.



Biomethanogenesis

Methanogenesis in microbes is a form of anaerobic respiration.[1] Methanogens do not use oxygen to respire; in fact, oxygen inhibits the growth of methanogens. The terminal electron acceptor in methanogenesis is not oxygen, but carbon. The carbon can occur in a small number of organic compounds, all with low molecular weights. The two best described pathways involve the use of acetic acid and inorganic carbon dioxide as terminal electron acceptors:

$$CO_2 + 4\ H_2 \rightarrow CH_4 + 2H_2O$$
$$CH_3COOH \rightarrow CH_4 + CO_2$$



Refuse-derived fuel (RDF)

It is a fuel produced from various types of wastes such as Municipal Solid wastes (MSW), industrial wastes or commercial wastes.

The World Business Council for Sustainable Development provides a definition:
"Selected waste and by-products with recoverable calorific value can be used as fuels in a cement kiln, replacing a portion of conventional fossil fuels, like coal, if they meet strict specifications. Sometimes they can only be used after pre-processing to provide 'tailor-made' fuels for the cement process"

RDF consists largely of combustible components of such wastes, as non recyclable plastics , paper cardboard, Labels ,Rand other corrugative Materials. These fractions are separated by different processing steps, such as Screening, air classification, ballistic separation, separation of ferrous and non ferrous materials, glass, stones and other foreign materials and shredding into a uniform grain size, in order to produce a homogenous material which can be used as substitute for fossil fuels in e.g. Cement Plants, Lime Plants, coal fired power plants or as reduction Agent in Steel Furnaces. RDF can be also further specified into e.g. Tyres derived fuels (TDF) from used Tyres, or solid recovered fuels (SRF).

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Others describe the properties, such as

- Secondary fuels
- Substitute fuels
- Solid recovered fuels (SRF)
- “Climafuel®” as trade name from Cemex
- “AF“ as an abbreviation for alternative fuels

Ultimately most of the designations are only general paraphrases for alternative fuels which are either waste-derived or biomass-derived .Yet it is the case, that worldwide there is no exact classification or specification which is used for such materials. Even legislative authorities have not yet established any exact guidelines on the type and composition of alternative fuels. The first approaches towards classification or specification are to be found in the Federal Republic of Germany as well as at European level (European Recovered Fuel Organisation). These approaches which are initiated primarily by the producers of alternative fuels, follow a correct approach: Only through a strictly and exactly defined standardization in the composition of such materials can both production and utilization be uniform worldwide.

First approaches towards alternative fuel classification:

2. CASE STUDY OF RANCHI

Ranchi is the capital city of Jharkhand that spreads on chhotanagpur platague. It is well connected by Rail and Roads. The name Ranchi is derived from the previous name of the Oraon village at the same site, Archi. "Archi" derives from the Oraon word for bamboo grove or stave. According to legend, after an altercation with a spirit, a farmer beat the spirit with his bamboo stave. The spirit shouted *archi, archi, archi* and vanished. Archi became Rachi, which became Ranchi.[5] One of the historically significant neighbourhoods of Rachi is Doranda (*duran* " " means *song* and *daah* " " means *water* in the Mundari language). Doranda lies between the Hinoo (Bhusur) & Harmoo Rivers, where the civil station, treasury and church established by the British Raj were destroyed by rebel forces during the Sepoy Mutiny. Although Ranchi has a humid subtropical climate, its location and the forests surrounding it combine to produce the unusually pleasant climate for which it's known. Its climate is the primary reason why Ranchi was once the summer capital of the undivided State of Bihar and was designated a preferable "hill station". Summer temperatures range from 20 °C to 42 degrees, winter temperatures from 0 °C to 25 degrees.

3. CURRENT MUNICIPAL WASTE MANAGEMENT SYSTEM

Door to door collection of waste by municipal sweeper or vehicle.waste is generally collected by community container & road sweeping . The study connected under RMC establish that at present the city produces approximately 255 ton of domestic solid waste per day based on a rate of 250 gms /cap/day .The municipal solid waste generated in the city mainly consists of domestic refuses and wastes from commercial areas ,vegetable fruit market ,bio medical waste and wastage from hotel and restaurant.
Apart from waste generated from these areas wastes are also collected from drains in the form of wet silts ,which are dried along the side of road itself.

