CONTROL OF FORMATION AND EMISSION OF DIOXINS AND FURANS FROM MSW INCINERATORS

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There are two approaches by which the introduction of polychlorinated dibenzo-p-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF) into the atmosphere and into the earth from incinerators can be controlled: (1) Removal of PCDD/PCDF from stack emissions of MSW incinerators prior to their emission into the atmosphere and destruction or removal of PCDD/PCDF from fly ash collected at electrostatic precipitators. (2) Prevention of formation of PCDD/PCDF at the post-combustion zone using various inhibitors. The first approach involves two separate technologies, one for stack emissions and the other for fly ash. The second approach is easy to implement, and involves the addition of inhibitors in the post-combustion zone. Inhibitors introduced in the post-combustion zone deactivate the catalytically-active sites on the fly ash, reducing the formation of PCDD/PCDF both in the stack emissions and in the fly ash.

To date, we have tested more than a dozen different inhibitors. Hundreds of laboratory experiments to test the effectiveness of these inhibitors have been performed. The inhibitors which proved to be effective in the laboratory tests were used in operational MSW incinerator tests. Several plant tests were conducted in the U.S.A. and in Germany. Effectiveness of the inhibitors in plant tests has been determined by analyzing the fly ash samples and the stack emissions prior to and during the introduction of inhibitors. The addition of 0.2% by weight of inhibitor to municipal refuse results in more than 80% reduction of PCDD/PCDF in fly ash and 70% in the stack emissions. Use of inhibitors also reduces acid gases in the stacks, resulting in the reduction of HCl up to 78% and SO_2 up to 80%. Fly ash samples collected prior to and during the introduction of inhibitors were analyzed by GC-ECD, which shows reduction in all chlorinated compounds in fly ash collected during the introduction of inhibitors. GC-FID analyses of these samples show no significant differences.

The formation of PCDD and PCDF in municipal solid waste (MSW) incinerators is a universal phenomenon. However, the amount of PCDD/PCDF detected in the MSW incinerator stack emissions and in the fly ash samples varies considerably from incinerator to incinerator. Studies from the late seventies have focused on sources, analytical *methodologies and toxicities of PCDD/PCDF*. From the mid-eighties, efforts have been made to find the mechanism of formation of PCDD/PCDF in MSW incinerators. Initial studies showed that MSW incinerator operational parameters play an important role. Incinerators operated at high combustion efficiencies have resulted in decreased PCDD/PCDF formation. The production of PCDD/PCDF in MSW incinerators also depends on the composition of waste feed. Incinerator facilities where municipal refuse is separated into combustible and non-combustible materials (the general practice in Japan), and only the combustible materials are incinerated, produce very low quantities of PCDD/PCDF. However, incinerators where municipal refuse has not been separated (the general practice in North America) produce higher quantities of PCDD/PCDF.

It has been confirmed by several studies that the formation of PCDD/PCDF occurs in the post-combustion zone of the incinerator at much lower temperatures than the temperature in the furnace. The mechanism of formation of PCDD/PCDF by the catalytic activity of fly ash and precursors or by *de-novo* synthesis is still not completely understood. However, for both mechanisms, the formation of PCDD/PCDF occurs between 200° and 400°C. Independent kinetic studies support the formation of PCDD/PCDF in MSW incinerators by catalytic reactions of fly ash and precursors.