Solid Recovered Fuel (SRF) an Efficient Technology and Manufacturing of SRF for Energy Generation

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Abstract: *Municipal solid waste management (MSWM) is one of the major environmental problems of Indian cities. Various studies reveal that about 90% of MSW is disposed of unscientifically in open dumps and landfills, creating problems to public health and the environment. Waste-to- Energy (WTE) technologies – recovering energy in the form of electricity and/or heat from waste are being developed worldwide. The thermo chemical technologies for energetic vaporization of calorific waste streams (WTE), with focus on solid recovered fuel (SRF) a processed form of municipal solid waste (MSW). The basic principles of the available technologies and process details of some specific technologies are summarized. This review concludes with an argumentation of the advantages of processing SRF as opposed to MSW, and a comparison between the different technologies, stressing factors affecting their applicability and operational suitability. A state-wise comparison was conducted along with comparative study of waste-to-energy plants in Bhopal.*

This review described manufacturing processes and quality of two types of Solid Recovered Fuels – SRF low quality and SRF premium quality – that are used in energy recovery plants. Finally investigated the quality and Physical- chemical analysis of two types of SRF. There are around 740 tons of municipal solid waste (MSW) generated daily, of which the combustibles namely plastics, paper and textile waste represent 28%. There are 460 tons which is equivalent to 19 tons/hour of SRF that can be generated daily from the MSW and this would generate 19 MW power. Total Carbon dioxide emission reduction approximate 5061 tons per year.

Keywords: Solid recovered fuel, Waste to Energy (WTE), Municipal solid Waste (MSW), Environmental impacts.

1. INTRODUCTION

When compared to the past, the present pattern of living has changed with a significant increase in the number of industries, a fast-growing economy rate and also a substantial expansion in the population living which has ultimately contributed to the humongous volumes of waste generation. This increase in the waste generation has led to undesirable pollution in the environment creating a negative impact on public health. Indiscriminate dumping of wastes and mass burning are the conventional techniques of disposal of wastes followed in India which has resulted in unacceptable environmental and health consequences. The country has however recognized the unfortunate consequences and the ill-effects of such techniques being practiced and has come forward to accommodate eco-friendly and affordable solutions for the dumping of wastes. [1] MSW has a very good calorific value which makes it a good source of energy. MSW power plants which are also called waste to energy plants are designed to dispose of MSW and to produce electricity as a by Product in an incinerator. Solid recovered fuel (SRF) from municipal solid waste can be an alternative form of energy to replace fossil fuels. SRF is the component of MSW that has higher calorific like paper, plastics and textile. [2]

Various studies reveal that about 90% of MSW is disposed of unscientifically in open dumps and landfills, creating problems to public health and the environment. In the present study, an attempt has been made to provide a comprehensive review of the characteristics, generation, collection and transportation, disposal and treatment technologies of MSW practiced in India. [3]

1.2 Municipal solid waste-to-energy potential in India

When the Researcher enquired about the potential of energy which can be generated from this MSW. The Ministry stated that "The solid waste generated from the cities/towns in India has present potential to generate power of approximately 500 MW, which can be enhanced to 1,075 MW by 2031 and further to 2,780 MW by 2050. According to the Ministry of New and Renewable Energy, in comparison to the levels of the developed world of 1 to 2.5 kg capita/day, average MSW generation in India is 450 gm/per capita/day. The MSW generation rate in the country is 200-300 gm/capita for small towns, 300-400 gm/capita for medium cities and 400-600 gm/capita for large cities [4,5].

The solid waste generated from the cities/towns in India has present potential to generate power of approximately 500 MW, which can be enhanced to 1,075 MW by 2031 and further to 2,780 MW by 2050. The State-wise potential for power generation from MSW shown in Table 01.

Table -01: The State-wise potential for power generation from MSW

No.	State	Total waste generation per day metric ton per day (MT/D)	Total waste generation per day million MT /annum
1	Andhra Pradesh	6525	2.382
2	Andaman & Nicobar Islands	115	0.042
3	Arunachal Pradesh	181	0.066
4	Assam	1134	0.414
5	Bihar	1192	0.435
6	Chandigarh UT	340	0.124
7	Chhattisgarh	1959	0.715
8	Daman & Diu	23	0.008
9	Dadra & Nagar Haveli	58	0.021
10	NCT of Delhi	10500	3.833
11	Goa	240	0.088
12	Gujarat	10145	3.703
13	Haryana	4514	1.648
14	Himachal Pradesh	342	0.125
15	Jammu & Kashmir	1792	0.654
16	Jharkhand	2451	0.895
17	Karnataka	10000	3.650
18	Kerala	1576	0.575
19	Madhya Pradesh	6424	2.345
20	Maharashtra	22570	8.238
21	Manipur	176	0.064
22	Meghalaya	268	0.098
23	Mizoram	201	0.073

