Concentration and Temporal Trends of PCDDs/PCDFs in Ambient Air at an Agent Orange Remediation Site between 2013 and 2017 Using Passive Samplers

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Background/Objective. During the Ranch Hand Operation, US army used about 80 million liters of herbicides to spray in Southern Vietnam. Three heavily-contaminated dioxin hot spots were identified at Da Nang, Bien Hoa and Phu Cat airports. Between 2013 and 2017, approximately 73,000 m^3 of dioxin contaminated soil was treated at Da Nang airport using the in situ/in-pile thermal desorption (ISTD/IPTD) technology. The passive and active high-volume air samplers were used at ISTD/IPTD area to evaluate the concentrations and temporal trends of PCDDs/PCDFs in ambient air. The results of this study are a valuable contribution for validating the use of the passive air sampling (PAS) technique for monitoring air quality.

Approach/Activities. Passive air sampler (PAS) with polyurethane foam (PUF) disk was applied to monitor PCDDs/PCDFs at the three independent sitesaround ISTD/IPTD. The study was carried out between March 2013 and February 2017 with 3-month sampling intervals to monitor the fluctuation and temporal trends of PCDDs/PCDFs contamination in the ambient air. Standards of ^{13}C-labeled PCDDs/PCDFs were spiked onto the PUF disk as surrogates at the beginning of sampling activity. The high volume active air sampler (HVAS) was integrated into this research to compare with the passive sampling technique. The frequency of the active air sampling was once a month. PCDDs/PCDFs were analyzed by high resolution gas chromatography and high-resolution mass spectrometry (HRGC/HRMS) according to the USEPA method 1613B.

Results/Lessons Learned. The passive air samplers were stable in the tropical climate of central Vietnam, and collected reliable and repeatable data on the concentrations of PCDDs/PCDFs in ambient air. The efficiency of ^{13}C-labeled PCDDs/PCDFs surrogate retention range from 20% to 185% across dry and rainy seasons, with no discernible seasonal patterns. Their averages were from 33% to 115%, with RSD of 12% to 69%. Only 3.7% of total surrogates (mostly ^{13}C-123789-HxCDF and ^{13}C-1234789-HpCDF) had efficiency of retention less than 20%.

The concentration of PCDDs/PCDFs in the ambient air depended on the emission sources from the ISTD/IPTD at different operation periods. When excavation and/or remediation activities were undertaken, concentration of PCDDs/PCDFs in the ambient air increased. In contrast, when these activities were not taking place, emissions from source were reduced. The decreasing trend in PCDDs/PCDFs concentrations was identified to be suitable with a third-order polynomial regression. At other sites were impacted indirectly from the ISTD/IPTD, the decreasing trend of PCDDs/PCDFs concentrations agreed with log-linear regression. In general, there was a significant decrease of PCDDs/PCDFs concentrations in the ambient air at all three sampling sites over time.

Linear regression was used to determine the correlation between the concentrations of PCDDs/PCDFs collected by passive and active air samplers. There is a high correlation of PCDDs/PCDFs concentrations (R^2 from 0.63 to 0.87 for total TEQs) determined by the passive and active sampling techniques at all three sites. Therefore, the monitoring PCDDs/PCDFs by passive air sampler is acceptable and comparable with the active air sampler. This passive air sampling technique is suitable to apply in the harsh tropical climate condition in Vietnam.

This research contributes to the global plan for monitoring POPs at sites contaminated with PCDDs/PCDFs from Agent Orange.