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Research Paper

Municipal Solid Waste Management through Incineration - A review

Environment

KEYWORDS : Landfilling, Incineration, Fuel gas.

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ABSTRACT

Presently in India, annual waste generation is about 960 million tonnes as by-products from municipal, agricultural, industrial & mining and other processes. Of this nearly 350 million tonnes from organic agricultural sources 290 million tonnes from inorganic waste of industrial and mining sectors and about 4.5 million tonnes are hazardous like hospital wastes in nature. The waste generation rate of our country is growing at fast rate. To safeguard the environment, efforts are being made for recycling different wastes and utilise them in value added applications. In this paper, among different waste management techniques importance and limitations of Incineration was discussed.

Introduction

Incineration is a waste treatment process that involves the combustion of organic substances contained in waste materials (Wikipedia 2013). Incinerators reduce the solid mass of the original waste by 80–85% and the volume (already compressed somewhat in garbage trucks) by 95-96%, depending on composition and degree of recovery of materials such as metals from the ash for recycling. It is a key process in the treatment of hazardous wastes and clinical wastes. It is mandatory in many countries that the medical waste be subjected to the high temperatures of incineration to destroy pathogens and toxic contamination it contains. Waste combustion is particularly popular in countries such as Japan where land is a limitted resource. Denmark and Sweden have been secured top in using the energy generated from incineration for more than a century, in localised combined heat and power facilities supporting heating schemes of that area (Klies et al., 2004). In 2005, waste incineration produced 4.8% of the electricity consumption and 13.7% of the total domestic heat consumption in Denmark. (Danish Energy Statistics 2005). A number of other European countries depend heavily upon incineration for safe handling municipal waste, particularly in Luxembourg, the Netherlands, Germany and France (Ramboll 2006).

Need For Waste Management (Incineration)

a. Urbanization in India: Urban population increased from 25 million in 1901 to 286 million (27%) in 2001 to 377 million in 2011 (31%), the projected increase in population is 590 million in 2030 with 68 cities having one million plus population. As per 2011 census: 7935 towns in the country, the number of towns has increased by 2774 since 2001 census (Regina, 2012). The growing population generating million tonnes of waste of which major portion can be recycled as well as used for power generation.. In India waste generation rate was rapidly increasing for each year (Ahok Pappu et al., 2004).

b. Landfill Disadvantages and Problems: A poorly designed or operated landfill shares many problems observed at uncontrolled dumping areas and often creates heavy pollution to surrounding areas. It is difficult to keep dangerous chemicals from leaching out into the surrounding land and into the water table or water bodies. Landfill can attract animals and insects to come such as flies, mosquitoes, raccoons, rats and cockroaches and it can cause sicknesses, illnesses, and diseases to humans and which may spread in communities. Landfill is problematic not only in communities but also has chances to cause global warming by releasing methane by anaerobic decomposition, a dangerous greenhouse gas has 20 times more dangerous greenhouse gas than carbon dioxide. Most important of all the Landfills are taking up lots of community land and that can also take away habitats for other animals.

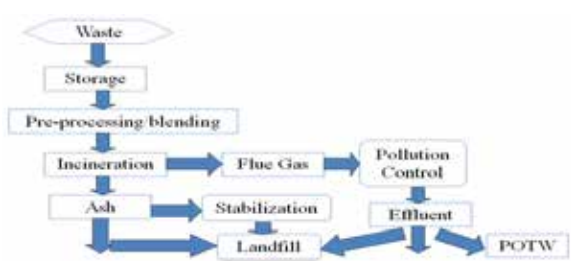
c. Waste characteristics: Per capita generation in Indian cities: 0.2 kg-0.6 kg/capita/day. Among these generated waste Compostable fraction: 29 – 65 %, Total recyclables: 9 -37 % and they are with Calorific value : 591 – 3766 kcal/kg (NEERI 2008)

Types of Incinerators

1. Rotary kiln
2. Liquid injection
3. Cement and lime kilns
4. Fluidized bed
5. Boiler systems
6. Oxygen enriched
7. Infrared
8. Fume
9. Multiple chamber
10. Multiple hearth
11. Cyclonic
12. Auger combustor
13. Two-stage (starved air)
14. Catalytic
15. Molten salt

System Components of incinerator

A. Refuse receipt/storage B. Refuse feeding
C. Grate system D. Air supply
E. Furnace F. Boiler



Typical Process Flow Diagram

Gaseous emissions: The major gaseous emissions through incineration process are

- Dioxin and furans
- CO_2
- Other emissions include nitrogen oxides (NOx), sulphur dioxide (SOx), hydrochloric acid, heavy metals (mercury), and fine particles (hydrocarbons and less SO2, HCl, CO and NOx).

Solid outputs

Incineration produces fly ash and bottom ash. The total amount of ash produced by municipal solid waste incineration ranges from 4 to 10% by volume and 15-20% by weight of this fly ash amounts to about 10-20% of the total ash.

Fly ash was observed with high concentrations of heavy metals like lead, cadmium, copper and zinc and also small amounts of dioxins and furans. The bottom ash seldom contains significant levels of heavy metals.