24	Nagaland	342	0.125
25	Odisha	2460	0.898
26	Puducherry UT	495	0.181
27	Punjab	4100	1.497
28	Rajasthan	6,500	2.373
29	Sikkim	89	0.032
30	Tamil Nadu	15547	5.675
31	Telangana	7371	2.690
32	Tripura	421	0.154
33	Uttar Pradesh	15500	5.658
34	Uttarakhand	1400	0.511
35	West Bengal	8675	3.166
	Total/ Average	145626	53.153

1.3 MSW characteristics and composition

The composition and the quantity of MSW generated form the basis on which the management system needs to be planned, designed and operated. In India, MSW differs greatly with regard to the composition and hazardous nature, when compared to MSW in the western countries [6,7]. The composition of MSW at generation sources and collection points was determined on a wet weight basis and it consists mainly of a large organic fraction (40–60%), ash and fine earth (30–40%), paper (3–6%) and plastic, glass and metals (each less than 1%). The C/ N ratio ranges between 20 and 30, and the lower calorific value ranges between 800 and 1000 kcal/kg. [8]

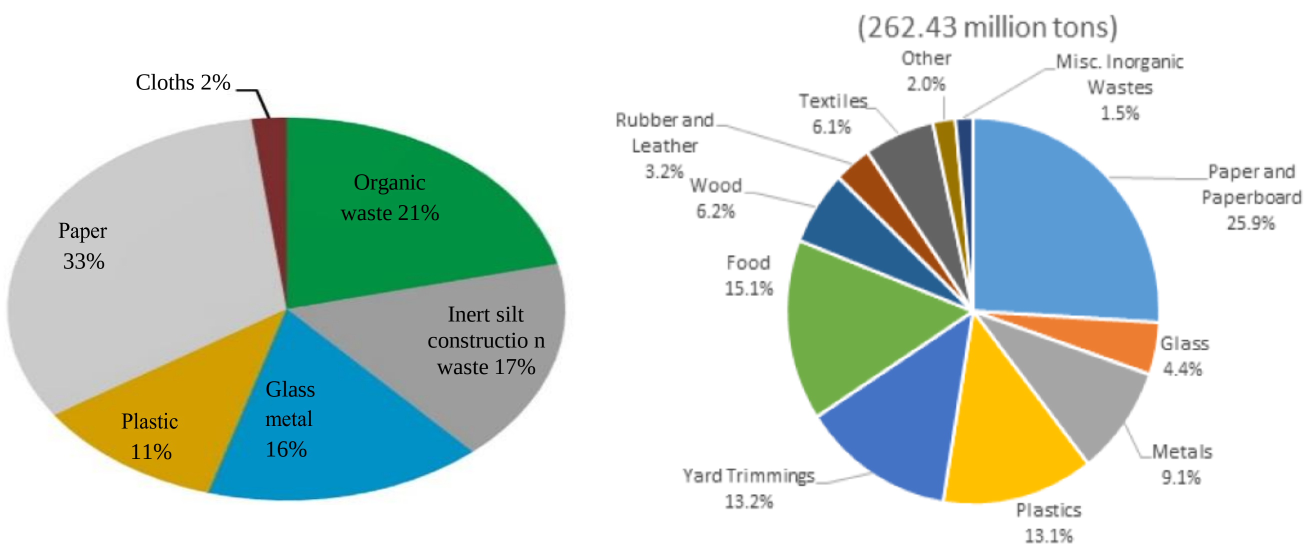


Figure – 01: Composition (Left) and MSW Generation by Material (Right)

1.4 MSWM Processes & Their operational challenges

WTE is the process of generating energy in the form of electricity and/or heat from the incineration of waste. 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. There are several Waste to energy technologies available based on the type, quantity and characteristics of raw material, the required method of the energy, economic conditions, environmental standards and specific factors. The most commonly used waste to energy technologies are thermal, bio-chemical and chemical technologies.

1.4.1 Thermal technologies- Incineration, pyrolysis, gasification and Solid recovered fuel (SRF) are included in thermal technologies of waste. In this process, numerous byproducts are formed that can be referred to different energy generation and resource recovery techniques for treatment.

Incineration

One of the most common waste treatment technology is incineration, in which waste mass is reduced by 70% and waste volume is reduced up to 90%. Incineration is suitable for high calorific value wastes process [9]. Incineration technology of Indian MSW is not convenient as it contains high organic composition, moisture content or inert content (range 30- 60% each) and low calorific value (range 800-1100 kcal/kg). Usually, in India small incinerators are used for burning of hospital waste. Still, a medium sized incinerator plant was installed to dispose of 300 tones of day-to-day waste at Delhi, India in 1987. However, the plant remained out of order currently, because non-availability of waste having required calorific value for incineration. At present, there is no large-scale incinerator working in India.

