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WASTE TO ENERGY BY INCINERATION

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Abstract**—** Incineration is the main waste-to-energy form of treatment. It is a treatment technology involving destruction of solid waste by controlled burning at high temperatures. It is accompanied by the release of heat. This heat from combustion can be converted into energy. Incineration is a high-quality treatment for Municipal Solid Waste (MSW), very useful in big or crowded cities, because it reduces the quantity and volume of waste to be land filled. It can be localised in an urbanised zone, and offers the opportunity of recovering energy. However, it should be taken into account that the economic investment needed is high.

The environmental conditions of the incineration process must be very precise to make it environmentally safe. The larger portion of the investment required is due to environmental measures such as emissions control. When choosing incineration as an alternative, the following issues should be considered: volume/quantity of waste produced, heat of combustion of waste, site location, dimensions of the facility, operation and maintenance costs and investment.

I. INTRODUCTION

In most of the countries both energy systems and waste management systems are under change. The changes are largely driven by environmental considerations and one driving force is the threat of global climate change. When making new strategic decisions related to energy system and waste management systems it is therefore of importance to consider the environmental implications.

Municipal Solid Waste (MSW) contains organic as well as inorganic matter. Part of organic matter is more as compared to inorganic matter. The latent energy present in its organic fraction is recovered for gainful utilisation through adoption of suitable Waste Processing and Treatment technologies. The recovery of energy from solid wastes also offers a few additional benefits which are as follows:

(i) The total quantity of solid waste gets reduced up to 90%, depending upon the waste composition and the adopted technology;

(ii) Demand for land, which is already scarce in cities, for land filling is reduced;

(iii) The cost of transportation of waste to far-away landfill sites also gets reduced; and

(iv) Reduction in environmental pollution.

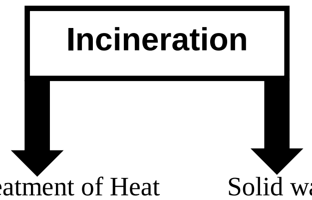
It is, therefore, only logical that, while every effort should be made in the first place to minimise generation of waste materials and to recycle and reuse them to the extent feasible, the option of Energy Recovery from Wastes be also duly examined. Wherever feasible, this option should be incorporated in the over-all scheme of Waste Management.

A waste hierarchy is used in waste policy making and is often suggested. Different versions of the hierarchy exist but in most of the cases the following order suggests:

1. Reduce the quantity of waste
2. Reuse
3. Recycle the materials
4. Incinerate with heat recovery
5. Landfill of inert ash

The first priority, to reduce the quantity or volume of waste, which is generally accepted. However, the remaining waste needs to be taken care of as efficiently as possible. The hierarchy after the top priority is often contested and discussions on waste policy are in many countries intense.

Especially the order between recycling and incineration is often discussed.



Functions: Treatment of Heat Solid waste

Desirable range of important waste parameters for technical viability of energy recovery:

		Important Waste Parameters	**Desirable Range**
Waste Treatment Method: Incineration	**Basic principle:** Decomposition of organic matter by action of heat.	Moisture content	< 45 %
		Organic/ Volatile matter	> 40 %
		Fixed Carbon	< 15 %
		Total Inerts	< 35 %
		Calorific Value (Net Calorific Value)	>1200 k-cal/kg

II. INCINERATION

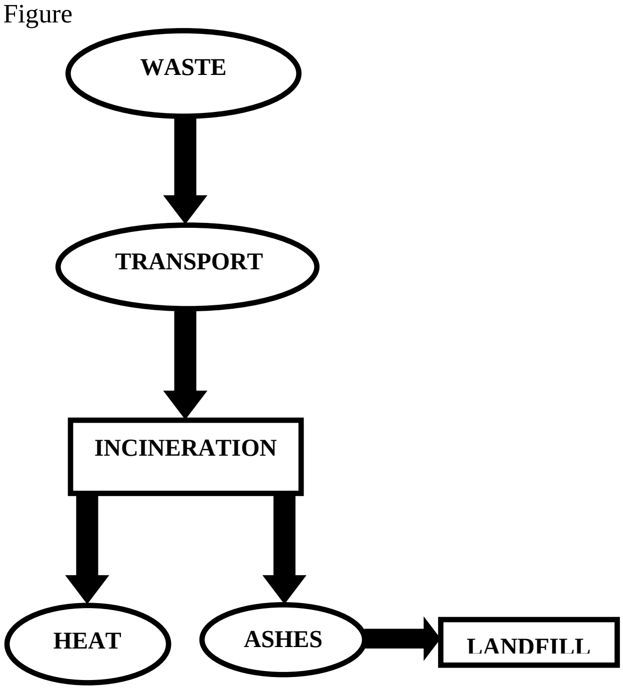
Incineration is the process of direct controlled burning of waste in the presence of oxygen at temperatures of about 800^0C and above, liberating heat energy, gases and inert ash. Net energy yield depends upon the density and composition of the waste. Relative percentage of moisture and inert materials, which add to the heat loss; ignition temperature; size and shape of the constituents; design of the combustion system, etc. In practice, about 65 to 80% of the energy content of the organic matter can be recovered as heat energy, which can be utilised either for direct thermal applications, or for producing power with the help of steam turbine-generators.