At present RMC collaborated with some utilities provider organization and waste managed in . good way. Recently solid waste management improved with acquisition of new trucks ,container & tractor etc. Now 1,02,000 houses are covered under SWM scheme. All collected waste are transported to existing land fill site at jhiri 18 km away from city. The program” Ranchi Nagar Nigam Aapke Dwar ” has significantly improve the sanitary and cleanliness in the city.

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Quantity of waste Generation

The waste generated in Ranchi is approx 255 ton MSW per day .The major source of waste generation is domestic waste, shops , and commercial establishments, hotels ,restaurants and fruit and vegetable waste .

Energy potential

Availability of transport carrying MSW

Type of vehicle	MSW in ton	No of vehicles	Total MSW
Tata ace	1.5	42	63
Compactor	3.0	10	30
Dumper	5.5	20	110
Tractor	2.6	20	52
Total waste-			255 tonn

Heat Energy (Dulong's Formula) to calculated heat energy generated in whole Ranchi .
Dulong's formula: **HV(KJ/Kg) = 338.2*C + 1442.8*(H O/8) + 94.2*S**
Where C, H, O and S are the % of these elements on dry ash .

Considering Literature Review taking percentage by Mass theoretical calculations are as follows:
C= 31.22 ,H= 8.17,O= 55.68, Sulphur very small so neglected
Applying to formulae we get Heat Energy Generated =12260.69 kJ/kg
First, heat energy generated is used to calculate steam energy which is 70% of heat energy.

Finally after steam energy calculation, net electric power generated by solid waste is calculated after Accounting station service allowance and heat losses.
Steam energy available = 70% of heat energy
Steam energy available = (0.70 ×12,260 .69) kJ/kg
Steam energy available = 8,582.483 kJ/kg.

Above calculated steam energy is used to run the turbines ,these turbines are coupled with generators which Produces electricity. Heat rate is the heat input required to produce one unit of electricity (kWh).
1 kW = 3,600 kJ/h

But practically no energy conversion is 100% efficient, considering the conversion efficiency of 31.6% in a power plant heat input of 3600 ÷ 31.6% = 11395 kJ/kWh is required.

So, to produce 1kWh electrical energy 11395 kJ of steam energy is required.
Electric power generation = Steam energy ÷ 11395kJ/kWh
Electric power generation = (8,582.483 ÷ 11395) kWh/kg
Electric power generation = 0.753179728 kWh/kg

Total weight of solid waste collected from Ranchi city=255 tons/day
Total electric power generation = (0.753179728×250000)kWh /day
Total electric power generation = 188295 KWh

Station service allowance = 6% of total electric power generatio
Station service allowance = (0.06 ×188295) kWh/day
Station service allowance = 11297.7 kWh/day

Unaccounted heat loss = 5% of electric power generation
Unaccounted heat loss = (0.05 × 188295) kWh/day
Unaccounted heat loss = 9414.75 kWh/day

Net electric power generation = Electric power generation –(station service allowance + unaccounted heat loss)
Net electric power generation = 188295 – (11297.7 +9414.75)
Net electric power generation = 167582.55 kWh/day =167.6 MW hr/day

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The above generated electricity is for one day and one day has 24 hours, so using this net electric power is calculated for per hour basis.
Net electric power generated = 167.6 MW hr / 24h
Net electric power generated= 6.76 MW

4. RESULTS & CONCLUSION

Above study and analysis leads us to calculate the contribution on the amount of solid waste generated by the various economic status of the society. From the study, it can be attributed that the Middle income groups contribute the maximum amount of solid wastes generation at lalpur area (7375 Kg & 1313) respectively. Contrary to popular belief, it has been also found that slums generate less solid waste compared to the other economic classes (138 Kg). Apart from this, it has been observed that the power generated from the solid waste generation of the study area can help to minimize the energy requirement to certain extent.

Also, if similar approach is applied for in developing countries, the power scenario may substantially improve. Spatial techniques can be successfully utilized to access the potential of power generation with further refinement in the process.

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