Pyrolysis

Pyrolysis is the thermal waste method, uses heat at 300-800oC to break down organic constituents in the anaerobic environment. It produces the syngas (methane, carbon dioxide, hydrocarbons, hydrogen and carbon mono-oxide), liquids and solids residues. The produced syngas can be utilized in different energy applications such as engines, boilers, turbines, heat pumps. Small temperature pyrolysis can also be used to generate a synthetic diesel fuel from plastic waste. Currently there is no pyrolysis plant working in India [10]. Figure shows the pyrolysis process of MSW to produce energy.

Gasification

Gasification process contains partial combustion of waste to generate energy. This is accomplished by providing high temperature (>700oC) with a limited amount of air (Partial combustion). The final product of the gasification process are char, tar and syngas. Syngas is energy rich content and clean through gas turbine or engine to produce energy and heat. This process can reduce about 70% mass and 90% volume of waste [9].

The process of SRF generation is described in Figure 02. SRF pellets is frequently used for pulp, paper industry, wood industry waste and saw-mill industry.

1.4.2 Biological technologies- Biological treatment of waste to energy is much more safe, economical and eco-friendly technologies as compared to the previous thermal technologies. In this composting, and anaerobic digestion methods are adopted in India generally [11].

Composting

Composting method comprises decomposition of organic MSW by microorganisms under controlled aerobic conditions in the presence of air under humid and warm environment. This method is divided into two different processes- Aerobic and Anaerobic composting.

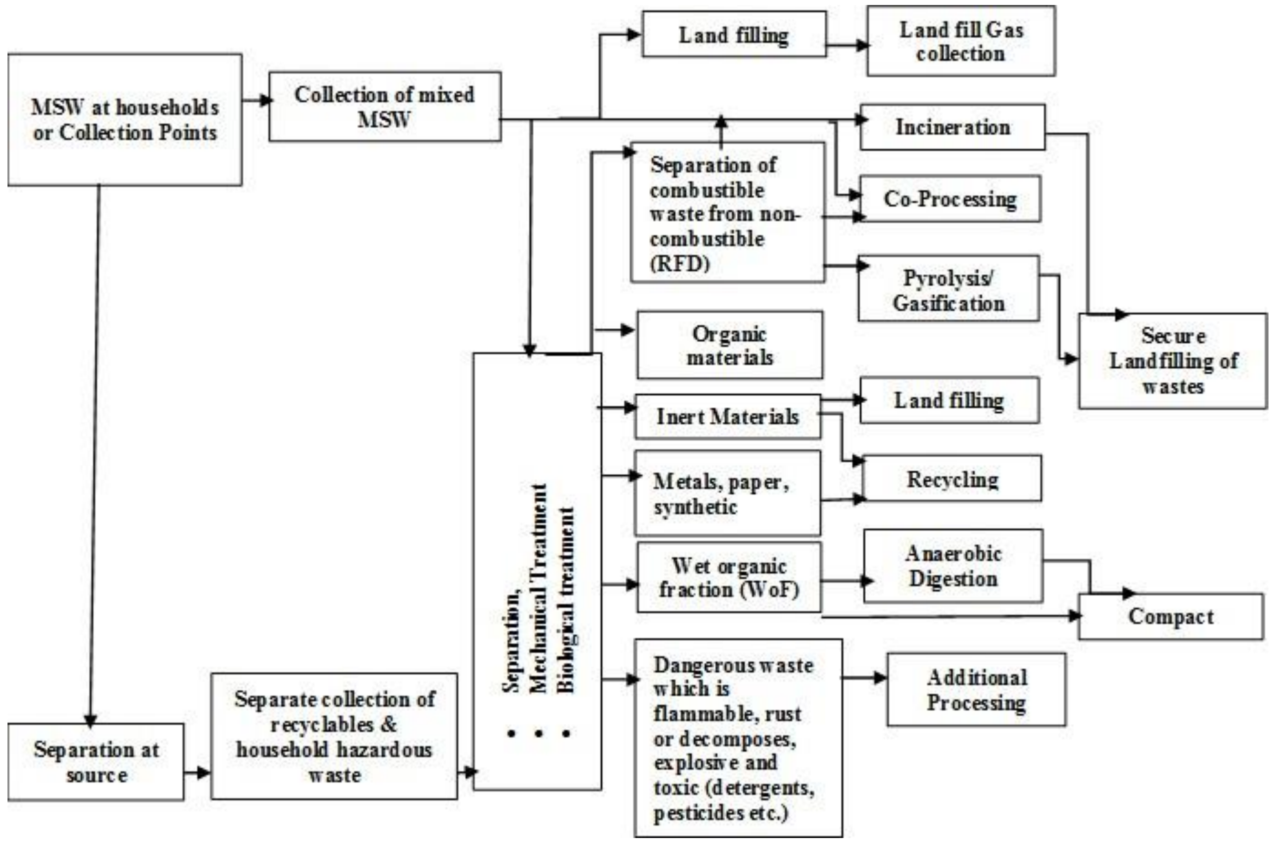


Figure - 02: Summary of the various techniques linked with different waste materials

