Impact Factor Value 5.856 **e-ISSN: 2456-3463**
International Journal of Innovations in Engineering and Science, Vol 5, No.6, 2020
www.ijies.net

Incineration Process for Municipal Solid Waste In Palghar District

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DOI: 10.46335/IJIES.2020.5.6.8

Abstract – *Today one of the major problem which remains in modern societies is Municipal Solid Waste (MSW), in spite of the significant efforts to prevent, reduce, reuse and recycle. In most of the developed countries at present, municipal solid waste incineration (MSWI) in waste – to – energy (WTE) plants is one of the main management options. The waste material collection is piling up every day in almost all cities in India and creating hazardous situation in terms of pollution. Palghar is a newly formed district from Thane district. Palghar district consists of Vasai, Virar, Palghar, Jawahar and Dahanu; housing a population of 13,35,316 as per Maharashtra Pollution Control Board , Annual Report 2017-18. The amount of solid waste treated in Palghar district is nil and MSW processing facility available is only dumping. Due to this the average life span of living beings has deteriorated to a great extent. Our main aim is to utilize these waste materials in an effective way to help mankind by the process of incineration. Incineration is the best process of combustion of organic materials present in the waste and giving useful by-products. The by-products of incineration are heat, flue gases and ash. The effective use of these by-products can be generation of electricity, growth in production of crops. We are attempting to assess the possible situation of the effective utilization of low cost incineration and air pollution control devices used for cleaning. Thus we propose a model for the incineration of MSW in Palghar district.*

Keywords- *Incineration, Municipal Solid Waste (MSW), Hazardous, Energy.*

I- INTRODUCTION

Solid waste is majorly classified into four types as

a. Municipal Solid Waste
b. Hazardous Solid Waste
c. Bio – Medical Waste
d. E – Waste

As per the data of 2017 – 18 given by Maharashtra Pollution Control Board, Total Generation and Treatment of Hazardous Waste in the State during 2017-18. Hazardous Waste Generation as per Consent (MT/annum)

Land fillable 725444.35
Incinerable 353286.72
Recyclable 1091514.03
Utilizable 276429.20

Indian Renewable Energy Development Agency (IREDA) estimates indicate that India has so far realized only about 2% of its waste-to-energy potential. Various technologies are available presently for the generation of energy from waste like "Thermal Conversion, Thermo - Chemical Conversion, Bio – Chemical Conversion and Electro – Chemical Conversion." Waste to energy, is an alternative to disposing of waste in landfills, waste to energy generates clean, reliable energy from a renewable fuel source, reduces dependence on fossil fuels, the combustion of which is a major contributor to GHG emissions. This method would reduce the amount of wastes, generate a substantial quantity of energy from them, and also significantly reduce pollution of water and air. Improper management of MSW institutes/ warrants a growing concern for cities in developing nations. Proper management requires the construction and installation of essential facilities and machinery, based on a suitable management plan (Shimura, S., 2001and Das et al., 1998).

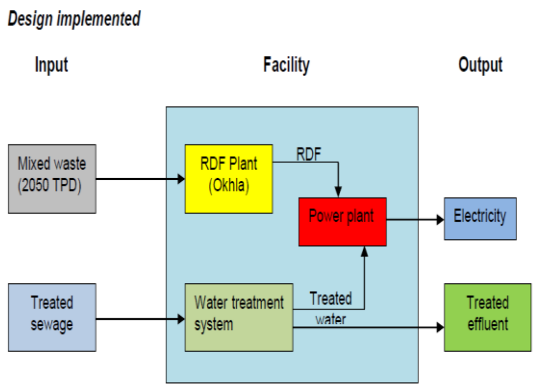
This project deals with processing and disposing off municipal solid wastes along with the production of the fluff and Refuse Derived Fuel for power generation that can be a source of revenue also. "Waste to Energy" plants remove recyclable or unburnable materials and shred or process the remaining trash into a uniform fuel. In an RDF plant, waste is processed before burning.

Typically, the non-combustible items are removed, separating glass and metals for recycling. A dedicated combustor, or furnace, may be located on-site to burn the fuel and generate power; or the RDF may be transported off site for use as a fuel in boilers that burn other fossil fuel. Thus the waste-to-energy plants offer two important benefits of environmentally safe waste management and disposal, as well as the generation of clean electric power.

The land for the site is an abandoned site adjacent to Dahanu Reliance Thermal Power Plant. Landfill site spread over 5.728 acres with an investment over of Rs.1000.00 million (approximately 18.20 million US$). The proposed plant at Dahanu, Palghar District is designed to process 1300 TPD (tons per day) of Municipal Solid Waste (MSW). A RDF plant based on DST-TIFAC Technology is designed to process 1300 TPD of MSW to generate around 433 TPD of RDF in the form of fluff and a power plant of 10 MW capacity based on RDF is provided.

