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SUSTAINABLE ENVIRONMENTAL SANITATION AND WATER SERVICES

Fluidized Bed Incineration of Hospital Waste

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Introduction

The proper disposal wastes, which contain hazardous and infectious materials, is a major concern today. Land filling of these wastes along with the municipal solid wastes is no longer environmentally acceptable. The unhygienic disposal of medical waste not only poses aesthetic problems, but also is responsible for a number of hazards like transmission of infections, increased morbidity and ill health in the community. The general objectives of medical waste treatment could be considered as disinfection, bulk volume reduction and to ensure that dangerous recyclables are not reused.

It is a must to have an integral approach for properly managing the wastes from hospitals. The Biomedical Waste (Management and Handling) Rules, 1998 specifies the different categories and treatment options for the different streams of wastes. The treatment of infectious wastes is a matter of concern is most cities of India. As per the rules, this kind of waste is to be incinerated and ash landfilled or buried deeply.

This paper describes the use of incinerators for the treatment of hospital wastes and the problems faced at present. It describes how the existing units fail to comply with the emission standards and give suggestions for improving the performance. Use of fluidized bed incinerators is described briefly.

Characteristics of Hospital Wastes

The extremely important aspect of managing the medical waste stream is its categorisation and segregation. Medical wastes include different types of wastes; viz. infectious, hazardous, radioactive and other general wastes, the infectious portion is only about 10 - 20% and the remaining is non infectious.

Hospital waste usually contain about 20 percent plastics. The plastics can be a major generator of toxic air emissions, while their high heat value has major significance in the control and operation of the incinerators.

Various studies in India have shown a waste generation rate ranging from 1.2 to 7.5 kg/bed/day for hopsital wards[2,3]. Delhi generate around 45 tons/day of biomedical wastes. The average compositions of wastes obtained from ten large hospitals in Bombay, Delhi, Calcutta and Nagpur during the period 1993-1996 shows that it contain Paper 15%, Plastics 10%, Rags 10%, Metals (sharps & others) 1% Infectious waste 1.5%, Glass 4% and General waste (Food waste, sweeping from hospital) 53.5%.

Treatment Methods for Hospital Wastes

Different categories wastes should be dealt separately and treated/disposed off separately. While the canteen waste goes for composting/vermi-composting or to a municipal sanitary landfill, the sharpnels (needles, blades, etc.) are disinfected/autoclaved, mutilated and may be sold for recycling. The plastics may be disinfected/ autoclaved, mutilated and solid. The infectious part of the waste goes for incineration (in yellow bags). The incineration of this part of the hospital waste is dealt in detail in this paper.

Hospital Waste Incineration

Incineration is the process by which materials are burned in a controlled environment, producing combustion gases and non-combustible residue as ash. Incineration reduces the mass and volume of the waste by about 70% and 90% respectively. Delhi has at least 59 documented hospital waste incinerators. Most of these incinerators are the batch-fed, double-chambered, fixed hearth type[5].

The Biomedical Waste (Management and Handling) Rules, 1998 specifies combustion efficiency and emission standards for Particulate Matters, NOx and HCl, the temperatures of the various combustion chambers. In spite of not having any standards on the emission of Hg, Cd, Cr, Dioxin and Furans, SO_2, etc for biomedical waste incinerators, their working is not satisfactory[4].

There are reports that about 60% of the incinerators in Delhi are working in the temperature range of 200 to 600°C (the temperature range that is most conducive for the formation of dioxins and furans) and only 20% are maintaining their temperatures as per the rules.

Monitoring of Hospital Waste Incinerators:

Results of the monitoring carried out by the regulatory bodies like Delhi Pollution Control Committee (DPCC) and Central Pollution Control Board (CPCB) were compared and a couple of hospital waste incinerators were monitored for their combustion efficiency and stack emissions. In general:

- Combustion efficiency is usually < 99%
- HCI Emission: 49 to 196 mg/Nm^3
- NOx Emission: usually within the limits (because the combustion temperature hardly goes above 1200°C)
- Particulate Emission: 132 to 8600 mg/Nm^3

Some of the reasons for the poor performance of these incinerators are: improper operation of the unit, ignorance of the operators, lack of segregation, high fuel and maintenance cost involved, batch operation of the incinerators (this reduces the temperature of the furnace), lack of mixing and low combustion efficiency.

