PCDD/FS IN AMBIENT AIR DURING THE FONPAU FESTIVAL 2001

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Introduction

The report of dioxin and furan inventories by the UNEP points out that the present number of national PCDD/Fs emission inventories is very small. The major sectors of PCDD/Fs release into the air have been identified. Nevertheless, PCDD/Fs sources may exist which have not been identified[1]. As part of our effort to estimate the Taiwan dioxin and furan inventory, we desired to measure the PCDD/Fs concentrations in the ambient air during the FonPau festival in order to investigate whether the proliferation of firecrackers might produce a measurable increase in PCDD/Fs emissions.

The origin of the FonPau festival could be traced to back the summertime about 180 years ago. A plague was prevailing in a small rural town, Salt-Water town, in the southern Taiwan. The number of victims increased as time went on. The use of medicine did not relieve the town of the plague. The divination foretold that a parade around the town led by the general Kuan Yu, the China's God of War, from the local shrine accompanied by letting off firecrackers during the night of Lantern Festival (on the 15th day of the First Moon on the Chinese lunar calendar) would stop the plague. The plague was indeed being stopped. Ever since the event has been celebrated. That's how the FonPau festival came. A FonPau consisted of three hundred thousand firecrackers and assembled into a 12-meter height and 76-meter surroundings beehive has been letting off. An enormous amount of smoke and dust were generated. The irritating smell of sulfur was prevalent.

Dyke and James[2] have conducted a similar study of measuring dioxins in ambient air before, during and after "bonfire night" 1994 in England. They have observed that bonfire and firework display gave an indication of possible changes in ambient level of dioxins.

Methods and Materials

Salt-Water town is a small town located 15-km from the seashore. There are two industrial parks located at 2-km and 15-km south of the town, respectively. The northern wind was prevalent during the winter. The measurements were conducted during the period 5-7 February 2001. We followed the US EPA Compendium Method TO-9A "Determination of Polychlorinated, Polychorinated and Brominated/Chlorinated Dibenzo-*p*-dioxins and Dibenzofurans in Ambient Air" for sampling and analysis. Three sampling sites (A, B, and C) were in the town. They were 1-km apart from each. The fourth sampling site (D) located at 2.5-km southeastern from the town (Figure 1). The samples were taken using the Graseby-Anderson PS-1 with a glass fiber filter followed by a polyurethane foam (PUF) plug. The PS-1 was located on the roof of a two-story building. The four samples were simultaneously taken over three periods to cover the time before, during and after the peak letting off of firecrackers.

The samples were extracted in 300 ml toluene for 24 hours followed by rotary evaporation and multi-step multi-column clean-up procedure. HRGC/HRMS analyses were carried out at a 10,000 mass resolution on a VG AutoSpec Ultima coupled to a HP 6890 GC system using a 60-m DB5-MS column.

Results and Discussion

Sampling information and analytical results expressed in pg-TEQ/Nm^3 for each sample using International Toxic Equivalent Factors (I-TEF) are shown in Table 1. The sampling site is a rural town. The dioxin concentrations found during the "before" (0.162 ~ 0.189 pg-TEQ/Nm^3) and "after" (0.141~0.249 pg-TEQ/Nm^3) period are higher than those reported for the urban location[3] (~ 100 pg-TEQ/Nm^3). The possible PCDD/F sources might come from the near-by industrial parks. The dioxin concentrations for each sampling site shown in Figure 2 indicate that the concentrations found "during" the festival period were lower. The meteorological conditions of an increasing wind speed during the festival (4.4 m/s compared to the 1.8 m/s before and 2.2m/s after) may cause the lower dioxin concentrations. The dioxin concentrations on sampling sites C and D, which were located down-wind of the festival site, are higher than those found on sampling sites A and B. The presence of large amounts of sulfur-containing compounds generated by the firecrackers in the air might be a less likely cause. Certain sulfur-containing compounds were reported to inhibit the formation of dioxins[4].