II- METHODOLOGY

Incineration is a waste treatment process that involves the combustion of organic substances contained in waste materials. Incineration of waste materials is converted into ash, flue gas and heat. This process is being planned to generate electricity from the Municipal Solid Waste generated in Palghar District. There are various types of incinerators out of which "Moving Grate Incinerator" is planned to use for the electricity generation. Moving grate incinerator is a typical incinerator plant for municipal solid waste. It enables the movement of waste through combustion chamber and complete combustion is done with more efficiency. A single moving grate boiler can handle up to 35 metric tons (39 short tons) of waste per hour, and can operate 8,000 hours per year with only one scheduled stop for inspection and maintenance of about one month's duration.Moving grate incinerators sometimes can be referred as Municipal Solid Waste Incinerators (MSWIs). The plant will be designed to work for two shifts per day and shall operate for 335 days in a year. There may be forced closure of plant during the short rainy days in Palghar District. Depending on many factor, the GCV of the fuel should be about 1150 kcal/kg ± 100 kcal/kg.



A specific environmental management system as well as proper air pollution control will be installed to ensure that all these possible emissions are within the limits as prescribed by National Ambient Air Quality Standards (NAAQS).

Considering chance emissions of dioxins and furans in future, a dioxin and furan emission control system will also be installed with injection of Activated carbon in the flue gases

Measures to Control Emissions

Emission	Source	Major Cause	Control Mechanism/technology
Carbon Monoxide (CO)	Carbon in fuel	Incomplete combustion	Boiler and grate design to enhance combustion and turbulence, auxiliary burners
Particulate Matter (PM)	Carbon and minerals in fuel	Incomplete combustion and	Boiler and grate design to enhance combustion and turbulence, auxiliary burners, fabric filters
Nitrogen Oxides (NOx)	Nitrogen in fuel and primary air	High temperature conditions	Flue gas recirculation, selective non-catalytic reduction
Sulfur Dioxide (SO2)	Sulfur in fuel	Product of Oxidation	Packed bed absorption with alkaline scrubbing liquid
Hydrogen Chloride (HCl)	Chlorine in fuel	Product of Halogenation,	Dry lime injection, packed bed absorption with acidic scrubbing liquid

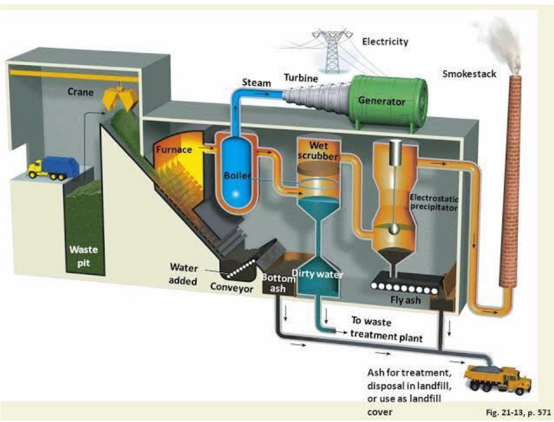
Dioxins and Furans	Organic chlorine in fuel	Incomplete combustion and temperatures between 140 - 149 °C	Auxiliary burners, high temperature oxidizing conditions, rapid gas cooling, adsorption by activated carbon injection
Mercury (Hg)	Hg in waste stream		Adsorption by activated carbon injection
Lead (Pb)	Pb in waste stream		Fabric filters
Trace organic compounds	Carbon and hydrogen in fuel	Incomplete combustion	High temperature oxidizing conditions
Fugitive Emissions	Initial waste handling		Negative pressure buildings and use as primary air for combustion

During the activity there are more possibilities of Green House gases (GHGs) emissions. Following table shows the sources and types of GHGs evolved during Baseline and Project activity.

	Source	GHG	Included?	Justification/Explanation
Baseline	Emissions From decomposition of waste at the landfill site	CO_2	Excluded	CO_2 emissions from the decomposition of organic waste are not accounted.
		CH_4	Included	The major source of emissions in the baseline.
		N_2O	Excluded	N_2O emissions are small compared to CH_4 emissions from landfills. Exclusion of this gas is conservative.
	Emissions from electricity consumption	CO_2	Included	Electricity may be consumed from the grid or generated onsite in the baseline scenario.
		CH_4	Excluded	Excluded for simplification. This is conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative.
	Emission from thermal energy generation	CO_2	Included	If thermal energy generation is included in the project activity
		CH_4	Excluded	Excluded for simplification. This is conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative.
Project activity	Emissions from on-site electricity use	CO_2	Included	May be an important emission source CO_2 emissions from fossil based waste from RDF combustion to generate electricity to be used on-site are accounted for.
		CH_4	Excluded	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be very small.
	Direct emissions from the waste treatment processes	N_2O	Included	N_2O can be emitted from RDF combustion.
		CO_2	Included	CO_2 emissions from gasification or combustion of fossil based waste shall be included.
		CH_4	Included	CH_4 may emitted from stacks of the gasification process and the RDF combustion.

Equipments like Cyclones, Venturi Scrubbers, Electrostatic Precipitators and Fabric filters are used to control the air pollution.

The various processes takes place in the incineration plant is schematically shown below.



