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Cost Analysis Study of Incineration as efficient Solid Waste Management System - A Case Study for Pune City SWMS

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Abstract: ***Arising quality of life, and high rates of resource consumption patterns have an unintended and negative impact on the urban environment - generation of wastes far beyond the handling capacities of urban governments and agencies. Waste management and utilization strategies are major concerns in many countries. Rapid increase in urbanization and per capita income has led to high rate of Municipal Solid Waste (MSW) generation (0.34kg/capita/day in 2018) and it is expected to have even higher rate of 0.70 kg/capita/day. In many developing countries solid waste is collected from the source and is disposed by open dumping. Open dumping has less human control and many environmental concerns like land pollution, ground water pollution and air pollution. Therefore, there is need of better approach to deal with this situation. Incineration is common technique for treating waste across the globe, as it can minimize volume of waste by 90% and has potential to produce electricity. The purpose of this feasibility study has been to investigate different conditions necessary when building a solid waste incineration plant with power generation in Pune City. The conditions have been divided into: Current situation of MSW in Pune city, Economical Feasibility.***

Keywords: Cost analysis Incineration Plant, MSW Management, Pune City.

I. INTRODUCTION

Pune is 8th largest city in India and 2nd largest city in state of Maharashtra. City is home of many Automobile and Software industries. It is one of the fastest growing cities in Asian-Pacific region. City is experiencing great population growth rate in current decade. It is expected that population of the city hits nearly 8.5M by 2041. This results to tremendous amount of generation of Municipal Solid Waste. Such huge amount of MSW, nearly hundreds of tons generated every day also generates many issues for transportation, treatment and its disposal. But these problems have also provided a window of opportunity for cities to find solutions - involving the community and the private sector; involving innovative technologies and disposal methods; and involving behaviour changes and awareness raising for treatment of waste. Today average MSW generation for Pune City is around 0.34 (kg/capita/day) and expected to increase up to 0.70 (kg/capita/day). Hence, to deal with this huge amount of waste, it is need of time to adopt new eco-friendly and economical solid waste management systems over conventional systems for city. Incineration method is one of the effective method for solid waste management and implemented by many countries across the wold. This feasibility study implies analysis of Incineration method as effective waste management for Pune City based on Economical feasibility.

A. *Objectives of Study*

1) To study current scenario and techniques used for solid waste management for Pune Municipal Corporation.
2) To study chemical and physical characteristics of Municipal Solid Waste.
3) To calculate construction cost and potential to generate revenue by selling electricity of Incineration Plant.

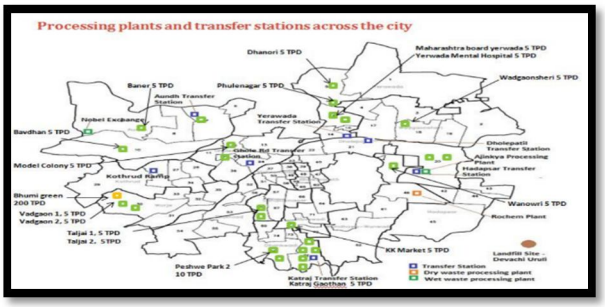
II. LITERATURE SURVEY

A. *Current MSW disposal Techniques*

1) *Composting:* Compost is a key ingredient in farming. Compostable matter and recyclable matter are segregated. Compostable matter is decomposed aerobically and recycled as a fertilizer and soil amendment. One of the major advantages of this method is compost formed. Segregation of MSW is required for composting and this is very tedious. Disadvantages: -1) Time consuming 2) More land requirement 3) More man power requirement
2) *Open Dumping:* Open dumping is practiced in India in almost every city. MSW is dumped on open land away from city area. This is cheapest method involves collection and transportation costs only. This method has no human control when it comes to the process of degradation. MSW is also dumped into the sea water but this causes lots of problems to aquatic life and it results into depletion of marine biodiversity. Disadvantages: - 1) Leachate causes ground water pollution 2) Gases causes pollution

3) *Incineration:* Incineration is the waste treatment process the combustion of organic substances contained in waste materials. Incineration and other high-temperature waste treatment systems are described as "thermal treatment". Incineration of waste materials converts the waste into ash, flue gas and heat. The ash is mostly formed by the inorganic constituents of the waste, and may take the form of solid lumps or particulates carried by the flue gas. The flue gases must be cleaned of gaseous and particulate pollutants before they are dispersed into the atmosphere. In some cases, the heat generated by incineration can be used to generate electric power. Disadvantages: -1) Expensive to build and operate 2) High energy requirement 3) Requires skilled personnel and continuous maintenance

B. *Overview of MSW Management done by PMC:*



(Source : Data given by PMC)

1) City generates 2000-2100 tons of solid waste per day.
2) 160 trucks collect waste door-to-door, collecting an average of 225-250 tons per day.
3) 700 containers and buckets dispersed around Pune.
4) Ward wise average- 350 to 750 gms per capita per day.

