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Power Generation in Thermal Power Plant Using Municipal Wastes Sources – A Review

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ABSTRACT: Energy production, waste disposal, and the minimization of pollution are key problems that must be addressed for sustainable cities of the future. Furthermore, waste management has become a major concern worldwide, and incineration is now being used increasingly to treat waste that cannot be recycled economically. For the foreseeable future, fossil fuels will be the major source of energy, but because of the dwindling resources of oil and gas and the need for fuel security, coal will become the major source of energy for heat and power in due course. The need for clean coal technology precludes the construction of new conventional pulverized fuel power stations in developed countries, and new technology is required. The total heat content of municipal waste in a developed country such as the United Kingdom now totals about 30% of that of the coal used for present needs. Unfortunately, current electrical generation efficiencies for coal burning plant and waste incinerators are only about 37% and 20% respectively.

KEYWORDS: Municipal solid waste, Technology, Pollution, Treatment, Recycling

I. INTRODUCTION

The Municipal Solid Waste (MSW) is a heterogeneous mixture of paper, plastic, cloth, metal, glass, organic matter, construction and demolition debris, dust, etc., generated from households, commercial establishments, markets and road cleaning activities. India generates about 62 million tons of Municipal Solid Waste annually, out of which, 82% is being collected and the remaining 18% is littered; out of the total collected waste, only 28% is being treated and disposed. If the current 62 million tonnes annual generation of MSW continues to be dumped without treatment, it will need 3,40,000 cubic meters of landfill space every day. Considering the projected waste generation of 165 million tons by 2031, the requirement of land for setting up landfill for 20 years (considering 10 meter high waste pile) could be as high as 66,000 hectares of precious land, which the country cannot afford to waste. Even to contain only untreated solid waste, 1,240 hectares of additional precious land every year would be required. Keeping in view that by 2031, the total generation of Municipal Solid Waste in the country would be 165 million tonnes -an increase of about 100 Million Tonnes in about 15 years, due to increasing industrialization, urbanization and changes in the pattern of life there is a urgent need to look into this subject and find out ways and methods to cope with this extremely large garbage problem. In developed countries, environmental concerns rather than energy recovery is the prime motivator for waste-to-energy projects, which help in treating and disposing of wastes. However, energy generation from MSW improves the viability of such waste management projects and that the major advantages for adopting technologies for recovery of energy from MSW are to reduce the quantity of waste and net reduction in environmental pollution, besides generation of substantial quantity of energy

Therefore there is an urgent need to step up efforts so as to achieve 100% scientific processing and disposal of Municipal Solid Waste by 2019, as envisaged by the Government, under the Swachh Bharat Mission. There should be some facility to collect and treat solid waste at Panchayat level also as all the waste in rural areas is not suitable to be converted into organic manure.

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II. TECHNOLOGY OPTIONS FOR POWER GENERATION FROM MUNICIPAL SOLID WASTE

i) Biomethanation for wet biodegradable wastes - Biomethanation is an anaerobic slurry-phase process that can be used to recover both nutrients and energy contained in biodegradable waste. Biogas can be used either as a source of thermal energy or to generate electricity by using gas engines and turbines.

ii) Combustion of RDF– Segregation of dry high organic component of combustible wastes from mixed MSW to prepare fuel in the form of briquette /pellets /fluff and combustion of same to generate energy.

iii) Mass burning of MSW - Complete combustion of MSW on as it is received basis (unprocessed MSW) to generate energy.

iv)In addition to the above, two other technologies which are currently under R&D and piloting stage are of

a) Gasification - Gasification is a process that converts organic or fossil based carbonaceous materials into carbon monoxide, hydrogen and carbon dioxide at elevated temperature in the presence of limited amount of oxygen.

b) Pyrolysis - Pyrolysis uses heat to break down organic materials in the absence of oxygen, producing a mixture of combustible gases (primarily methane, complex hydro carbons, hydrogen, and carbon monoxide), liquids and solid residues."