1.5 Total Potential of MSW in Bhopal City

Municipal solid waste management is an important as it impacts health, Environment and aesthetic society if it is not managed properly. Hence to improve quality and standard of living, the Bhopal Municipal Corporation (BMC) has proposed to strengthen the covering collection, segregation, recycling, transportation, processing and disposal with option for composting, waste to energy, disposal in 8 Urban Local Bodies (ULBs) in Bhopal. The BMC intends to institutionalize a holistic Integrated, sustainable environment and eco-friendly Municipal Solid waste Management System in the urban local bodies (ULBs).

Therefore, BMC has initiated the project that involves setting up an Integrated Solid Waste Management System (ISWM) for a cluster comprising of 8 ULBs within a radius of 80 km of Bhopal. The Bhopal cluster comprises of 8 ULBs from 3 districts namely Bhopal District (Bhopal and Berasia), Raisen District (Mandideep, Obaidullaganj) and Sehore District (Sehore, Ashta, Ichhawar, Kothri).

Table 02:- Urban local bodies (ULBs) wise waste generation at Source (2018)

ULB	Wards	Population 2018	Total-waste generation (TPD)
Bhopal	85	2411972	909
Mandideep	26	87676	17
Obaidullaganj	15	2526	08

Berasia	18	343709	10
Sehore	35	1214533	32
Ichhawar	15	16539	04
Kothri	15	11988	04
Astha	18	61286	16
Total			1000

1.6 SRF (Solid Recovered Fuel)

SRF is a fuel produced by shredding and dehydrating solid waste, typically consisting of combustible components of municipal solid waste (MSW) such as;

- **Biodegradable waste**; food and kitchen waste, green waste, paper.
- **Recyclable material**; paper; glass, bottles, cans, metals, certain plastics, fabrics, clothes, etc.
- **Inert waste**; construction and demolition waste; dirt, rocks, debris.
- **Composite wastes**; waste clothing, Tetra-Packs, waste plastics such as toys, garden furniture etc.

SRF (Solid Recovered Fuel) processing facilities are normally located near a source of MSW and, while an optional combustion facility is normally close to the processing facility, it may also be located at a remote location. Currently most UK produced SRF (Solid Recovered Fuel) is exported.

The production of SRF (Solid Recovered Fuel) may involve some but not all of the following steps;

- Preliminary liberation/sorting
- Course, pre-shredding
- Size screening
- Magnetic separation
- Refining separation
- Fine, secondary shredding
- Baling & wrapping

2. MATERIAL AND METHODS

2.1 Waste-to-Energy (WTE) generation process through SRF

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

2.2 Steps for process methodology

(a) Identified Location and Organization of Primary Collection

Primary operations shall be covered utilizing vehicles for Door to Door collection. The methodology for primary operations shall be as under. Time of primary operations shall be from 6 AM in the morning till 2 PM in the afternoon. Some special and commercial collection shall be completed from 9 PM to 6 AM as and when desired. Tata Mega / Supro vehicles have been desired to cover 1300 households and Rickshaw has been desired to cover 300 households in Bhopal.

(b) Methodology of Secondary Collection

The secondary operation would start from 2 PM to 10 AM. Each Prime mover (Hook Loader) will make 3 trips in a day. Total number of compactors placed in all Mini transfer station have 69. Waste collected through these bins have been transported to dumping site with help of 19 units of refused compactor and 2 JCB have been taken into provision for road side secondary points. Waste quantification has been carried out for Bhopal city & other ULBs from the following sources:

- Market waste
- Street sweepings and Drain cleaning
- Hotels & restaurants
- Marriage Halls
- Hospitals/Health
- Construction waste
- Commercial Establishments (Shops, Offices, Institutions)
- Temples & Gardens

2.3 Manufacturing processes of Solid Recovered Fuels

Manufacturing processes and quality of two types of Solid Recovered Fuels- i.e SRF low quality and SRF premium quality – that are used in energy recovery plants. In total, two case studies. First case study is about the external processing and confectioning of non-hazardous household, industrial and commercial mixed wastes as well as the internal treatment and homogenization of various waste fractions at the incineration plant for production of SRF low quality that is utilized in a Waste to Energy (WTE) stationary Fluidized Bed Incinerator. In the second case study, production SRF premium quality that are used for substitution of primary fuels like coal and petrol coke in the cement kiln is described. Finally, data on SRF quality of all investigated waste types have been summarized and discussed.

