C25 Released Petroleum Products Containing BTEX—Aerobic or Anaerobic Biodegradation

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The goal of this presentation is to provide a simple method to determine the type of natural attenuation that is occurring in soil or groundwater at a petroleum release site. The information may be helpful for remediation choices.

This presentation will impact the forensic community and/or humanity by demonstrating a new method of analyzing natural attenuation of petroleum releases.

Benzene, toluene, ethylbenzene, and xylenes (BTEX) are found in the petroleum products gasoline, mineral spirits, kerosene, jet fuels, diesel fuel, and home heating oil. In fresh petroleum products, the ratio of the concentration of ethylbenzene to the total concentrations of the three xylene isomers is 0.17 " 0.05. This value can be found in numerous references. The consistency of this ratio makes logical sense because all four of these hydrocarbon chemicals are in the class of C_2 benzenes. They have the same molecular weight and similar vapor pressures, water solubilities and soil adsorption coefficients. Thus, sampling, analytical errors and the fate and transport mechanism differences for ethylbenzene and the xylenes are canceled out by use of the ratio of their respective concentrations in any matrix.

These chemical and physical characteristics allow the relative rates of biodegradation to be measured by the ethylbenzene to xylenes ratio. Anaerobic biodegradation removes xylenes faster than ethylbenzene. This will make the ratio increase as the concentration of the xylenes decreases faster than the ethylbenzene concentration. At most petroleum hydrocarbon release sites, the aerobic biodegradation of the initial release or releases of hydrocarbon make the soil and groundwater anaerobic. Large releases of hydrocarbon will also make the soil and groundwater anaerobic, yet the ratio remains constant at 0.17 " 0.05 due to the large amount of petroleum product at the location of the release.

Groundwater plumes of BTEX will lose toluene first then the ethylbenzene to total xylenes ratio will increase to values approaching one and greater until the xylenes are no longer present. Soils can also show this same type of fate mechanism.

There are sites where the concentration ratio of ethylbenzene to total xylenes is less than 0.12. According to the literature, ethylbenzene is aerobically biodegraded faster than the xylenes. This ratio allows one to map aerobic, anaerobic and LNAPL locations at a petroleum release site using the BTEX data. This may be of value in determining source areas of the release or releases.

A case study will be given to illustrate this concept.

BTEX, Anaerobic, Aerobic

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