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The EPA (Environment Protection Agency) announced in 2012 that the safe limit for human oral consumption is 0.7 picograms Toxic Equivalence (TEQ) per kilogram bodyweight per day. Studies conducted by the US-EPA demonstrated that the emissions from just one family using a burn barrel produced more emissions than an incineration plant disposing of 200 metric tons (220 short tons) of waste per day by 1997 and five times that by 2007 due to increased chemicals in household trash and decreased emissions by municipal incinerators using better technology.

Flue-gas cleaning

Particulate is collected by particle filtration (electrostatic precipitators (ESP) and / or baghouse filters). Acid gas scrubbers are used to remove hydrochloric acid (HCl), nitric acid, hydrofluoric acid, mercury, lead and other heavy metals. Sulphur dioxide may also be removed by dry desulfurisation by injection limestone slurry into the flue gas before the particle filtration. NOx concentration can be reduced either by catalytic reduction with ammonia in a catalytic converter (selective catalytic reduction, SCR) or through a high temperature reaction with ammonia in the furnace (selective non-catalytic reduction, SNCR). Heavy metals are often adsorbed upon injected active carbon powder, which can be collected by the particle filtration.

Generally, the efficient breakdown of dioxin requires exposure of the molecular ring to higher temperature (1200o C) for sufficient time so as to initiate thermal breakdown of the strong molecular bonds holding it together. There is also a time element to the temperature exposure to ensure heating completely through the thickness of the fly ash and the volume of waste gases. There is alternate between increasing either the temperature or exposure time. Generally where the higher temperature operated for molecular breakdown, the time required for heating can be shorter, but very high temperatures can also cause wear and damage to other parts of the incineration equipment. Likewise the molecular breakdown temperature can be lowered to some degree but then the exhaust gases would require a greater exposure period to high temperature perhaps several minutes, which requires large or long heating chambers that take up a great portion in the treatment plant space.

Waste Incineration – Advantages: Volume and weight of waste is reduced by approximately 90% volume and 75% weight, Waste reduction is immediate, no long term residency required, Destruction in seconds where as land filling requires 100s of years, Incineration can be done at waste generation site so that it does not require transport for distances, Air discharges can be controlled, Ash residue is usually non-putrescible, sterile, inert, Small disposal area required and Cost can be offset by heat recovery/ sale of energy.

Waste to Energy – A solution for India's growing energy demand?

The annual electricity generation capacity has increased from 66 GW in 1991 to over 200 GW (1 gigawatt = 1000 megawatts) in 2012. (Theoretical) potential of generating energy from waste by 2030 is 1500 MW from MSW, 225 MW from sewage/ sludge and 1300 MW from industrial waste (MNRE). Provided potential of 1700 MW of energy from urban wastes, as estimated by MNRE (Ministry of New and Renewable Energy), is achieved and assuming 30% of efficiency factor for production of electricity which is equal to 0.42 % of current peak electricity consumption.

Waste Incineration – Disadvantages:

High capital cost, Skilled operators are required (particularly for boiler operations), Some materials are noncombustible, Some material require supplemental fuel, Public disapproval for incineration units because they think that Risk imposed rather than voluntary, Incineration will decrease property value (perceived not necessarily true) and distrust of government/industry ability to regulate.

Policies, Instruments & Stakeholders

Policies/ Instruments	Government Framework	Stakeholders
National Environment Policy, 2006	Municipal Solid Waste (Management & Handling) Rules 2000 Plastic Waste (Management & Handling) Rules 2011	MoEF
JNNURM, 2005	Reforms, Grants	MoUD
	MSW Manual	CPHEEO
	Planning rules	TCPO
National Action Plan on Climate Change, (NAPCC), 2008	Various Missions	GoI
	NMSH, 2010	MoUD
National Master Plan for Development of Waste to Energy in India	Subsidies/ grants- Program on Energy Recovery from MSW	MNRE
National Urban Sanitation Policy (NUSP), 2009	State Level Strategies incl. waste	States, MoUD
	City Sanitation Plans incl. waste	Cities

Mo EF- Ministry of Environment and Forest, Mo UD- Ministry of Urban Development, CPHEEO- Central Public Health and Environmental Engineering Organisation, TCPO - Town and Country Planning Organisation, GoI- Government of India, MNRE - *Ministry of New and Renewable Energy.*

MNRE supported Waste to Energy Plants in India:

DELHI	Timarpur-Okhla : M/s Jindal Ecopolis 1300 TPD of waste; RDF production – 450 TPD; power generation -16 MW Plant commissioned since January 2012.
DELHI	Ghazipur 200 TPD of waste; RDF production – 433 TPD; power generation -12 MW Plant under construction.
BANGALORE	M/s Srinivas Gayithri Resources Recovery Ltd power generation - 8 MW Plant under construction.
PUNE	700 TPD of waste; power generation -10 MW gasification plant Plant under construction.
HYDERABAD	1000 TPD of waste; power generation -11 MW gasification plant Plant under construction.

TPD: Tons per day, RDF: Refuse Derived Fuel.

Conclusions: The continuous growth of population creating high demand for natural resources like land, water and air. The waste generated by people polluting natural environment so we need to continue our efforts to minimize waste production, not all waste produced can be recycled but we should not waste our waste - it is too valuable. Landfilling is neither environmentally responsible nor is it economical – All we do is leave future generations a legacy of irresponsibility.

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