a) *Source of MSW*

Sr. No.	Source of Generation	Quantity (m/t)	% of Total
1	Household	950	69.1
2	Street sweeping & drainage cleaning	140	10.2
3	Hotels & Restaurants	150	10.9
4	Markets / Commercial Area	50	3.6
5	Construction and Demolition waste	75	5.5
6	Fruit, Vegetable, Meat market waste	7.5	0.5
7	Biomedical Waste	1.8	0.1

(Source : Data given by PMC)

b) *Composition of MSW*

Sr.No.	Components	Percentage
1	Organic Matter	57.33
2	Plastic	13.94
3	Paper	11.84
4	Glass	8
5	Cloths	6.5
6	Inert	1.59
7	Metals	0.8

(Source : Experimental Study of landfill site at Uruli Devachi)

c) Properties of MSW

Sr. No.	Parameters	Value
1	Moisture Content (%)	50.27
2	Volatile Matter (mg/kg)	427.16
3	Density	437
4	Gross Calorific Value (kcal/kg	937
5	C/N	22.85

d) Current Processing of waste in PMC

Plant Name	Capacity	Actual Operation
Hanjer Biotech Plant	1000 TPD, Composting, RDF Pellets and Bio-Fuel	200 to 400 Tones
	Location - Urali Devachi and Fursungi	
Disha Waste Management	100 TPD; Vermi- compost and compost	100 tones
	Ram Tekdi Industrial Estate	
AjinkyaBioFert	200 TPD; Vermi- compost and compost	200 tones
	Hadapsar Ramp	
Biogas and mechanical Compost	100 TPD; Electricity and Compost	100 tones
	22 Decentralized Plants	
Rochem Separation System	700 TPD; Electricity	250 Tone. D but no electricity
	Ram Tekdi, Hadapsar	

III. CALCULATIONS AND ECONOMICS

A. Estimated Population and MSW generation of the City

Sr.No.	Year	Population	Waste Generation (TPD)	Considering 80 % of waste is Incinerable
1	2011	31,15,431	1374	1099.2
2	2021	44,87,573	2677	2141.6
3	2031	62,11,404	3800	3040
4	2041	85,97,417	6071	4856.8

(Source : Data taken from PMC website)

B. Block Estimate Of Similar Proposed Plant

The Cost estimates for the proposed Incineration plant includes:

1) capital investment for Pre-processing unit
2) MSW Processing Plant
3) Pollution Control Equipment,
4) Continuous Emission Monitoring System
5) Information Communication Technology
6) Auxiliary Power Supply System and
7) Allied Infrastructure.

Component	Desription	Cost (Rs. Crores)
Component-A	1: Site & Periferal Preparation including 2.Site Survey 3.Geotechnical Investigation, 4.Waste Physico-chemical Characterization Study 5.Site Clearance, Excavation, Filling & Compaction 6. Compound Wall 7. Pipeline & Pumping Station 8.Preparation of Eastern Periferal area slope 9. Landscaping 10. Storm Water Drain	146.95
Component-B	Design including all approvals	28.64
Component-C	Pre-Processing Plant	138
Component-D	Processing Plant (Electric Power Plant) including Civil, Electrical, Mechanical, I&C, Water System, Construction, Supervision, Pollution Control Equipments, etc.	469.09
Component-E	Allied Infrastructures including Internal Road, Storm Water Drainage, Fire Ring main, Weighbridge, Water Treatment Plant and Storage, Leachate Treatment Plant, Sewage Treatment Plant, Effluent Treatment Plant, Truck Parking area, Security Booth, Administration/ Laboratory Building, Pile Foundation Car Parking, Material Entry/ Exit Gate, Visitor Entry/Exit Gate, Workers Area, Canteen, Landscape area with irrigation system complete, Pile Foundations, Continuous Emission Monitoring System (CEMS), Information Communication Technology (ICT), Auxiliary Power Supply System, Laboratory Equipment, Safety and security arrangement including electronic surveillance, etc.	54.53
Component-F	Power Evacuation Line	21.17
Component-G	Process by-product Management and Disposal (Ash/ Sludge/ Rejects/ other) Plant	4.99
Component-H	Tests on Completion and Training	9.38
Component-I	Provisional Sums – General	5
	Total (Rs. Crores)	877.76

C. Cost Analysis

Incineration plant needs large investment. Therefore, cost and economics of plant plays important role. Availability of MSW, investment of plant, revenue generated through energy and payback period of investment are important element in economics of project. Some assumptions are required to proceed. Those are given below: -

1) The MSW generated is 2100 MT/day
2) The incinerable matter present in the MSW generated is 80%% i.e. 1680 MT/day.
3) Calorific value is assumed = 937 kcal/kg
4) Collection efficiency of MSW is 100%
5) Electricity generated through incineration plant is provided for only industries at the rate of Rs10/unit.