It is a must to find out the appropriate ways of operating the existing hospital waste incinerators (batch-fed, double-chambered, fixed hearth type) so that they comply with the emission standards. Suggestions in this regard are:

- ◆ Practice proper segregation (no chlorinated plastics should find their way to an incinerator)
- ◆ Avoid excess capacity and operate on a continuous mode as far as possible
- ◆ Use of the proper air pollution control equipments
- ◆ Operate the primary chamber in the starved air mode while the secondary chamber in the excess air mode.
- ◆ Use of centralised large capacity units instead of the many small units

Fluidised bed incineration istead of the existing batch-fed, double-chambered, fixed hearth incineration, may be an alternate technology for dealing with the yellow bags (the infectious biomedical waste).

Controlled Air Incineration

The existing double chambered fixed hearth type incinerators may be operated in the starved air mode in the primary chamber and in the excess air mode in the secondary chamber to attain high combustion efficiency and low particulate emissions. However, it cannot lower the HCI emissions.

In the primary chamber of the incinerator, waste is dried, heated and burned at about 40-60% of the stoichiometric oxygen requirement. combustion gas produced in the primary chamber is mixed with excess air and burned completely in the secondary chamber. Excess air is introduced into the secondary chamber at between 100 and 150% of the stoichiometric requirement. A supplementary fuel burner is used to maintain elevated gas temperature for complete combustion[4].

Fluidized Bed Incineration

There are some basic limitations on the fixed hearth technology. This type of incinerator, in general, cannot give high combustion efficiency. They always lack proper mixing. So the waste combustion is not always complete. Perhaps, adoption of fluidized bed technology can solve this problem to a great extent. Fluidization is a phenomenon in which fine solid particles are suspended by the upward flow of a gas or liquid through the mass of solids.

Fluidized bed incineration systems can burn any kind of waste and have been proved to be highly efficient and environment friendly than the other incineration systems. Fluidized bed reactors operate at relatively lower temperatures than the other types. Complete combustion of the gases is ensured in the integrated combustion chamber with sufficient excess oxygen. The chamber is sized to ensure at least 2 seconds flue gas residence time at 850 °C or the temperature required by local legislation.

Fluidized bed incinerators are primarily used for liquids, sludges or shredded solid wastes including soil. In its simplest form, fluidized bed incinerator consists of a vertical steel cylinder, usually refractory lined, with a sand bed on a supporting grid plate and air injection nozzles. When air is forced up through the bed, the bed fluidizes and expands up to twice its resting volume. The boiling action of fluidized bed promotes turbulence and mixing. Fluidized bed incinerators offer high gas-to-solids ratios, high heat transfer efficiencies, and high turbulences in both gas and solid phases, uniform temperature throughout the bed and has the potential for in-situ acid gas neutralization by the addition of limestone or carbonate.

The fluidized bed reactor can be bubbling type or circulating type commonly known as CFB (Circulating Fluidized Bed) or the recirculating type known as RCFB (Recirculating Fluidized Bed). The conventional bubbling fluidized bed is characterized by low fluidizing gas velocities that maintain a well-defined bed with higher solids density. The fluidized velocity (typically 1-2 m/s) is matched to the particle size to maintain adequate fluidization. But in the circulating systems, the air velocity is high (5 to 13 m/s typically) and hence the pressure drop across the bed is also high. The CFB (or RCFB) combustion system can destroy hazardous wastes, including PCBs, with a destruction and removal efficiency exceeding 99.9999%[6]. But for the incineration of Hospital/Biomedical wastes, perhaps, the conventional bubbling type fluidised bed may be the right choice.

Conclusions

The possibility of energy recovery and the scarcity of landfill sites contribute to the extensive use of the incineration techniques. However, incineration of wastes gives rise to a number of complaints, especially atmospheric emmissions. To control the toxic emissions, the incinerator should be properly designed and operated; and appropriate air pollution control equipment should be installed.

In India, the incineration technology is not at all popular for the treatment of municipal solid waste at present. However, it is recognised as one of the technologies for dealing with the Biomedical and Hazardous wastes. Many of the existing biomedical/ hospital waste incinerators are not operated properly and are thus infamous. The performance of the incinerators is based on the type of incineration technique that is chosen to burn the waste and how the unit is operated. Fluidized bed incinerators can be a good option due to their different advantages over the conventional incinerators.

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