Reduction of Dioxin Emissions by the Continuous Operation of Intermittent Incinerators

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Abstract

Because many municipal solid waste (MSW) incineration plants in Japan are operated on a repetitive schedule of daily startup and shutdown, there is a vital need to reduce the amount of dioxins emitted during such intermittent operation. Here, to investigate the dioxin emission reducing effect of continuous operation, we continually operated a facility normally operated in an intermittent manner (8 h/d) and compared flue gas measurements taken during both operating modes. As a result, we found that dioxin emissions in the flue gas per ton of waste dropped from 322 μg/t under intermittent operation to 29 μg/t under continuous operation, thereby confirming that emissions can be reduced by 9/10ths by switching to continuous operation.

Introduction

There are approximately 1,900 MSW incineration plants in Japan, and about 3/4ths of them operate intermittently with daily startups and shutdowns.[1] It has been pointed out in earlier papers that, relative to steady-state operation, comparatively high concentrations of dioxins are given off during startups and shutdowns.[2-4] To reduce the amount of dioxins given off by MSW incinerators, it is both important and urgent to reduce the amount of dioxins given off during such intermittent operation. In this study, we explored the potential of continuous operation as a means to reduce dioxin emissions by conducting investigation of (a) dioxin generation during startup and shutdown at a facility normally operated intermittently (8 h/d) and (b) dioxin generation at the same facility during continuous operation.

Experimental Method

The equipment flow for the facility is shown in Fig. 1. The plant is equipped with stoker furnaces (each having a processing capacity of 2 t/h), water-spray gas cooling equipment, slaked lime injection for HCl removal, and a bag house. Normally, the plant is operated intermittently eight hours per day, five days per week (dormant on weekends). We first sampled the flue gas under normal intermittent operation over a five day period from Monday to Friday during three time periods -- startup (8:30 - 11:00), steady-state operation (11:00 - 16:30), and shutdown/late-night dormancy (16:30 - 8:30). Then, beginning the next Monday, we took flue gas samples three times while operating the incinerator continuously (with a temporarily connected automatic combustion control device) from Monday to Friday. We next compared the two sets of

measurements.

Results and Discussion

Gas temperature and CO, O_2 record during both operating modes is shown in Fig.2. Dioxin concentrations (I-TEQ) measured in each of the periods are shown in Table.1. The five-day mean values for each time period are 25.51 ng-TEQ/m^{3}N for startup, 27.58 ng-TEQ/m^{3}N for steady-state operation, and 63.46 ng-TEQ/m^{3}N for shutdown/late-night dormancy. It had been expected that the dioxin content would be higher during startup and shutdown because of unstable combustion at those times. However, the use of auxiliary burners[3] rapidly brought up the temperature in the furnace; and, as a result, the dioxin concentration during startup remained at the same level as that during steady-state operation. The dioxin concentration during the shutdown/late-night dormancy period was considerably higher than that during steady-state operation despite the implementation of burn-out shutdown method.

The mean measurements for dioxin concentration during the three time periods under continuous operation were 2.3 ng-TEQ/m^{3}N, 1.7 ng-TEQ/m^{3}N, and 3.2 ng-TEQ/m^{3}N, respectively. These values are much lower than that for the steady-state period under intermittent operation. This is thought to be because (a) combustion becomes increasingly more stable with longer continuous operation times and (b) the adverse influence[2,4] of the shutdown and startup time periods becomes progressively weaker.

Fig. 3 shows a comparison of daily results under intermittent operation; Fig. 4, a comparison of mean values under intermittent operation and dioxin generation under continuous operation.

The comparison of daily values (Fig. 3) reveals a high value of 486 μg/t for Monday. The concentration is especially high during startup. This is presumably due to the fact that the startup occurred after two day period of dormancy – with little heat remaining in the incinerator, much time would be required for combustion to stabilize.

Next we compared mean values for dioxin emissions in flue gas per ton of waste taken during both operating modes. (Fig. 4). (Data taken during intermittent operation was used as a proxy for dioxin emission levels during startup and shutdown in continuous operation.) The mean dioxin concentration during intermittent operation was 322 μg/t. Of this, nearly 40% was produced during startup and shutdown; the remainder was from steady-state operation. Because, together with other benefits, continuous operation reduces the frequency of startups and shutdowns, its use in this case (i.e., continuous 5-day operation) enabled the startup/shutdown concentrations to be lowered to about 1/7th of previous levels.