III. MSW COMPOSITION

As per the Task Force Report on Waste to Energy (WTE), the waste composition has changed rapidly during 1996-2011 and there is over 380% and 1650% increase in paper and plastic waste, respectively, which calls for serious effort to utilize compostable as well as burnable waste, adopting both compostable and waste to energy technologies. The proportion of high calorific value waste is increasing as shown in the table below

The waste that is generated in the country is a mixed waste comprising a large amount of inert material and a very high moisture level unlike in other countries. High level of moisture and inerts in the waste make it difficult to derive power from it. There is no proper public system of primary collection from the source of waste generation and municipal sanitation workers collect waste primarily through street sweeping, etc. Also, there is no practice of sorting of waste at source in a scientific way. Citizens should be encouraged to keep segregated bins for wet, dry and hazardous waste and stop littering on the streets. Segregation of waste should be made mandatory and if need be a penalty may be imposed for non-compliance.

Table1: State-wise waste generation, collection and treatment

S. No	STATES	QUANTITY GENERATED (TPD)	Collected (TPD)	Collected %	Treated (TPD)	Treated %
1	Andaman & Nicobar	70	70	100	05	7
2	Andhra Pradesh & Telangana	11500	10656	93	9418	82
3	Arunachal Pradesh	110	82	82	74	74
4	Assam	650	350	54	100	15

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5	Bihar	1670	NR	NR	NR	NR
6	Chandigarh	340	330	97	250	74
7	Chattisgarh	1896	1704	90	168	9
8	Daman Diu & Dadra	85	85	85	NIL	0
9	Delhi	8390	7000	83	4150	49
10	Goa	183	182	99	182	99
11	Gujurat	9227	9227	100	1354	15
12	Hariyana	3490	3440	99	570	16
13	Himachal Pradesh	300	240	80	150	50
14	Jammu & Kashmir	1792	1322	74	320	18
15	Jarkhand	3570	3570	100	65	2
16	Karnataka	8784	7602	87	2000	23
17	Kerala	1576	776	49	470	30
18	Lakshadweep	21	--	0	-	0
19	Madhya Pradesh	5079	4298	85	802	16
20	Maharashtra	26820	14900	56	4700	18
21	Manipur	176	125	71	-	0
22	Meghalaya	268	199	74	98	37
23	Mizoram	552	276	50	NIL	0
24	Nagaland	270	186	69	18	7
25	Orissa	2460	2107	86	30	1
26	Pondicherry	495	495	100	NIL	0
27	Punjab	3900	3853	99	32	1
28	Rajasthan	5037	2491	49	490	10
29	Sikkim	49	49	100	0.3	1
30	Tamilnadu	14532	14234	98	1607	11
31	Tripura	407	407	100	NIL	0
32	Uttar Pradesh	19180	19180	100	5197	27
33	Uttarkhand	1013	1013	100	NIL	0
34	West Bengal	8674	7196	83	1415	16
	TOTAL	143449	117644		32871	-

Table 2: Variation in MSW composition in India

YEAR	Composition (%)							
	Bio - degradable	Paper	Plastics/Rubber	Metal	Glass	Rags	Others	Inerts
1996	42.21	3.63	0.60	0.49	0.60	Nil	Nil	45.13
2005	47.43	8.18	9.22	0.50	1.01	4.49	4.026	25.26
2011	42.51	9.68	10.1	0.63	0.96			17
2011	52.32	13.8	7.89	1.49	0.93	1		22.57

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IV. TREATMENT OF BIODEGRADABLE WASTE

The composting plant performs composting of separately collected biodegradable waste. The processes aerobic or anaerobic type of composting and run mostly in an enclosed hall, separately from the employees and the environment. The procedure is fully automated and controlled from the control room. The prepared composting mixture is handled only by appropriate technology. The composting process is designed to make the biodegradable waste decompose into compost in the shortest amount of time possible. For this purpose, the mass is constantly treated with air (aerobic process) which is an essential element for a quick and effective decomposition or just mixed in closed reactor (anaerobic process). Such conditions ensure the suitable quality of the end product.

The plant consists of three parts:

- The reception area
- The composting area (reactor)
- The refining area (reactor)

In case of anaerobic treatment biogas is produced. The biogas consists of 40% to 60% from methane and can be utilized in power and heat production. In developed countries it is generally used to power engines of turbines to produce highly subsidized electrical power. Technologies are also available to upgrade this biogas into bio-methane, having the same properties as natural gas what gives a possibility to inject this renewable source gas into national natural gas grid.