2.3.1 Requirements for manufacturing of SRF

SRF is a mixture of various non-hazardous waste materials from different sources (households, commerce and industry) that are undergoing distinct treatment and manufacturing steps like: multistage shredding, classifying, separation of Fe and Non-Fe-metals, exclusion of heavyweight inert materials as well as sorting out of unwanted materials like polyvinyl chloride (PVC) or of recycling materials like PET.

2.3.2 Manufacturing of Two types of SRF

Manufacturing of SRF low quality
A comprehensive study have been carried out on the characterization of waste fuels burnt in a fluidized bed incinerator plant. Here the input materials Household Waste, Commercial Wastes, Bulky Waste and Construction Site Waste are undergoing external (different suppliers) and internal (incineration plant) treatment to produce SRF low quality.

Manufacturing of SRF high quality
SRF with higher quality – higher heating value and narrow defined particle size (d_{95}) ≤ 10_{3D} –30_{2D} (mm) for 2-dimensional (2D) and 3-dimensional (3D) grains separately – like SRF premium quality have been produced.

When manufacturing high quality SRF, there are some *unwanted elements* like chlorine (Cl), antimony (Sb), mercury (Hg) and chromium (Cr) in the waste stream, the concentration of which have to be controlled in the end product. For example, chlorine is mainly introduced by PVC in plastic waste and salt (NaCl) from foodstuff – residues in lightweight packaging waste fractions.

Antimony is present as stabilizer in plastics, e.g. in polyethylene terephthalate (PET) drinking water bottles.

2.4 Process MSW to SRF Conversion

There are a number of different processes for preparing SRF from MSW. 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
• Storage
Solid-recovered fuel (SRF) refers to solid wastes in any form that is used as fuel. The term SRF, however, is commonly used to refer to solid waste that has been mechanically processed to produce a storable, transportable and more homogeneous fuel for combustion. SRF systems have two basic components: SRF production and SRF incineration. SRF production facilities make SRF in various forms through material separation, size reduction and pelletizing.

Figure 03:- SRF Pellets

2.5 Combustion of SRF in Incinerator

One of the most common waste treatment technology is incineration, in which waste mass is reduced by 70% and waste volume is reduced up to 90%. Incineration is suitable for high calorific value wastes. In this process, produced energy is converted in electricity generation.

Incineration processes can also provide a means to enable recovery of the energy, mineral and/or chemical content of waste. Incineration is a chemical reaction in which carbon, hydrogen and other elements in the waste mix with oxygen in the combustion zone and generates heat. The air requirements for combustion of solid wastes are considerable. For example, approximately 5000 kg of air is required for each tone of solid wastes burned. Usually, excess air is supplied to the incinerator to ensure complete mixing and combustion and to regulate operating temperature and control emissions. Many incinerators are designed to operate in the combustion zone of 900°C – 1100°C. This temperature is selected to ensure good combustion, complete elimination of odor and protection of the walls of the incinerator.

2.6 Energy Recovery

Most of the MSW incineration currently practice energy recovery in the form of steam, which is used either to drive a turbine to generate electricity or directly for heating or cooling. In the past, it was common to simply burn MSW in incinerators to reduce its volume and weight, but energy recovery has become more prevalent.

In waste-to-energy (WTE) plants, heat from the burning waste is absorbed by water in the wall of the furnace chamber or in separate boilers. Water when heated to the boiling point changes to steam. At this point, the steam is used either for heating or to turn turbines to generate electricity. The amount of energy recovered from waste is a function of the amount of waste combusted, energy value of the waste stream and the efficiency of the combustion process.

2.7 Generation of electricity

Electricity is the most common form of energy produced and sold from WTE facilities constructed today. By directing the steam produced from a WTE system through a turbine generator, electricity can be produced and sold. A process flow diagram of an electrical generation system is shown in Figure 04.

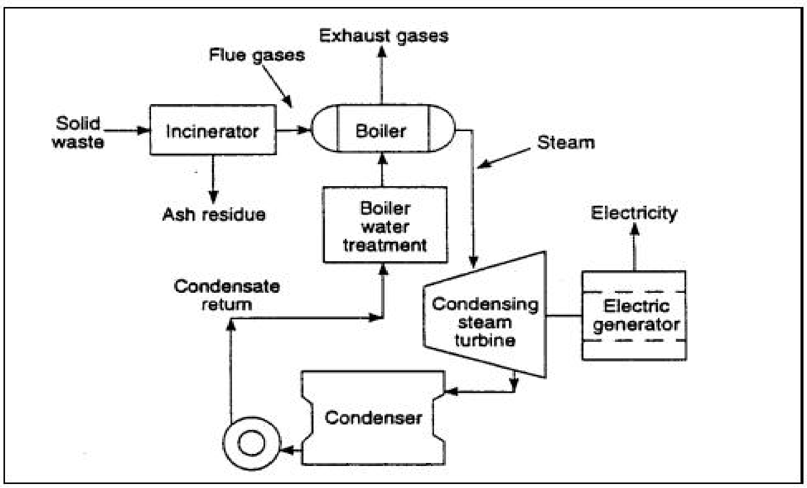


Figure - 04: Incinerator and Electrical Generation System

2.8 Computation of Energy potential

Total MSW produce in Bhopal city per day = 740 tons
Conversion efficiency MSW to SRF =60%
Total SRF production per day = 740 x 0.60 = 444 tons