Sr. No.	Description	Value
1	Total Waste (TOD)	2100
2	Waste incinerated (80% of Total Waste) (TOD)	1680
3	Electricity generated per day	18 MW
4	Revenue Generated by selling electricity per day	180000 Rs/d

IV. CONCLUSION

A. From Cost analysis, it is seen that there is minimum potential of generating 18 MW of energy per day generating revenue of 180000 Rs/d. Energy output and revenue can be optmise by including auxillary fuel and pre-treatment proccess.

B. Waste in Pune is still being dumped in land fill sites. Environmental measures or recycling programs are not available yet. There is a great need for establishing and implementing a proper waste management. The result of the cost analysis indicates potential economic savings for the waste management system in Pune City. It is therefore worthwhile for policy makers to consider adding waste incineration to their agenda of improving the city's waste management system for environmental protection and for economic efficiency.

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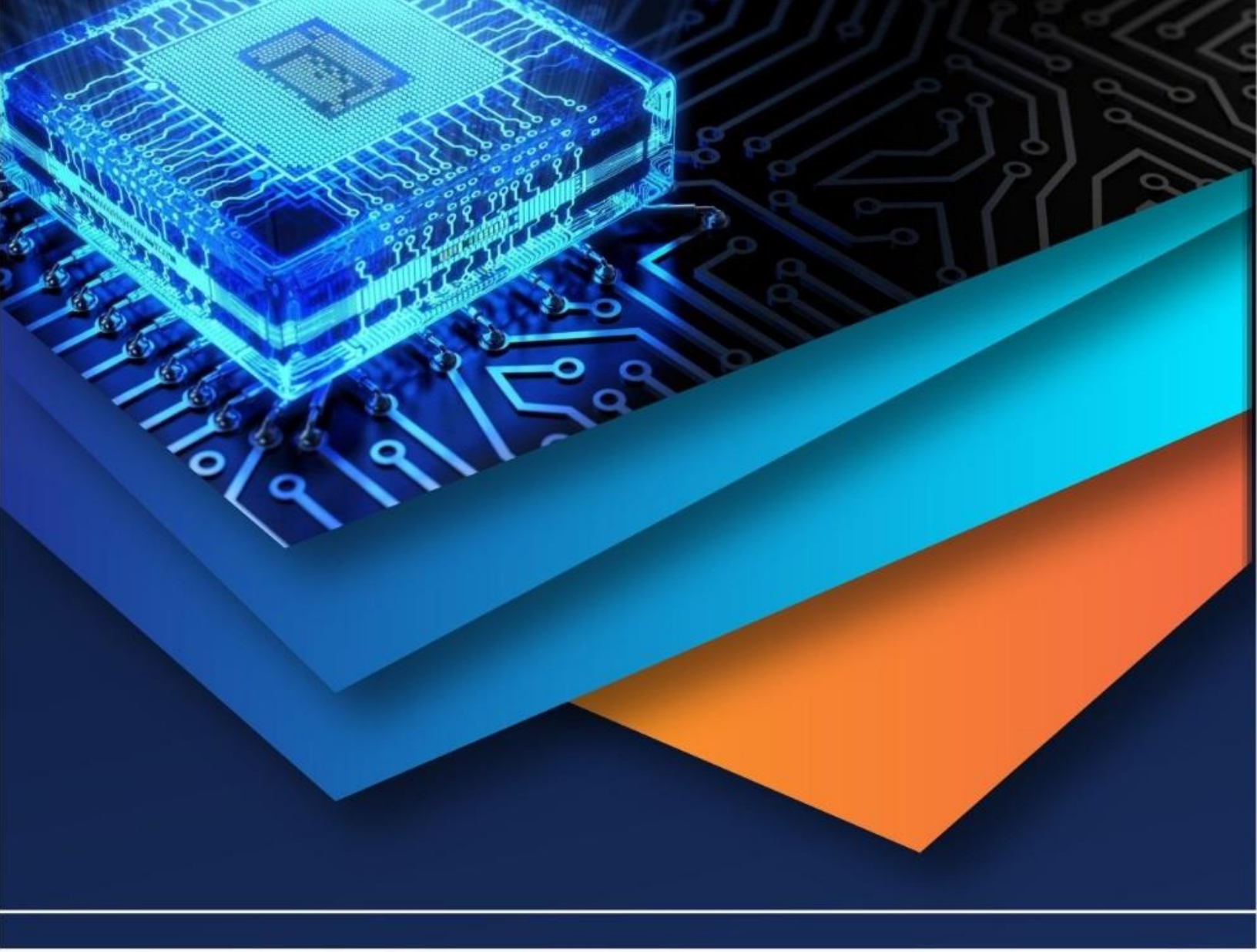

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