Incineration Technology and Emissions

Introduction

Incineration is controlled burning at temperatures typically over 850°C in the presence of air to ensure the destruction of pathogens (e.g. fungi, bacteria and viruses) and hazardous pollutants (e.g. volatile organics). It is an effective technology widely used in waste treatment which can reduce the volume of municipal solid waste (MSW) by some 90% and hence extend the life of landfills. In some cases, heat generated from waste incineration is recovered and used as an energy source.

Advanced Emission Control in Modern Incinerators

2. Incineration requires proper process control and pollution abatement and gas cleaning systems in order to avoid the emission of pollutants such as acid gases, oxides of nitrogen, dioxins, heavy metals and mercury.

3. Modern incinerators adopt advanced process control measures to optimise the combustion process. Such measures include long residence time and high turbulence to ensure complete combustion of MSW to destroy all organic pollutants and prevent the production of new pollutants. Modern incinerators are also installed with advanced gas cleaning and pollution abatement equipment (e.g. fabric filters, scrubbers and activated carbon powder injection system) which can effectively control the release of pollutants and meet the most stringent emission standards adopted internationally.

4. The major pollution abatement measures are described below -

a. **Acid gases** – acid gases are formed from sulphides and chlorides within the raw waste stream. Acid gases pose no direct health risk but are respiratory irritants that should be controlled. The air emission control system includes an acid gas control system where a lime-solution is used to neutralize the acid gases.

b. **Oxides of nitrogen** – oxides of nitrogen (NO_X) are formed by all combustion processes. While they do not pose a direct health risk, they are respiratory irritants which should be controlled. A computer-based system optimises combustion temperatures to minimise NO_X generation, and a selective catalytic reduction system converts most of the NO_X into elemental nitrogen.

c. **Dioxins** – dioxins are generated by all combustion sources, both man-made and natural. They are highly toxic and must be properly controlled to minimise the emissions. The flue gas resulting from the combustion process is raised to a temperature of 850 ^{o}C for at least 2 seconds in the combustion chamber so that the dioxins generated from the incineration of MSW will be completed destroyed.

However, dioxins may reform in the energy recovery system in trace quantity when the temperature drops to the range of 400 ^{o}C to 200 ^{o}C. To minimize this dioxin reformation, the flue gas is cooled down quickly to below 200 ^{o}C. Boiler tubes are also cleaned regularly to prevent the build up of fly ash which can serve as a catalyst for dioxin reformation.

Dioxins, if reformed in the energy recovery system, are adsorbed onto a powdered activated carbon (PAC) injection system which operates in parallel with the alarm warning system to capture any dioxins reformed. The used PAC is then combined with the fly ash for stabilisation before disposal at landfill.

d. **Heavy metals** – the raw waste stream contains heavy metals in small amount. The high combustion temperature tends to volatilise the more volatile heavy metals within the combustion chamber. The heavy metals are then cooled within the heat recovery system, and are condensed onto the fly ash particles and removed with the fly ash.

e. **Mercury** – mercury exists in the waste stream in small amount and is volatilized inside the combustion chamber. While other volatilized heavy metals condense onto the fly ash particles, mercury stays in the gaseous state. Mercury is absorbed by the PAC, and the used PAC is collected with the fly ash for stabilisation before disposal at the landfill.

f. **Odours** – odours, usually generated in waste handling areas, are controlled by drawing air from the raw waste handling areas into the combustion chamber so that the odorous gases are destroyed during combustion. A back-up odour control system such as chemisorption filter or scrubber can also be installed to provide additional safeguard to remove odorous gases.

g. **Fly ash -** The inert fraction of the mixed waste is unchanged by the incineration process. Over 95% of it is quite heavy and exits the combustion chamber at the bottom, and hence is known as bottom ash. The remaining lighter dust-like inert materials exit the combustion chamber and enter the heat recovery system with the exhaust gases as fly ash.

All exhaust gases enter the air emission control section where a filter removes well over 99% of the fly ash. The fly ash is stabilised by the addition of cement to physically trap the heavy metals. The resulting concrete-like mixture can then be safely disposed of at the landfill.

Stringent Emission Standard

5. The emission standards to be adopted for the Integrated Waste Management Facilities (IWMF) will be one of the most stringent standards among those technologically advanced countries. Real-time data measured by the continuous emission monitoring system can be made available to the public to demonstrate that the incinerator operates in compliance with the emission standards.

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