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Interpreting Vapor-Intrusion Data with Radar Plots

Martin Schmidt (mort_schmidt@coxcolvin.com)
(Cox-Colvin, & Associates, Plain City, OH, USA)

Background/Objectives. Volatile organic compounds (VOCs) may be present in indoor air as a result of vapor intrusion (VI), and from indoor and outdoor sources (i.e., background). Questions about vapor sources can be resolved by using the multiple-lines-of-evidence (MLE) approach, which involves sampling indoor air, outdoor (ambient) air, soilgas, and in many cases, groundwater, from multiple locations over several seasons. The ratios of chemical concentrations are compared to each other, to screening levels, and to the conceptual site model (CSM), to determine if they are consistent with VI, and if so, if VI poses an unacceptable risk.

Unfortunately, the interpretation of VI data can be highly complex. The calculations yield a large, often bewildering array of numbers that are difficult to interpret, for even smaller data sets. This presentation describes the use of radar plots, or “spider graphs”, using Microsoft® Excel or similar spreadsheet applications. The interpretation of data with radar plots is far faster and more intuitive than interpretation using tables of numeric data.

Approach/Activities. Analytical results are placed on a spreadsheet, with columns corresponding to chemicals, and rows corresponding to samples. The data are graphed with the “radar plot” or “spider plot” function. Each chemical corresponds to a “spoke” on the circle, and its concentration corresponds to distance from the center of the circle, plotted on a logarithmic scale. Each polygon represents a different sample, and sample types are distinguished by line color or style. For example, soil gas polygons are one color, indoor air polygons are a second color, and ambient air polygons are a third color. Screening levels can be plotted as well, using yet another color or line type.

The attenuation of sub-slab soil gas as it mixes with indoor air is almost entirely the result of dilution. Consequently, if chemicals in indoor air result from VI, indoor-air polygons will be the same shape as soil-gas polygons, only smaller, and the radial difference between indoor-air and soil-gas peaks is a function of the attenuation factor. Anomalously high indoor-air concentrations for some compounds, relative to soil-gas concentrations, suggest the presence of background sources.

For a particular sample type, e.g., soil gas, variability in polygon size, on a given date, indicates spatial heterogeneity. Variability in polygon size, at a given location, indicates temporal heterogeneity. If indoor-air or soil-gas polygons touch, or nearly touch screening-level polygons, screening levels have been exceeded, or are at risk of being exceeded. If indoor-air or soil-gas polygons are much smaller than screening-level polygons, the VI risk is minimal.

Results/Lessons Learned. The significance of VI data is more obvious when multiple samples are displayed on radar plots, as opposed to reviewing tabular data. In a minimal amount of time, radar plots provide semi-quantitative answers to questions about background sources, attenuation factors, spatial and temporal variability, and VI risk relative to screening levels.