The combustion temperature of conventional incinerators fuelled only by wastes are about 760^0C in the furnace and in excess of 870^0C in the secondary combustion chamber. These temperature are needed to avoid odour due to incomplete combustion but are insufficient to burn or even melt some of the inorganic contents such as glass. To avoid the deficiencies of conventional incinerators, some modern incinerators utilise higher temperature of up to 1650^0C using auxiliary fuel. These reduce waste volume by nearly 97% and convert some inorganic contents such as metal and glass to inert ash.

Wastes burned solely for volume reduction may not need any supplementary fuel except for start-up. When the objective is steam production, auxiliary fuel may have to be used with the pulverized refuse, because of the variable energy content of the waste or in the event that the quantity of waste available is insufficient.

While Incineration is extensively used as an important method of waste disposal, it is associated with some polluting discharges which are of environmental concern, although in varying degrees of severity. These can fortunately be effectively controlled by installing suitable pollution control devices and by suitable furnace construction and control of the combustion process.

A flow chart of the incineration system is shown in Figure



III. INCINERATION TECHNOLOGY

The basic operational steps of a waste incineration plant may include the following:

- Reception of incoming waste
- Storage of waste and raw materials
- Pre-treatment of waste
- Loading of waste into the process
- Thermal treatment of the waste
- Energy recovery and conversion
- Flue-gas cleaning
- Flue-gas cleaning residue management
- Flue-gas discharge
- Emissions monitoring and control
- Waste water control and treatment (e.g. from site drainage, flue-gas treatment, storage)
- Ash/bottom ash management and treatment (arising from the combustion stage)
- Solid residue discharge/disposal.

There are many options for MSW incineration plant technology. The range of equipment varies from experimental to well-proven, though only the well-proven are recommended. Development problems with new technology are complicated and costly to solve, as developing countries lack the internal technical expertise to overcome them. Such problems could cause the entire project to fail. Based on the intended application, incineration plant equipment may be grouped in four main categories:

A. Pre-treatment
B. Combustion system
C. Energy recovery
D. Flue gas cleaning

IV. INCINERATION RESIDUES

The main residue from MSW incineration is slag. The amount generated depends on the ash content of the waste. In the combustion process, the volume of waste from high income cities will by experience be reduced by approximately 90% and the weight by 70 to 75%. For low income areas the amount of ash in the waste can be high—for example, in areas using coal, wood, or similar for heating.

In addition to the slag, the plant generates residues from more or less advanced dry, semidry or wet flue gas cleaning processes. The amount and its environmental characteristics will depend on the technology applied.

The slag from a well-operated waste incinerator will be well burnt out, with only a minor content of organic material. Besides, the heavy metals in the slag, which are normally leachable, will to some extent become vitrified and thus insoluble. Much of the slag may therefore be used as road construction material or something similar after sorting.

The other residues must, however, be disposed of. Therefore, a well-designed and well-operated landfill, preferably located in abandoned mine shafts or other places where leaching with rainwater can be prevented must be available.

Proper disposal of fly ash and other flue gas cleaning residues is the subject for another study. However, in general, it should be treated as hazardous waste and disposed of according to leachate properties.

The fine particle size of the residues calls for special precautions during handling at the plant and the landfill.

V. USE OR DISPOSAL OF ASH

Modern waste incineration plants differ in technical solutions, but it may be assumed that emissions are kept within the limits of legal restrictions, regardless of the composition of the incinerated waste. This suggests that, despite a site-specific approach, the model is rather general regarding emissions to air and water, for plants working under the same legal restrictions. Residual products, consumption of additives and energy recovery are more site specific.

Companies and researchers have been investigating ways of treating ash residues from WTE facilities. Ash consists of residues left in the combustion chamber (bottom ash) and in their pollution treatment devices (fly ash). The post-treatment of ash produced by the low temperature combustion chambers such as fluidized beds usually involves vitrification at high temperatures in order to immobilize the metals. The main aim of ash treatment is to prevent the toxic constituents of the ash, especially dioxins, furans and heavy metals, from escaping into the environment after disposal. Solidification by means of vitrification or the application of various chemicals is further means of decreasing the chances of leaching metals. Phosphate has been shown to stabilize heavy metals in dusts that result from the vitrification of incinerator ash. Treatment of ash is a much more mature technology than re-use.

The bottom ash produced in the plant resembles clinker ash and, after mechanical separation of ferrous and non-ferrous metals, has a relatively high specific gravity (typically 2.25) and as per reports contains less than 2% carbon and less than 1% fines. The toxicity characteristics leaching test based on the EPA standard has shown that the metals in bottom ash are not leachable.

VI. ENERGY RECOVERY

Energy recovered from waste can be used in the following ways:

A. Generation of Power (electricity),
B. Generation of Heat,
C. Generation of Heat and Power (CHP).

The energy generation option selected for an incineration facility will depend on the potential for end users to utilise the heat and/or power available. In most instances power can be easily distributed and sold via the national grid and this is by far the most common form of energy recovery.