- Collection vehicles transport incinerable waste to the WTE plants. The vehicles are weighed on a weighbridge before and after they discharge their loads into large waste pit. This weighing process enables the WTE to keep track of the amount of waste disposed of by each vehicle.
- To prevent odours from escaping into the environment, the air in the waste pit is kept below atmospheric pressure.
- The waste from the waste pit is fed into the furnace by a grab crane.
- As the furnace is operated at temperatures between 850 and 1000 degree Celsius, a lining of refractory material protects the incinerator walls from the extreme heat and corrosion. After incineration, the waste is reduced to ash which is about 10 per cent of its original volume.
- In contrast to furnace, in the boiler the heat produced in furnace in the form of gases get cooled by convective heat transfer to tubes located in the flow.
- Water in the wall tubes get boiled and turns it into steam. This steam passes through turbine at high pressure and turbine drives the generator. This generator generates electricity.
- Some part of waste is incombustible, this part remains after incineration which we called as bottom ash. And high quality building materials used it; for example concrete and asphalt.
- The wet scrubber are effective air pollution control devices for removing particles and gases from streams.
- A wet scrubber operates by introducing a dirty gas stream with a scrubbing liquid - typically water.
- An efficient flue gas cleaning system comprising electrostatic precipitators, which is a filtration device that removes fine particles like dust and smoke from a flowing gas, before it is released into the atmosphere via chimney, as per government regulation and under some limits.
- And remaining fly ash is used as filling material in asphalt.

III- EQUATIONS & CALCULATIONS

Mathematical formulas for calculating waste collection.

$$PWG = (PBY + PBY \times AGP) \times (PCWB + PCWB \times AGW) \times 365 \times 1/1000$$

Here,
PWG = projected wastes generation in a year (tons); (686750 MT or 2050 TPD)
PBY = population in baseline year; (30,00,000)
AGP = annual growth rate of population; 30%
PCWB = per capita wastes generation in baseline year (kg/cap/day); (1.1 kg/cap/day)
AGW = average growth rate in the per capita waste generation (3.7 kg)

Mathematical formulae for electricity generated by Incineration process.

Expression to Calculate the Amount of Electricity that can be obtained from Incineration

$$ERPi = \eta\ (M.\ LCVMSW)/1000$$

Where,
ERPi = Energy Recovery Potential from incineration [MWh/day]. (20.9 MW)
M =Total mass of dry solid waste [Kg/day]. (2050×1000)
LCVMSW = Lower Calorific Value of the Waste [kWh/Kg]. (0.04)
η = Total process efficiency. (0.25)

Financial Analysis

Items	*Assumptions*
Debt -Equity	2:1 (66.67:33.33)
Interest rate	10%
Processing Fee	2%
Loan Repayment Period	5Yrs.
Moratorium	1 yr
Infrastructure Development (Establishing 10 MW Electricity Plant)	1 Year. (2020-2021)
Inflation	6% (2020-2025), 7% (2025-2030), 8% (2030- 2035) and 9% (2035-2040)
Security Deposit period	5 12 months

Operation & Maintenance Cost *(In Million INR)*

Cost	First 5-Years (2020-2025)	Second 5-Years (2025-2030)	Third 5-Years (2030-2035)	Last 5-Years (2035-2040)
Operation & Maintenance	250.00	360.00	420.00	560
Escalation Cost	6%	7%	8%	9%

Total Project Cost (In Million Indian Rupees)

Items	2020-2040
Base Project Cost	1000.00
O&M Cost	1190.00
TPC (Total Project Cost)	**2190.00**

Total Revenue (In Million Indian Rupees)

Item	2020-2040
Revenue from 10MW Electricity	10468.50
Revenue from Carbon Credit	313.11
Total Revenue from Electricity Generation and Carbon Credit*	**10781.61**

Result of Debt-Equity Ratio in Million INR

Year	Year1 2020	Year 2021	Year 2022	Year 2023	Year 2024
Opening Balance		666.70	500.00	366.68	225.00
Loans	666.70	0.00	33.33	33.33	33.33
Interest & processing fees @12%	80.00	80.00	64.00	48.00	31.00
Principal Repayment	0.00	166.68	166.68	175.01	183.34
Closing Balance	666.70	500.03	366.68	225.00	74.99
Equity	333.30	0.00	16.67	16.67	16.67

IV-RESULTS

a. Total MSW Waste to be processed at the proposed Incineration Plant is 686750 MT of waste per year @ 2050 TPD of MSW.
b. The Project will Sell 121.53 GWh of Electricity.
c. The Estimated Cost of the Project is Rs. 2190 Million.
d. Total Revenue form Electricity Generation and Carbon Credit Rs. 10781.61 Million

V- FUTURE SCOPE

i. In today's generation incineration is being widely used for the reduction of the volume of municipal solid waste and to produce electric energy.
ii. It reduces the toxicity of chemical and biological waste.
iii. By implementing incineration the pollution can be controlled up to some extent and certain amount of energy can be recovered.
iv. The emission rate of green houses cases i.e. CH4, CO,CO2 and many more gases which are hazardous can be reduced.
v. If the outputs from incineration process are achieved up to the mark then the usage of fossil fuels can be reduced up to some extent.
vi. Integrated waste management can be achieved.
vii. Lesser land usage for dumping as some part of the MSW sent for the incineration which helps in the reduction of land consumption for dumping of waste.

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