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Biodegradation of light-end aliphatic hydrocarbons: Suitable rates for gasoline-type releases

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Gasoline is widely stored and handled and accidental releases potentially lead to elevated concentrations of hydrocarbon compounds in soils and groundwater. Established risk-assessment frameworks and tools are available to enable risk-prediction and to inform management decision that prevent harm to human health and the environment. The use and implementation of these is however complicated, as the complex and variable composition of gasoline means that numerous constituents of potential concern (COPC) will be present.

Historically, bulk total petroleum hydrocarbons (TPH) analysis was used to assess the severity of impact. However, this approach is widely accepted in the scientific community as inappropriate as it does not give a useful basis for the evaluation of potential risks to human health or the environment. Instead, derivation of specific COPCs based on potential exposure and chemio-toxicological characteristics is recommended. For gasoline-type releases these COPCs are commonly individual compounds such as benzene or aromatic / aliphatic TPH fractions based on equivalent carbon ranges such as the TPH Criteria Working Group (CWG) approach.

The fate of hydrocarbons in the sub-surface is largely dependent on their natural attenuation properties and as such, biodegradation rate is a key property in groundwater risk-assessment. Biodegradation rates for individual aromatic COPCs (e.g., benzene, naphthalene) are widely available as these generally are more soluble and toxic. In contrast there are no established biodegradation rates for light-end aliphatic compounds and / or fractional groups. Risk-assessments of aliphatic COPCs are commonly based on the use of either aromatic biodegradation rates or theoretical / predicted values. This can lead inaccurate risk estimation and to unnecessary risk-management actions.

This paper describes results from a research project to determine empirical aqueous biodegradation rates for light-end aliphatic TPH CWG fractions. Bespoke biodegradation laboratory experiments are used to determine biodegradation rates. These experiments have been based on internationally recognised OECD test methods and include both positive (toluene and pentane) and sterile controls. Preliminary results suggest that aqueous biodegradation rates that are commonly used for light-end aliphatic fractions are inaccurate, and may lead to overly conservative risk-assessments and the potential for unnecessary and unsustainable remedial activities. It is recommended that results presented in this paper are used in future groundwater risk-assessments for light-end aliphatic fractions.