Two methods applying for computation of Energy potential

a) Dulong's Formula
b) Net Calorific Method

a) Dulong's Formula

Heat Energy (Dulong's Formula) to calculated heat energy generated from SRF. The heat value of waste is directly proportional to the carbon content of the waste and inversely proportional to the ash and moisture content. The heating value of wastes can be calculated by using Dulong's formula:

Dulong's formula: HV (KJ/Kg) = 337(C) + 1419 (H_2 – 0.125O_2) + 93 (s) + 23(N)

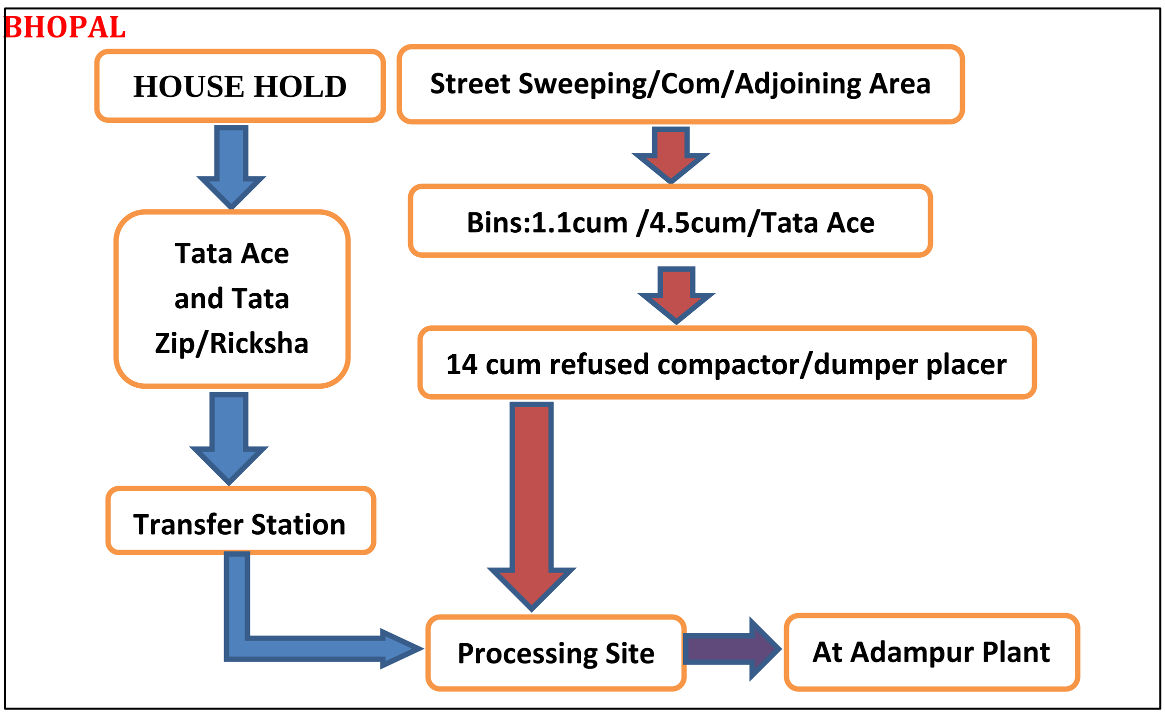
b) Net calorific Value method

Evaluation of Potential of Energy Recovery options from Bhopal MSW considered here is incineration of SRF (Fluff/Pallets). A rough assessment of the potential of recovery of energy from smaller size of the constituents aids in faster decomposition of the waste. Wastes of the high density reflect a high proportion of biodegradable organic matter and moisture. Low density wastes on the other hand indicate a high proportion of paper, plastics and other combustibles.

Net Power generation potential (KW) = 0.012 x NCV x W

3. RESULT AND DISCUSSION

For the ISWM (Integrated Solid Waste Management) & sanitary land filling of solid waste from Bhopal & other ULBs, Adampur and Chhawani site have been selected. This site has area of 63 acres and it is located 16 km from Bhopal. The proposed site has little or no vegetation with a small number medium sized tree sparsely located. Thus the site does not involve removal of vegetation or tree cover. A few human settlements (about10-15 kuchha houses) have encroached over the site over the last few years and these would need to be suitable.