V. POLLUTION CONTROL FROM WASTE TO ENERGY PLANT

Waste-to-energy plant emits less air pollution than coal plants. Waste-to-energy plants are designed to reduce the emission of air pollutants in the flue gases exhausted to the atmosphere such as nitrogen oxides, sulphur oxides and particulates, and to destroy pollutants already present in the waste, using pollution control measures such as bag houses, scrubbers, and electrostatic precipitators. High temperature, efficient combustion, and effective scrubbing and controls can significantly reduce air pollution outputs. Burning municipal waste does produce significant amounts of dioxin and furan emissions to the atmosphere as compared to the smaller amounts produced by burning coal or natural gas. Dioxins and furans are considered by many to be serious health hazards. However, advances in emission control designs and very stringent new government regulations, as well as public opposition to municipal waste incinerators, have caused large reductions in the amount of dioxins and furans produced by waste-to-energy plants.

Waste to energy plant produce fly ash and bottom ash just as is the case when coal is combusted. The total amount of ash produced by waste to energy plant ranges from 15% to 25% by weight of the original quantity of waste, and fly ash amounts to about 10% to 20% of the total ash. The fly ash, by far, constitutes more of a potential health hazard than does the bottom ash because the fly ash contains toxic metals such as lead, cadmium, copper, and zinc as well as small amount of dioxins and furans. The bottom ash may or may not contain significant levels of health hazardous materials. In the United States and perhaps in other countries as well, the law requires that the ash be tested for toxicity before disposal in landfills. If the ash is found to be hazardous, it can only be disposed of in landfills which are carefully designed to prevent pollutants in the ash from leaching into underground aquifers. Odor pollution can be a problem when the plant location is not isolated. Some plant stores the waste in an enclosed area with a negative pressure, which prevents unpleasant odors from escaping, and the air drawn from the storage area is sent through the boiler or a filter. However, not all plants take step to reduce the odor, resulting in complaints. An issue that affects community relationship is the increased road traffic or garbage trucks to transport municipal waste to the waste to energy facility.

Due to this reason, most waste to energy plant is located in industrial areas. Landfill gas which contains about 50% methane, and 50% carbon-di-oxide, is contaminated with a small amount of pollutants. Unlike at waste-to-energy plants, there are little or no pollution controls on the burning of landfill gas. The gas is usually flared or used to run or reciprocating engine or micro turbine, especially in digester gas power plants. Cleaning up the landfill gas is usually not cost effective because natural gas, which is substitute for, is relatively cheap. So now the time has come when we and our government should also alter our thinking and initiate establishing waste-to-energy plants in our cities and colleges too and protect ourselves from harmful consequences of waste materials and generate electricity from our wastes and come forward as a nourishing country with implementation of such innovative ideas and techniques.

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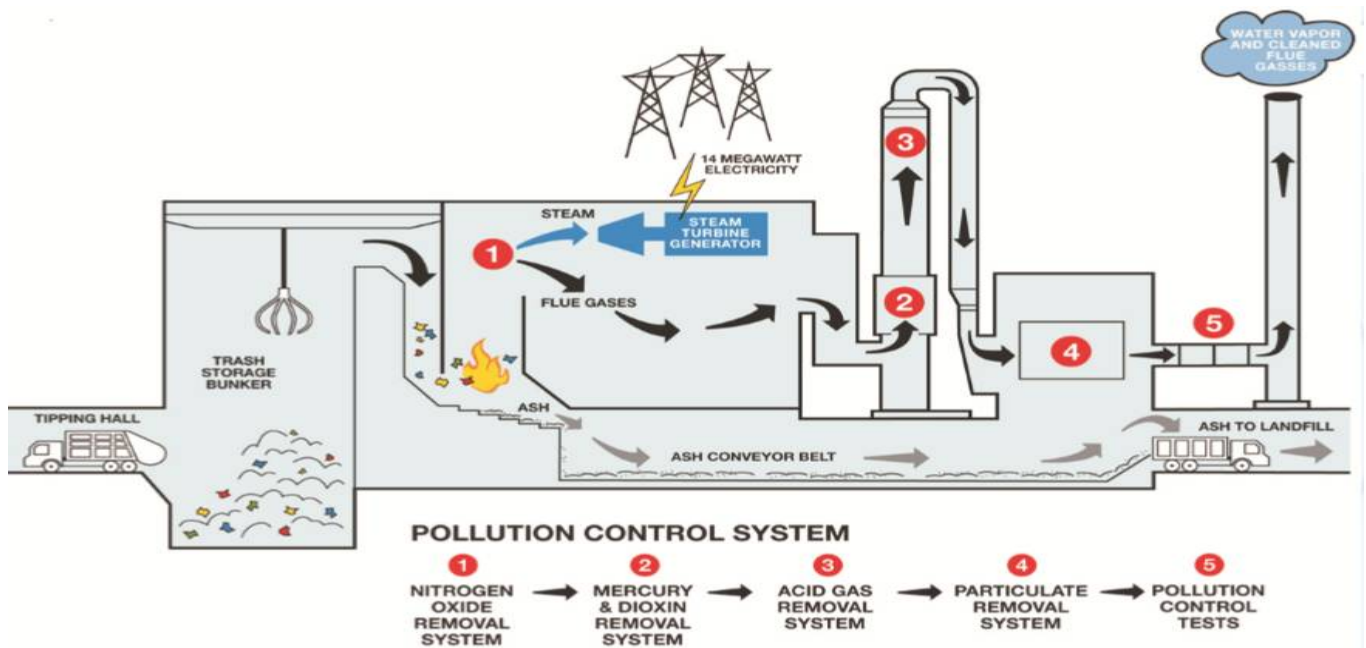


