Screening Methods for Petroleum Hydrocarbons in Drilling Wastes

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Introduction

Alberta's drilling waste disposal G-50 guidelines (AEUB, 1996) are currently being revised. After disposal, receiving soil parameters must fall within risk-based end-points. The end-points for petroleum hydrocarbons (PHCs) are those developed in the Canada-wide standard method for PHCs, recently introduced by the Canadian Council of Ministers of the Environment (CCME, 2001).

Using spiked standard soils, Enviro-Test Laboratories (ETL) participated in a validation study of the CCME method for PHCs, which is a lengthy procedure. In addition, we compared recoveries of PHC fractions extracted from 200 real-world oil-contaminated soils by the 16 h Soxhlet and 2 h Soxtec procedures. We also researched a screening method for total extractable hydrocarbons (TEHs), with the aim of finding a procedure suitable for rapid screening of drilling waste samples.

Materials and Methods

Suitable quantities (15 kg) of surface and sub-surface soils were obtained and air-dried, milled and sieved (2 mm), thus obtaining well-homogenized materials. Particle size and organic matter data indicated that the soils largely conformed to CCME specifications for validation testing.

Following CCME directives, soils were spiked with aliquots of diesel solutions supplying known quantities of petroleum hydrocarbons in the F2 and F3 PHC fractions. A solution of engine oil was used to spike samples with known amounts of F4 PHCs. Tests were replicated seven times. The following extraction procedures were compared:

- full-blown CCME procedure using Soxhlet extraction (16 h)
- Soxtec™ extraction (2 h)
- Wrist-action shaker at room temperature ("cold-shake")
- End-over-end tumbling
- Sonic bath

In a separate, in-house study approximately 200 real-world soil samples containing total PHC concentrations ranging from zero to 20,000 mg/kg were retrieved from storage at ETL and analyzed for F2, F3 and F4 hydrocarbons by both the Soxhlet and Soxtec procedures.

Drilling Wastes

We also experimented with two gel-chem wastes supplied by a client from the oil and gas sector. The wet wastes were spiked then analyzed for TEH using the CCME procedure, and the cold-shake method with either hexane alone, or a hexane-acetone mixture.

Results and Discussion

For F2 PHCs, all soil-extraction techniques except the sonic bath method recovered the added spike in equivalent quantity, within experimental error. However, for the F3 and especially the F4 PHC fraction, only the Soxtec method consistently gave 100 %