3.1 Quality of Investigated SRF And Physical-chemical analyses of Two types of investigated SRF

In following Figure, all two investigated types of SRF (Figure-05) are depicted. It becomes obvious that the particle size of the SRF types presented is completely different. The quality of SRF manufactured depends primarily on the input waste materials as well as on type and extent of processing steps applied in the multistage (mechanical/physical) SRF process- sing plants. Additionally, when innovative sorting techniques like NIR-separation are integrated in the SRF-manufacturing process, different plastic fractions (like for energy recovery processes unwanted PVC or for recycling processes valuable PET that may contribute to circular economy) can be detected and separated out of process stream. In the case studies reported, obtained results on the quality of two different SRF types manufactured, namely *SRF low quality* and *SRF premium quality*, are presented.

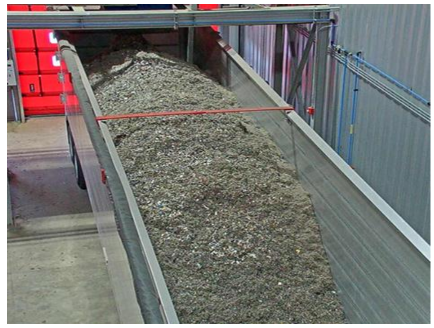



Figure - 05: *SRF low quality* (Left) and *SRF premium quality* (Right)

Table - 03: Results of Physical-chemical analyses of Two investigated SRF types

Parameter	Unit	SRF Low Quality		SRF Primum Quality	
		Med.	80th	Med.	80th
Moisture content	$\%_{os}$	25.5	30.2	14.5	28.1
Lower heating value$_{os}$	Mj kg$_{os}$	8.3	9.8	18.1	22.1
Lower heating Value$_{DM}$	Mj kg$_{os}$	13.2	14.2	24.0	25.8
Ash content	W$\%_{os}$	29.2	34.7	11.2	13.6
Chlorine content	G kg$_{DM-1}$	8.6	11.2	12.2	16.2
Sulphur content	G kg$_{DM-1}$	2.3	3.1	3.2	4.6
Ratio Chlorine/ Sulphur	_	2.8	3.1	4.8	4
Total carbon content	W$\%_{DM}$	-	-	51.6	57.3
Fossil CO_2 Emission factor	G kg$_{DM-1}$	-	-	42.3	54.2

Note: - Med.= Median 80th =80th Percentile

Analysis of power generation potential land environment effects after the SRF production are defined below through Dulong's Formula for steam generation method and net calorific method for direct combustion method. The current operating Plant capacity is 17.9 MW under construction using direct dry MSW.

3.2 Actual Computation of Energy Potential by Dulong's Formula

Heat Energy (Dulong's Formula) to calculated heat energy generated from SRF

Dulong's formula: HV(KJ/Kg) = 337(C) + 1419 (H2– 0.125O2) + 93 (s)+ 23(N)

Where C, H, O and S are the % of these elements on dry ash free basis.

C = 51.7

H_2 = 7.0

O_2 = 40.25

N = 1.20

S = 0.30

Cl = 0.76

HV (KJ/Kg) = 337(51.7) + 1419 (7.0 – 0.125 x (40.25)) + 93 (0.30) + 23(1.20)
= 17422.9 + 1419 (7.0-5.03) + 27.9 + 27.6
= 20271.4 (KJ/Kg)
Applying to formulae we get Heat Energy Generated = 20271.4 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 ×20271.4) kJ/kg
Steam energy available = 14189.98 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 30% in a powerplant heat input of 3600 ÷ 30 % = 12000 kJ/kWh is required.
So, to produce 1 kWh electrical energy 12000 kJ of steam energy is required.
Electric power generation = Steam energy ÷ 12000 kJ/kWh
Electric power generation = (14189.98 ÷ 12000) kWh/kg
Electric power generation = 1.18 kWh/kg
Total weight of solid waste collected from Bhopal city= 740 tons/day Total
RDF production from MSW = 740 x 60% = 740 x 0.06 = 444 tons
Total electric power generation = (1.18 × 444000) kWh/day = 523920 kWh/day generation
Station service allowance = (0.06 ×523920) kWh/day = 31435.2 kWh/day
Unaccounted heat loss = 5% of electric
Power generation Unaccounted heat loss = (0.05 × 523920) kWh/day = 26196 kWh/day
Net electric power generation = Electric power generation – (station service allowance + unaccounted heat loss)
Net electric power generation = 523920 – (31435.2 + 26196) = 466288.8 kWh/day
Net electric power generation = 466288.8 kWh/day = 466.288 MWh/day
The above generated electricity is for one day and has 24 hours, so using this net electric power is calculated for per hour basis
Net electric power generated = 466.288 MWh / 24 h
Net electric power generated = 19.42 MW
The numerical computation has been carried out and following total energy potential is calculated which provides the feasibility of the WTE incineration in Bhopal City

