D34 Let's Leave the Junk in the Junk Yard

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After attending this presentation, attendees will be able to recognize that junk science exists in environmental forensic science and where it is often found.

This presentation will impact the forensic science community by increasing awareness of the fact that age-dating contaminant releases is often misused in environmental forensic science and some of the common misunderstandings that often turn into junk science.

One of the first questions often asked in environmental litigation concerning the release of a contaminant into the environment is, When was it released? The answer to this question is important in determining responsibility and liability for the release, particularly when there was a series of owners or operators of the facility. Determining when a contaminant was released is often referred to as "age-dating." The literature contains numerous proposed procedures for estimating the timing of a release. Too often these procedures are used by so-called "experts" as a stand-alone magic formula to age-date the release and they ignore the science behind the procedure.

A case in point is estimating the age of the released gasoline product samples using the toluene-to-n-octane (T8) ratio technique by Schmidt, et al.[1] The T8 procedure is based on the increasing enrichment of aromatics in gasoline in the 1970s and the reduction of n-alkanes in gasoline beginning in the 1980s. Schmidt, et al. examined gas chromatograms of 130 regular and mid-grade gasolines produced between 1973 and 2001 and graphed the T8 ratios versus the year of production. The T8 ratios fell into three groups: T8 less than 5 was the 1973 to 1983 group, T8 between 5 and 10 was the 1984 and 1993 group, and T8 greater than 10 was the 1984 to 2001 group. In one recent case involving gasoline contamination from an underground storage tank, the consultant said the gasoline was released between 1994 and 1993 based on the T8 ratio; however, the consultant used the results from a groundwater sample collected from a monitoring well. In doing so, the consultant ignored basic chemistry, including solubilities and Raoult's Law in comparing groundwater results to that of dispensed gasoline. The equilibrium solubility of toluene in water is more than 700 times greater than that of n-octane at 20oC. This is akin to the idiom "comparing apples to oranges." In addition, the consultant also ignored the effect of biodegradation, volatilization from the groundwater, and transport (including sorption and retardation) differences that will create changes in the ratio between toluene and n-octane dissolved in groundwater, all of which will change the T8 ratio. This consultant's methodology was just junk science.

Another commonly misrepresented age-dating method is the Christensen and Larsen Age-Dating Model for diesel fuels.[2] The Christensen and Larsen model is based on the assumption that n-heptadecane (n-C17) aerobically biodegrades in the environment at a constant and uniform rate while pristane (2,6,10,14-tetramethylpentadecane or Pr) is resistant to biodegradation. Christensen and Larsen reported a linear relationship when the n-C17/Pr ratio is plotted against the known age of diesel spills from 12 sites in Holland and Denmark over a 20-year period. In order for this model to work, the biodegradation of n-C17 must be aerobic, uniform, and consistent over time. Christensen and Larsen placed a number of caveats on the use of the model and many aspects of the method are still raising a large caution flag over its use; however, many "experts" ignore the caution flag and just plug numbers into equations based on the Christensen and Larsen Model to age-date petroleum releases.[3] This happened in a recent case where a consultant tried to age-date a release of No. 6 fuel oil. The consultant ignored the fact that the physical properties of No. 6 fuel oil are different from diesel fuel and what effect these differences have on aerobic biodegradation. Christensen's and Larsen's caveats were ignored. The consultant also used a sample containing more than 30% No. 6 fuel oil for the age-dating. At this concentration, there is free-phase oil present, which inhibits microbial action. With free-phase product present, there is less aerobic biodegradation on the interior of the product than on the surface. Thus, the biodegradation of the No. 6 fuel oil was not constant and uniform as required by the model. The age-date calculated by the consultant was nothing more than junk science.

References:

1. Schmidt, G.W., D.D. Beckmann and B. E Torkelson, "A Technique for Estimating the Age of Regular/Mid-grade Gasolines Related to the Subsurface Since the Early 1970's," *Environmental Forensics*, Vol. 3, pp. 145-162, 2002.
2. Christensen, Lars Bo, and Thomas Hauerberg Larsen, "Method for Determining the Age of Diesel Oil Spills in the Soil," *Ground Water Monitoring & Remediation*, Vol. 13, No. 4, pp. 142-149, Fall 1993.
3. Smith, James S., Leslie Eng, and Denise A. Shepperd, "Age-Dating Oil: Is Christensen and Larsen Applicable?," *The Chemist*, Vol. 78, No. 1, pp. 9-13, March/April 2001.

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