The graphical representation of the measured data shown in Figures 3 and 4 is expressed as the TEQ fractions of each congener compared to the sum of the 17 toxic congeners. The number 1 ~ 17 on the x-axis represents the 2,3,7,8-TeCDF, 1,2,3,7,8-PeCDF, 2,3,4,7,8-PeCDF, 1,2,3,4,7,8-HxCDF, 1,2,3,6,7,8-HxCDF, 2,3,4,6,7,8-HxCDF, 1,2,3,7,8,9-HxCDF, 1,2,3,4,6,7,8-HpCDF, 1,2,3,4,7,8,9-HpCDF, OCDF, 2,3,7,8-TeCDD, 1,2,3,7,8-PeCDD, 1,2,3,4,7,8-HxCDD, 1,2,3,6,7,8-HxCDD, 1,2,3,7,8,9-HxCDD, 1,2,3,4,6,7,8-HpCDD, and OCDD, respectively. The pattern is dominated by the penta-chlorinated dioxins. The furans are lower. Figure 3 compares the data by sampling period. The fraction of 2,3,4,7,8-PeCDF has increased from about 30 % (before the festival) to about 35 % (during and after the festival). The fraction of 2,3,7,8-TCDD increased to about 9 %only during the festival, comparing to the about 3 % before and after the festival. Figure 4 compares the data by sampling site and shows similar phenomena. The patterns, found during and after the festival on sampling site A, B, and C, are similar to the urban air pattern found in Hsinchu city, except an elevated level of 23,7,8-TCDD. In conclusion, the result gives an indication of possible increase of 2,3,7,8-TCDD in ambient levels of dioxins during the FonPau festival. The lower dioxin concentrations measured during the festival was attributed the increasing wind speed.

Acknowledgements

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References

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Table 1. Sampling information and ambient air concentration

2001	Sample Code	A	B	C	D
2/5~2/7 (Before)	Air Volume (Nm^3)	767.1	782.9	786.8	775.0
	Temperature (℃)	24 ± 3	22 ± 2	22 ± 3	20 ± 3
	Relative humidity (%)	68 ± 7	76 ± 3	70 ± 6	73 ± 3
	ΣTEQ (TEQ-pg/Nm^3)	0.175	0.162	0.189	0.170
2/7~2/8 (During)	Air Volume (Nm^3)	378.4	376.0	381.0	392.2
	Temperature (℃)	24 ± 2	22 ± 2	23 ± 2	20 ± 3
	Relative humidity (%)	59 ± 3	67 ± 6	62 ± 2	65 ± 5
	ΣTEQ (TEQ-pg/Nm^3)	0.073	0.079	0.091	0.089
2/8~2/9 (After)	Air Volume (Nm^3)	450.7	439.6	452.3	452.9
	Temperature (℃)	25 ± 2	24 ± 4	24 ± 2	22 ± 3
	Relative humidity (%)	55 ± 1	59 ± 3	57 ± 3	57 ± 3
	ΣTEQ (TEQ-pg/Nm^3)	0.141	0.147	0.156	0.249

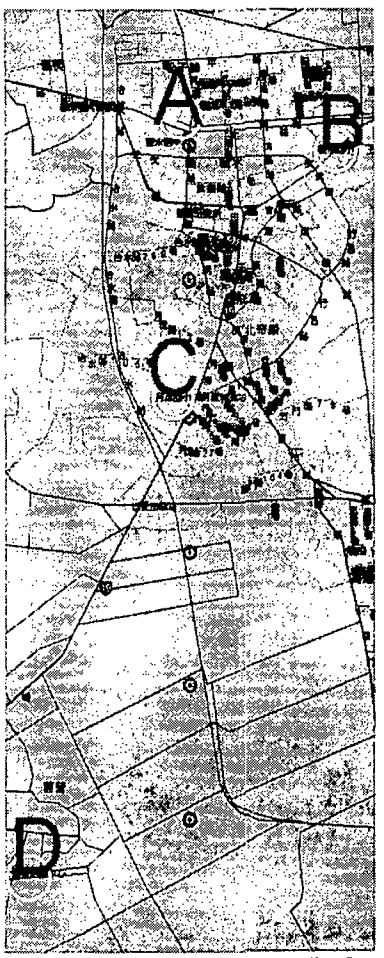

Figure 1. Sampling Sites A, B, C, and D

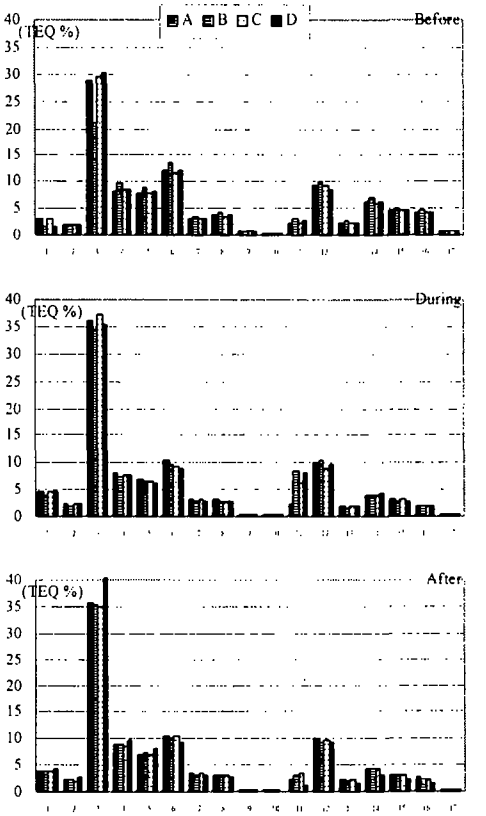

Figure 3. Congener profiles found before, during, and after the FonPau festival 2001 before,during,after celebration in Taiwan