For heat, the consumer needs to be local to the facility producing the heat and a dedicated distribution system (network) is required. Unless all of the available heat can be used the generating facility will not always be operating at its optimum efficiency.

The use of CHP combines the generation of heat and power (electricity). This helps to increase the overall energy efficiency for a facility compared to generating power only. In addition, as power and heat demand varies a CHP plant can be designed to meet this variation and hence maintain optimum levels of efficiency.

Incineration processes are designed to recover energy from the waste processed by generating electricity and/or heat for use on site and export off site. Electricity generated from the biodegradable fraction of waste in an Incinerator with good quality heat and power can benefit from support under the Renewables Obligation and Renewable Heat Incentive scheme.

VII. INCINERATION ADVANTAGES

Incineration is an efficient way to reduce the waste volume and demand for landfill space. Incineration plants can be located close to the centre of gravity of waste generation, thus reducing the cost of waste transportation. Using the ash from MSW incinerators for environmentally appropriate construction not only provides a low cost aggregate but further reduces the need for landfill capacity. In particular, incineration of waste containing heavy metals and so on should be avoided to maintain a suitable slag quality. The slag quality should be verified before it is used. Energy can be recovered for heat or power consumption.

All waste disposal alternatives eventually decompose organic materials into simpler carbon molecules such as CO_2 (carbon dioxide) and CH_4 (methane). The balance between these two gases and time frame for the reactions varies by alternative. Incineration provides the best way to eliminate methane gas emissions from waste management processes. Furthermore, energy from waste projects provides a substitute for fossil fuel combustion. These are two ways incineration helps reduce greenhouse gas emissions.

One of the most attractive features of the incineration process is that it can be used to reduce the original volume of combustibles by 80 to 95%. Air pollution control remains a major problem in the implementation of incineration of solid waste disposal. In the United States, the cost of best available technology for the incineration facility may be as high as 35% of the project cost. The cost of control equipment will, however, depend upon the air pollution regulations existing in a given lesser developing country.

VIII. INCINERATION DISADVANTAGES

An incineration plant involves heavy investments and high operating costs and requires both local and foreign currency throughout its operation. The resulting increase in waste treatment costs will motivate the waste generators to seek alternatives. Furthermore, waste incineration is only applicable if certain requirements are met. The composition of waste in developing countries is often questionable in terms of its suitability for auto combustion. The complexity of an incineration plant requires skilled staff. Plus, the residues from the flue gas cleaning can contaminate the environment if not handled appropriately, and must be disposed of in controlled and well-operated landfills to prevent ground and surface water pollution.

CONCLUSION:

All sorts of waste materials are generated in the Indian cities as in other countries. However, in the absence of a well-planned, scientific system of waste management (including waste segregation at source) and of any effective regulation and control of rag-picking, waste burning and waste recycling activity, the left-over waste at the dumping yards generally contains high percentage of inert (>40%) and of putrescible organic matter (30-60%). It is common practice of adding the road sweepings to the dust bins. Papers and plastics are mostly picked up and only such fraction which is in an unrecoverable form remains in the refuse. Paper normally constitutes 3-7% of refuse while the plastic, content is normally less than 1%. The calorific value on dry weight basis (High Calorific Value) varies between 800-1100 k-cal/kg. Self-sustaining combustion cannot be obtained for such waste and auxiliary fuel will be required. Incineration, therefore, has not been preferred in India so far.

The only incineration plant installed in the India at Timarpur, Delhi way back in the year 1990 has been lying inoperative due to mismatch between the available waste quality and plant design.

However, with the growing problems of waste management in the urban areas and the increasing awareness about the ill effects of the existing waste management practices on the public heath, the urgent need for improving the overall waste management system and adoption of advanced, scientific methods of waste disposal, including incineration is imperative.

REFERENCES:

1) A. Sz. Váradi, L. Strand, and J. Takács, 'Clean Electrical Power Generation from Municipal Solid Waste', IEEE trans. Energy Conversion2009, pp 293-300.

2) A. Sz. Váradi and J. Takács, "Electricity Generation from Solid Waste by Pilot Projects" International Symposium on Power Electronics, Electrical Drives, Automation and Motion, 2008, pp 826-831

3) BerntJohnke, 'Emissions From Waste Incineration',Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, 2009, pp 455-468

4) C. Palanichamy, 'MSW fuelled Power generation for India', IEEE Trans on Energy Conversion, Vol 17, Dec 2002, pp 556-563.

5) Eric Solano, 'Life cycle basedSolid waste Management, vol 1 & 2', Journal of Environmental Engg, 2002, 128, pp 993-1005

6) Marc J. Rogoff and Francois Screve, 'Waste-to-Energy Technologies and Project Implementation', Second Edition, William Andrew, 2011.

7) S.B.Karajgi, Udaykumar.R.Y, G.D.Kamalapur, 'Power Generation using Municipal Solid Waste in India', (IJECE) Vol.2, No.2, April 2012, pp. 197~202 ISSN: 2088-8708

8) Waste-to-Energy Research and Technology Council (WTERT); http://www.wtert.org