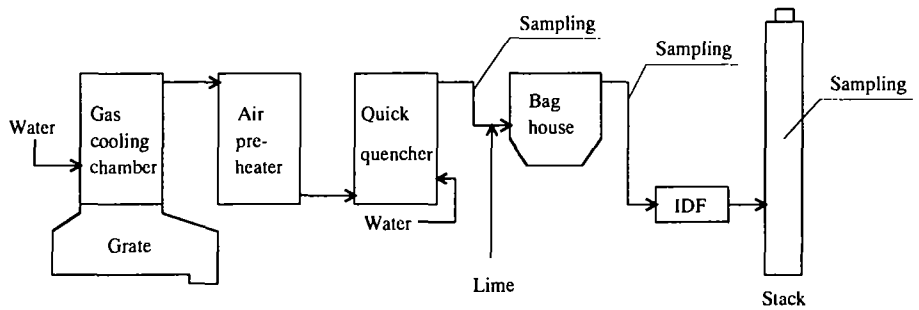
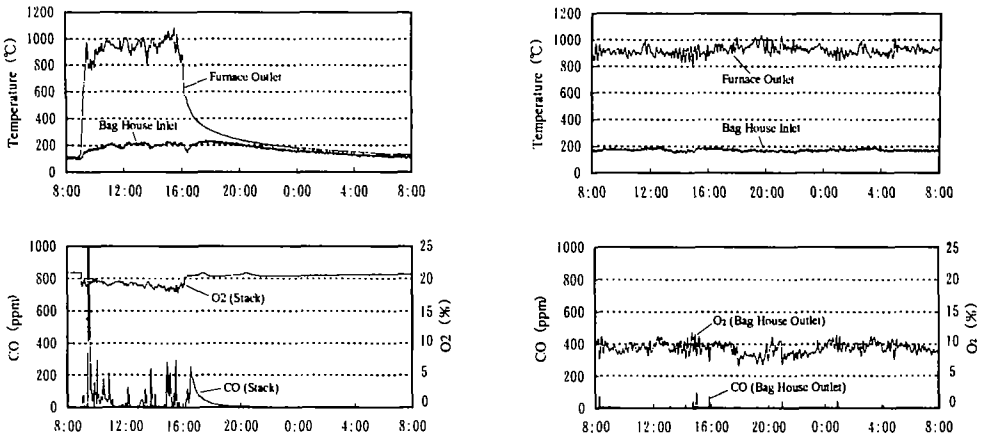


Fig.1 Flow Sheet



(Intermittent Operation) (Continuous Operation)

Fig.2 Gas Temperature and CO, O2 Record

Even in steady-state operation, the use of an automatic combustion controller, the curtailment of startup/shutdown memory effects [5] by extended operation, and other beneficial actions lowered the dioxin concentration in the flue gas down to about 1/11th of previous levels. Total dioxin emissions for continuous operation were 29 μg/t, which demonstrates that the emission of dioxins in the flue gas can be reduced by about 9/10ths by operating the incinerator continuously. While continuous operation was only carried out for five days in this investigation, continuous operation over longer periods has the potential of bringing about a further reduction in dioxin emissions.

Conclusion

We confirmed in this investigation that dioxin levels in the flue gas can be reduced by about 9/10ths by operating an intermittent incinerator in a continuous manner. These results will provide one more data point in the formulation of japan's new guidelines for dioxin control in incineration plant based on the fundamental premise that intermittent operation should be forsaken in favor of continuous operation.

Literature Cited

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Table.1 PCDDs, PCDFs in flue gas (brackets: 12% O_2 corrected data)

Intermittent Operation

	Monday	Tuesday	Wednesday	Thursday	Friday	Average
< Startup : 2.5h >						
CO [ppm]	199 (303)	113 (236)	143 (242)	122 (187)	224 (430)	134 (280)
Dioxins [ng-TEQ/m ^{3} N]	35.04 (53.40)	11.37 (23.82)	7.02 (11.87)	18.31 (28.04)	5.41 (10.41)	15.43 (25.51)
< Steady-state Operation : 5.5h >						
CO [ppm]	67 (101)	36 (68)	31 (56)	51 (94)	62 (99)	49 (84)
Dioxins [ng-TEQ/m ^{3} N]	22.00 (33.43)	13.98 (26.20)	10.94 (19.51)	15.54 (28.72)	18.81 (30.04)	16.25 (27.58)
< Shutdown / Late-night : 16h >						
CO [ppm]	18 (131)	11 (95)	17 (151)	25 (222)	16 (147)	17 (149)
Dioxins [ng-TEQ/m ^{3} N]	7.92 (59.39)	5.23 (47.07)	6.55 (58.93)	10.40 (93.57)	6.48 (58.32)	7.31 (63.46)

Continuous Operation

	Sampling1	Sampling2	Sampling3
CO [ppm]	9 (7)	7 (6)	6 (5)
Dioxins [ng-TEQ/m ^{3} N]	2.88 (2.30)	1.88 (1.69)	3.47 (3.16)

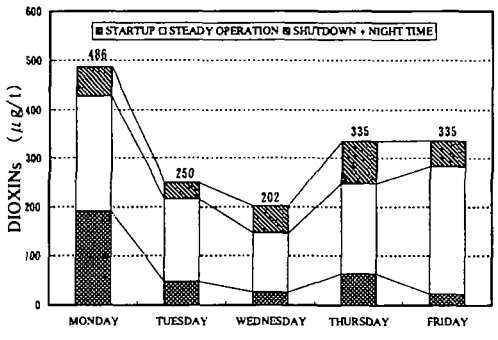

Fig.3 Dioxins Emissions on Intermittent Operation

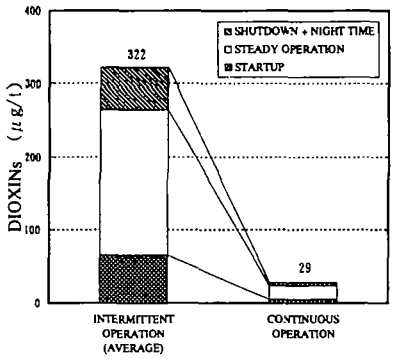

Fig.4 Reduction of dioxins Emissions