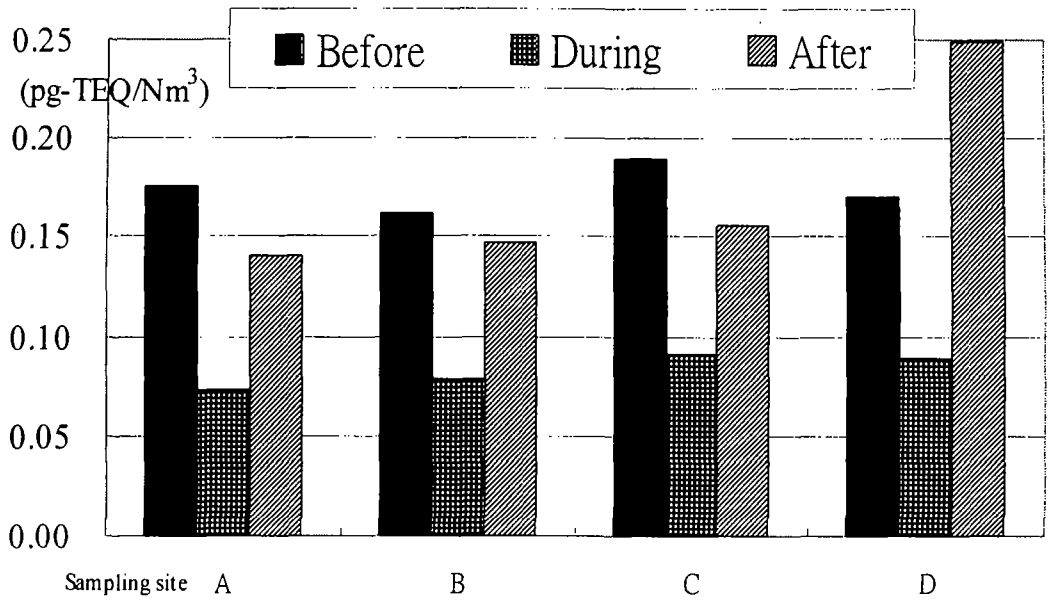

Figure 2. Ambient air concentrations expressed as ΣTEQ found before, during, and after the FonPau festival 2001

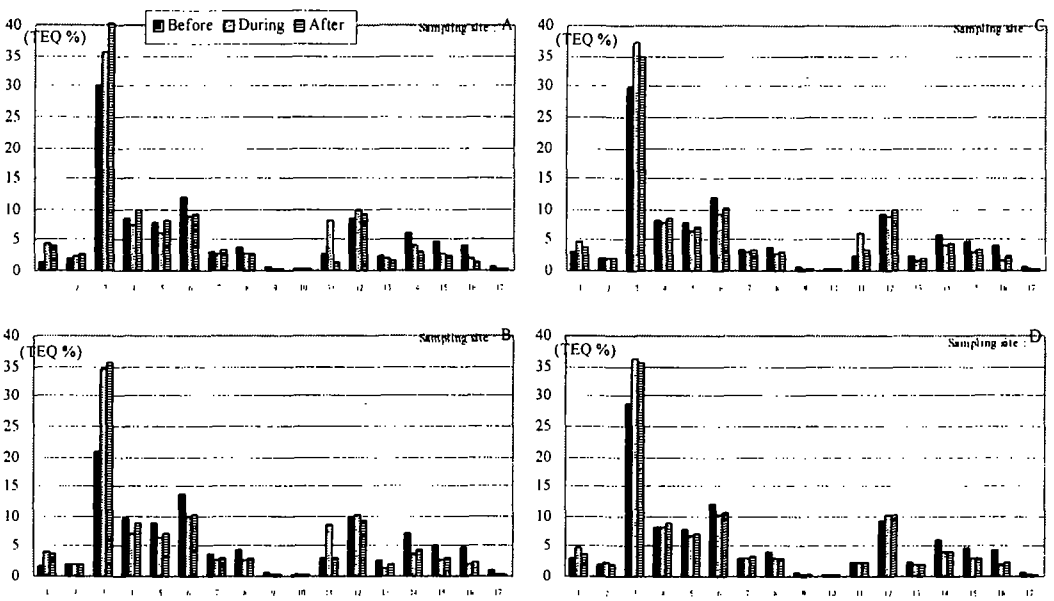

Figure 4. Congener profiles for sampling sites A , B, C, and D