Fig: Waste to energy plant pollution control system

VI. COST OF WASTE TO ENERGY PLANT

Cost of waste to energy plants may have a significant cost advantage over traditional power options, as the waste-to-energy operator may receive revenue for receiving waste as an alternative to the cost of depositing waste in a landfill, typically referred to as a “tipping fee” per ton basis, versus having to pay for the cost of fuel, whereas fuel cost can account for as much as 45 percent of the cost to produce electricity in a coal-powered plant, and 75 percent or more of the cost in a natural gas-powered plant. The national solid waste management association estimates that the average united state tipping fee for 2002 was \$33.70 per ton and 2190 Rs in Indian currency.

The best thing is that in this we do not need external fossil fuels to produce electricity we are just using our daily life activities waste as a source to produce electricity in this way we can save fossil fuels which are non renewable source of energy in form of electricity and finally protect our environment from harmful effects of waste materials.

VII. WASTE TO ENERGY PLANT MAKES STEAM AND ELECTRICITY

MSW is usually burned at special waste-to-energy plants that use the heat from the fire to make steam for generating electricity or to heat buildings. In 2015, 71 waste-to-energy power plants and four other power plants burned MSW in the United States. These plants burned about 29 million tons of MSW in 2015 and generated nearly 14 billion kilo watt hours of electricity. The biomass materials in the MSW that were burned in these power plants accounted for about 64% of the weight of the MSW and contributed about 51% of the energy. The remainder of the MSW was non biomass combustible material, mainly plastics. Many large landfills also generate electricity by using the methane gas that is produced from decomposing biomass in landfill

VIII. CONCLUSION

The rapid increase in volume and composition of MSW as a result of continuous economic growth, urbanization and industrialization is a problem for national and local governments, if they aim at ensuring an effective and sustainable

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management of waste. Solid waste incineration requires complex and sophisticated plants, whose running and installation costs are much higher than those of plants that work with traditional fuels. Moreover, energy recovery in fairly small-sized plants is affected by the high cost of the interventions. Considering the difficulties in waste collection due to geographic and demographic conditions, separated collection should be carried out only for complying with the regulations. The residual fraction should be sent to the incineration process for energy recovery, with positive environmental effects for the whole integrated solid waste management (ISWM) system. Moreover, in low waste production area where the establishment of a unique MSW collection policy is difficult, the residual fraction quality is variable. Such issue can be solved with an appropriate pre-treatment process which improves the characteristics of secondary fuel. The analysis of the obtained results in non-densely populated area demonstrates the potential of the co-generative incineration residual MSW for energy recovery after sieving, an effective and low cost pre-treatment process. Co-generative incineration is advantageous from an energetic point of view, especially considering the quality and the amount of the energy that can be obtained, (power, heat). All these factors, including low cost of secondary fuel which tends to increase its heating value, should be taken into account for a sustainable mid-term ISWM system planning in both developing and developed countries where the sustainable management of MSW cycle is penalized by the difficulties in source separated collection and the low flow of material recovery.

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