Guidance Note on TPH/TRH in Vapour

In relation to the analysis and interpretation of TPH/TRH vapour data collected from contaminated sites this note has been prepared to clarify two issues that will assist in ensuring that vapour data collected is sufficiently robust and comparable between laboratories.

Analysis, Reporting and Interpretation of TPH/TRH >C_{10}-C_{16}

The Health Screening Levels (HSLs) adopted in the NEPM (Schedule B1) provide screening criteria for TPH/TRH in soil vapour for the fraction grouping >C_{10}-C_{16}. Analytical methods (particularly for whole gas samples collected in canisters), however cannot reliably report TPH/TRH beyond C_{12}. This means that analysis of these samples will typically only report TPH/TRH fraction groups up to C_{12}, with some laboratories reporting the highest group as C_{12}+ (but no fractions higher than C12 specifically presented).

The HSL groupings and aromatic/aliphatic weightings were determined on the basis of the proportion of these fractions in particular Australian petroleum products (petrol/diesel). Analysis (Brewer et. Al. 2012) of the vapour phase above petrol and diesel, however, has indicated that TPH/TRH in the vapour phase is dominated by fractions C_5-C_8, with a lower percentage reported in C_9-C_{12}. In relation to TPH/TRH >C_{12} these were <1% of vapours from petrol and <5% for vapours from diesel. Hence the analysis and reporting of TPH/TRH C_6-C_{10} and >C_{10}-C_{12} will provide an appropriate measure of volatile TPH/TRH fractions from these sources and should be considered acceptable.

Review of the basis for the derivation of the HSL for group >C_{10}-C_{16} (including the weighting factors for aromatic and aliphatic fractions) has indicated that the derived HSL for >C_{10}-C_{16} is consistent with (and slightly more conservative than) a soil vapour guideline which could be derived for >C_{10}-C_{12}. On this basis it is appropriate that TPH/TRH >C_{10}-C_{12} results reported for soil vapour can be directly compared against HSLs published for TPH/TRH >C_{10}-C_{16}. No adjustment of the HSLs is required.

Reporting of TPH/TRH Concentrations

Analysis of TPH/TRH volatile fractions is usually first determined as ppm (or ppmv) or ppb (or ppbv) then converted to a concentration as mg/m^3 or µg/m^3 for comparison with HSLs or use in a site-specific risk assessment.

The conversion of TPH/TRH data from ppmv into mg/m^3 is complicated as the TPH/TRH fractions reported apply to a range of compounds with varying molecular weights. Often a surrogate is specified by the laboratory and the molecular weight of that surrogate compound used when converting between units. The following surrogates are commonly adopted by analytical laboratories for these calculations:

Volatile TPH/TRH grouping reported	Examples of Suitable Molecular Weights and Surrogates (g/mol)
C_6-C_8 aliphatic	100 (n-heptane)
C_6-C_8 aromatic*	92 (toluene)
>C_8-C_{10} aliphatic	128 (n-nonane)
>C_8-C_{10} aromatic	120 (1,3,5-trimethylbenzene/propylbenzene)
>C_{10}-C_{12} aliphatic	170 (n-dodecane)
>C_{10}-C_{12} aromatic	134 (1,2,4,5-tetramethylbenzene)

* Note that in the application of the HSLs individual aromatic C6-C8 compounds, namely benzene, toluene, ethylbenzene and xylenes (BTEX), are subtracted prior to consideration.

The surrogates selected by the laboratory should be reported to ensure transparency in reporting these results.

It is noted that some laboratories may only present the data in ppmv. In this case the above surrogates can be used to calculate an appropriate concentration in mg/m^3.

Assuming a soil gas pressure of 1 atm, the ideal gas equation can be modified to convert a vapour phase concentrations from ppmv to mg/m^3.

$$\textit{Concentration in mg/m}^3 = (\textit{Concentration in ppmv})*(MW)/[(0.08206)*(273.15 + °C)]$$

where
ppmv = ppm by volume (i.e., volume of gaseous concentration per 10^6 volumes of vapour)
mg/m^3 = milligrams of gaseous concentration per cubic metre of vapour
MW = molecular weight of the chemical (g/mol)
°C = vapour temperature in degrees Celsius
0.08206 = universal gas constant (L atm K^{-1} mol^{-1})

Example Calculation

For a vapour sample containing benzene (MW = 78.1 g/mol), convert 20 ppmv to mg/m^3 at 25 °C.

$$\textit{Concentration of benzene in mg/m}^3 = (20*78.1)/[0.08206*(273.15 + 25)] = 63.8$$

References

Brewer R., Bailey L. and Nagashima J., 2012. Field Investigation of the Chemistry and Toxicity of TPH in Petroleum Vapors: Implications for Potential Vapor Intrusion Hazards. Report prepared for the Hawai'i Department of Health, Hazard Evaluation and Emergency Response.

Friebel E. and Nadebaum P., 2011. Health screening levels for petroleum hydrocarbons in soil and groundwater, Parts 1 to 3. CRC CARE Technical Report no. 10, CRC for Contamination Assessment and Remediation of the Environment, Adelaide, Australia.

National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended in 2013.