3.3 Net Calorific Method for Power generation Potentials

Quantity of MSW: 1200 TPD
Assumed Net Calorific Value: 1662.31 Kcal/kg Assumed Conversion Efficiency: 24%
Energy Recovery Potential from 1200 TPD is estimated as per the following universally accepted general formula.
Total MSW quantity: W tones = 1200 TPD
Net Calorific Value: NCV Kcal/kg. = 1662.51 Kcal/kg
Energy recovery potential (kWh) = NCV x W x 1200/860
= 1.163 x NCV x W
= 1.163 x 1662.31 x 1200
= 2319919.8 KW / h
Power generation potential (kW) = 1.163 x NCV x W/ 24

= 1.163 x 1662.31 x 1200/24
= 96663.3 KW

Conversion Efficiency = 24%
Gross Generation potential (Minimum) = 23199.19 kW = 23.20 MW
Auxiliary Consumption (16%) = 3.71 MW
Net Sellable Power = 19.49 MW

In general, 740 tons of raw MSW can generate about 17.9 Mega Watt power, depending upon the waste characteristics. So we follow this thumb rule and calculate the power generation on assumption that 2.4 MW per 100 tons, then it will be 17.9 MW which is almost nearer the calculated value on considering Calorific Value. The above calculation show total power generation potential in average 19.4 MW per day using SRF.

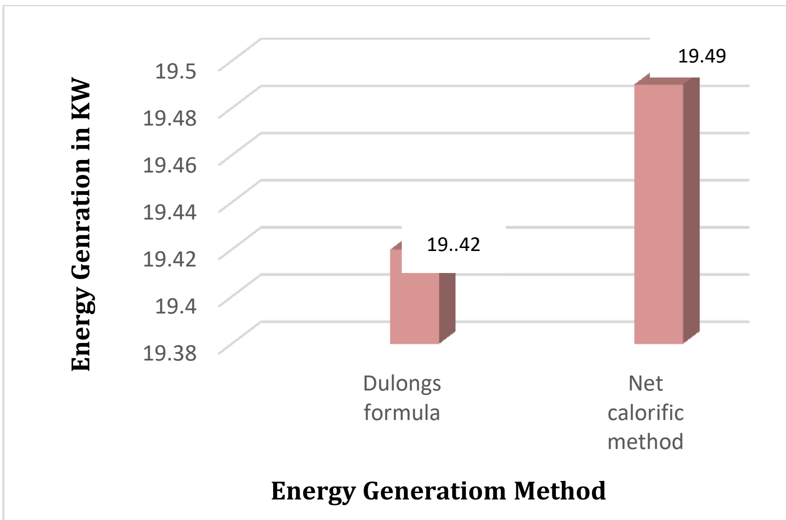


Chart 01: Graph shows Power generation Potentials of Two methods

3.4 Predicted air emissions from the site

During the construction phase, pollution emission sources shall be distributed throughout the project site and shall fall under the category of area source.

Table - 04: Air emission limit values and expected value for waste incineration

Parameter	Permitted value $(mg/Nm)^3$	Expected value $(mg/Nm)^3$
O_2	Up to 6 volume wet	05
CO	50	15
Particulate	10	08
SO_2	100	0.1
NO_2	200	191
HCL	10	02
HF + HBr	2	0.1

VOC	10	01
PAH	0.2	0.003
Total Heavy metals	0.6	0.001

4. CONCLUSION

The cost of energy from conventional energy sources is becoming very high and harnessing power from waste is becoming more important nowadays. An extensive economic analysis of an MSW management have been carried out to evaluate the feasibility of integrating SRF production to energy facilities under current MSW generation in Bhopal (M.P.). The economic feasibility of SRF 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 19.4 MW power plant has attractive.

Electricity Production using SRF as a supplemental fuel is an economically viable option to reduce fuel costs and reduce landfill disposal. Produces beneficial effects on air emission and ash residue when used as a fuel, produces a more homogeneous fuel which burns more evenly at a higher temperature thereby making combustion control easier and has a higher calorific value content, lower ash and moisture content.

The total waste quantity in Bhopal is about 740 tons per day. Assuming that 60% can be utilized as SRF, this translates 444 tons per day of SRF fuel. A power potential of 19 MW exists if all the SRF can be utilized in Bhopal but this will account for approximately 4-6 % of the total energy demand of the Bhopal. Researchers and scientists should be allowed to investigate and do research in the WTE plant. The investigation should include efficient waste management techniques and technology following environmental impact studies.

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