Vapor Intrusion and Air Cleaners: A Review of Field Performance Data: Application Selection Methods and Research Needs

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Background/Objectives. In the field of vapor intrusion (VI), air cleaners are commonly used when a temporary reduction of volatile organic compound (VOC) concentrations in indoor air is needed while a longer-term solution is put in place. In these cases, portable air cleaners can be deployed while the longer-term solution is designed, permitted, and constructed. Similarly, these units can be used to reduce indoor air VOC concentrations while possible sources are investigated. To date, little guidance has been provided in respect to selection and sizing of air cleaners for use in VI applications. Air cleaners can be ineffective if not properly selected for the target compounds and/or are improperly sized for building and site-specific conditions.

Approach/Activities. During preparation of an EPA “Engineering Issue” paper a literature survey was conducted to address five aspects of air cleaner use: (1) What research has been conducted on air cleaners that demonstrate their effectiveness? (2) What air cleaners are commercially available, how do they work, and what are the recommended protocols, performance goals, and monitoring for their use? (3) Based on available test results, how effective are commercially available air cleaners at removing or destroying chlorinated VOCs from indoor air? (4) What are the building- and unit (device)-specific factors that influence performance? and (5) How should air cleaners be selected, installed, and maintained?

Results/Lessons Learned. There has been considerable variability in the effectiveness of the practical applications of air cleaners to VI. Most field applications have been to rapid action cases and have relied on rules of thumb rather than computational engineering design approaches. Not all currently marketed air cleaners can be recommended for use. Some of the devices are ineffective or produce excessive ozone. Therefore, the use of sorbent-based (e.g., carbon-based) air cleaners in current applications is preferred. A multitude of factors go in to appropriate selection of sizing of air cleaners. These include: indoor air concentration; treatment space volume, contaminant infiltration rate and subsurface concentration; outdoor air exchange rate and concentrations; flow rate and concentration of indoor sources of contaminants; exchange rate and concentration of air recirculated from an adjacent HVAC zone to the treated zone. Every input will vary over time and these variations can be difficult to predict but equations suitable for initial sizing are presented. However, variations in indoor product use, flux across the slab due to barometric pressure changes/temporal changes in subslab concentrations, changes in operation of HVAC units, and other factors will impact both the effectiveness of treatment and carbon saturation times. Follow-up monitoring is required to confirm that the correct number and size of air cleaners have been installed as well as to monitor breakthrough times. Additional research including alternatives to sorbent-based units, in-duct sorbent testing, quantitative reviews of existing field applications with additional data collection, and field-scale demonstrations would provide useful information to refine air cleaner selection processes.