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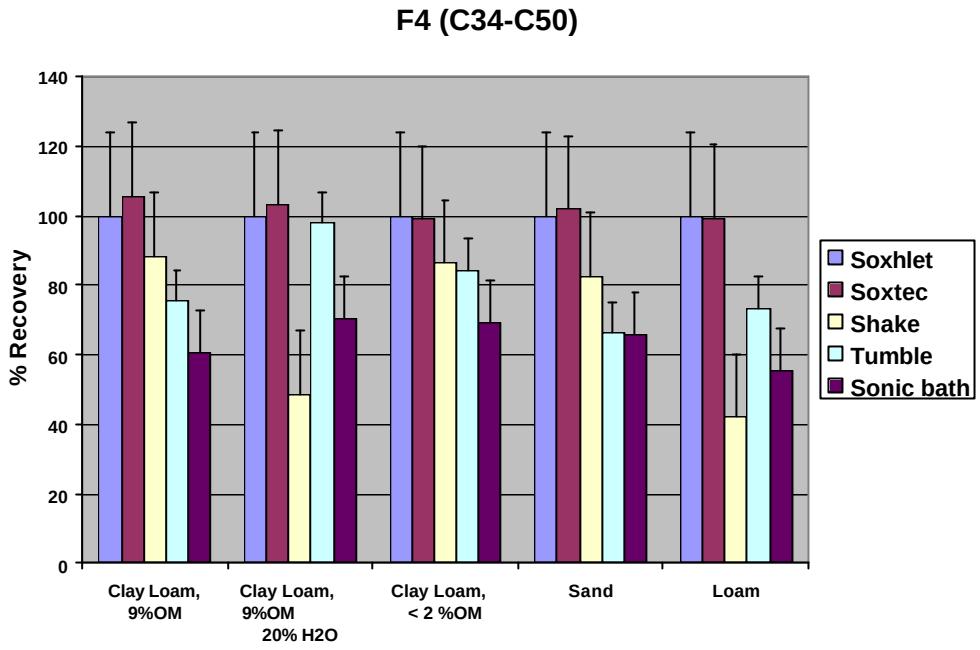
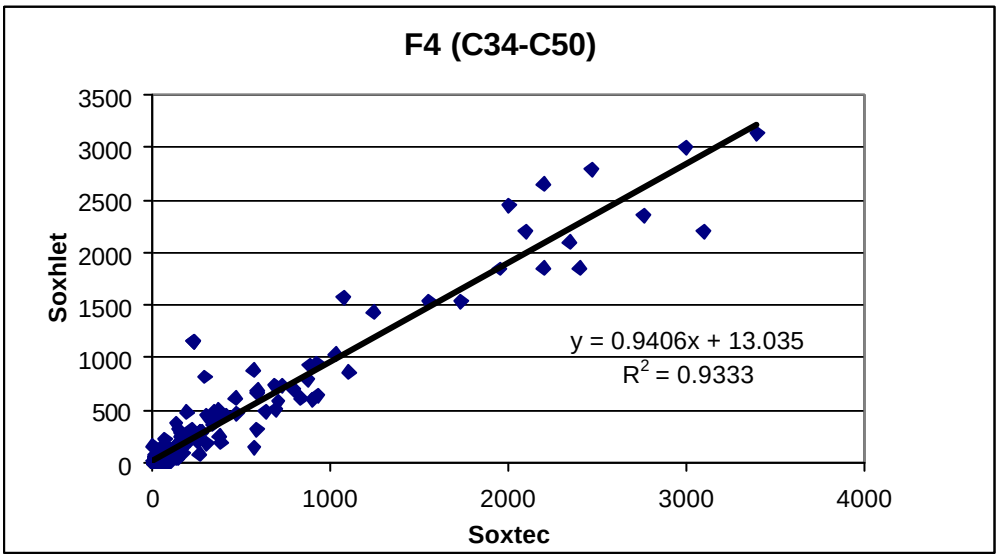


recovery, relative to the CCME Soxhlet procedure. The error bars (Fig. 1) indicate 2 standard deviations. Incomplete recoveries may have been caused by partition of PHCs into soil organic matter. Clay minerals may also have been responsible for some PHC sequestration. However, it should be noted that several extraction methods gave low F4 recoveries even from a sandy soil low in organic matter. The effects of moistening the clay loam sample were inconsistent.

In-house PHC extraction comparison. For our 200 real-world soils, we found a close and essentially 1:1 relationship between amounts of F4 hydrocarbons extracted by either Soxhlet or Soxtec apparatus (Fig. 2). Similar results were obtained for the F2 and F3 hydrocarbon fractions (graphs not shown for reasons of space).



Drilling Waste Analysis. For the two drilling waste samples, recovery of the added spike (relative to the CCME Soxhlet method) was consistently near 100 % using the cold-shake

procedure, with hexane as the solvent (data not shown). However, including acetone reduced TEH recovery, perhaps because of interference from water in the waste samples.

Conclusions

For rapid screening purposes, the "cold-shake" procedure can be used to quantify TEHs in drilling wastes, with hexane as the solvent. Sequestration of PHCs was more apparent with soils than with drilling wastes. Therefore, soils will probably need the full CCME procedure. However, extraction can be done in 2 h using a Soxtec apparatus, giving recoveries equivalent to 16 h Soxhlet extraction.

Acknowledgement

We thank Lloyd Hodgins (ETL, Calgary) for regression analysis on the real-world soil hydrocarbons extraction data (Fig. 2).

References

AEUB (1996) Drilling Waste Management. Guide 50. Alberta Energy and Utilities Board, Calgary, Alberta.

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