HOW COMBUSTION CONTROLS AND SCRUBBER TEMPERATURES

INFLUENCE EMISSIONS OF DIOXINS AND FURANS

AND THE LEACHING PROPERTIES OF ASH

FROM COMBUSTION OF MUNICIPAL SOLID WASTE

by

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SUMMARY

Optimum combustion conditions result in minimum emissions of precursors which can form trace organics such as dioxins (PCDD) and furans (PCDF).

The use of acid gas scrubbers which reduce flue gas temperatures to temperatures below 300°F, and preferably down to 250°F or less has been found to obtain high efficiencies (95% or higher) in the removal of the acids HCl, SO₂, HF, heavy metals, and organic and mercury vapors. Temperatures around 250°F make it possible to use the minimum amount of alkaline reagent in capturing the acid gases. This is important, since the use of excessive lime results in a surplus in the flyash which can produce a high pH which causes the lead and cadmium in the flyash to become highly soluble.

Extensive parametric testing of a refractory-lined excess-air municipal solid waste combustor with flue-gas recirculation, in Pittsfield, Massachusetts has provided detailed evidence of the effect of furnace temperatures and excess oxygen of emissions of carbon monoxide (CO) and trace organics such as dioxins (PCDD) and furans (PCDF).

- Various wastes were burned to determine the effect of municipal waste (MSW), MSW with added PVC, commercial waste, commercial waste with added PVC, and high moisture waste.

- Secondary furnace temperature was found to have a logarithmic relationship to CO at temperatures less than 1700°F, but an increase in CO emissions was found from 1700°F to 1900°F, probably due to reduction in oxygen concentration needed to achieve these temperatures.

- Approximately the same relationship was found between furnace temperature and PCDD and PCDF emissions as was seen with CO, indicating a close relationship between CO and emissions of trace
organics such as PCDD and PCDF.

- The supply of oxygen influences the temperatures which can be achieved in the furnace. Too much or too little oxygen cause increased emissions of CO and organics. Oxygen control of combustion has been found to be the best way to maintain optimum combustion conditions, associated with minimum CO and organic emissions.

- Intense mixing of secondary air with the partially burned products of combustion is needed to complete combustion.

Optimization of combustion controls by the use of CO monitors to assure good mixing and oxygen control to maintain the best conditions results in minimum organic emissions, and makes possible the reduction of PCDD plus PCDF to 20 to 50 ng/Nm³. The Toxic Equivalent of this is within the Swedish guideline of 0.5 to 2 ng/Nm³.

The use of acid gas scrubbers and baghouses makes it possible to bring stack emissions of PCDD+PCDF down to 1 ng/Nm³ or less. At this level the Toxic Equivalent of 2378 TCDD by the Eadon method is less than 0.10 ng/Nm³, which is the Swedish goal.

Avoiding excessive lime addition in acid gas controls the flyash and bottom ash reduces the risk of failing the fast leaching Extraction Procedure toxicity test which adds acid to the leaching fluid. Water leaching tests which allow the natural alkalinity in the ash to prevail result in pH ranges which do not result in leaching of lead and cadmium in significant amounts.

Figure 1 Variation of carbon monoxide with secondary furnace temperature, showing linear relationship between the logarithm of CO with temperatures up to 1700°F, and a sharp increase at higher temperatures.

Figure 2 Variation of PCDD+PCDF with secondary furnace temperature, showing linear but erratic relationship between ln PCDD+PCDF with temperature up to 1700°F, and a sharper increase at higher temperatures than CO.

Figure 3 Variation of PCDD+PCDF with excess oxygen showing optimum at 9%, increasing with either more or less oxygen. Points marked "PVC added" show strong increase with reduced oxygen.

Figure 4 Variation of PCDD+PCDF with CO, showing Pittsfield data as well as data from waterwall plants having scrubbers. The minimum PCDD+PCDF occured at about 16 ppmv of CO. Tulsa emissions with ESP are higher than Marion with scrubber/baghouse. Quebec with high emissions has scrubber outlet in same range as Marion.

Figure 5 Removal efficiency of sulfur dioxide as a function of scrubbing temperature and stoichiometric ratio of lime. At 125°C the same efficiency was achieved with less lime.
FIGURE 3
PITTSFIELD DIOXIN TESTS
TOTAL PCDD+PCDF VERSUS OXYGEN

FIGURE 4
PITTSFIELD DIOXIN TESTS
PCDD+PCDF VERSUS CARBON MONOXIDE

Quebec (22°F)
FIGURE 5

SULPHUR DIOXIDE REMOVAL VERSUS TEMPERATURE AT DIFFERENT STOICHIOMETRIC RATIOS [NITEP]
Floyd Hasselriis, is Senior Mechanical Engineer at Gershman, Brickner and Bratton, Inc., consultants in management of municipal wastes.

He received a BS in ME from Columbia University in 1943 and a Masters in Mechanical Engineering from the University of Delaware in 1950. A licensed Professional Engineer in New York, Massachusetts, New Hampshire and Florida, he is also a Diplomate of the American Academy of Environmental Engineers.

He has been an active Member of the ASME Research Committee on Industrial and Municipal Wastes, of which he is Research Needs Chairman, and Co-chairman of the recently formed Ash Residues Subcommittee.

With 45 years experience in combustion, he has directed his attention in the last 15 years to the combustion of wastes, and emissions from combustion, especially dioxins. Six years ago he supervised research on ash residues, the findings of which are very important today.